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EXECUTIVE SUMMARY

Hydroelectric power generation potentially can result in the entrainment and subsequent mortality of fish due to rapidly changing pressures during passage through penstocks and powerhouses or to physical trauma caused by turbine passage. The CAWG 9 study objective is to characterize entrainment mortality at power diversions in the Big Creek Hydroelectric system (Project) (SCE 2001a).

To meet this objective, a three tiered study approach was implemented. The first step of the tiered study approach was to review scientific literature addressing potential turbine mortality associated with turbine-types used at Big Creek power generation facilities. This review 1) assessed fish vulnerability to entrainment at intakes by species and life history stage, and 2) reviewed turbine mortality for turbine types similar to those in use in the Big Creek system.

The second step in the study approach was to conduct an initial evaluation of the potential for entrainment and mortality at major Project intakes, including intakes in the major and medium sized impoundments. The evaluation was based on power intake design, location, depth, water velocities, and relative abundance of potentially vulnerable fish near the intakes. Information on the abundance of fish in the vicinity of intakes at the major ALP Project reservoirs was determined from fish sampling data and hydroacoustic data collected as part of the CAWG 7 Fish Study Report (SCE 2003a).

The vulnerability of fish to entrainment was prioritized by intake and waterbody. This initial evaluation focused on intakes in large reservoirs that may entrain fish directly to powerhouses and result in turbine passage, the primary source of entrainment mortality. A summary of factors affecting potential turbine mortality by location, as well as fish species potentially present, is presented in Table CAWG 9 ES-1. The potential for entrainment at smaller diversions also was evaluated based on characteristics such as intake design, velocities, and presence of potentially vulnerable fish.

The third step in the study approach was to select locations for sampling with concurrence of the CAWG and then document actual entrainment rates at intakes most likely to result in significant fish entrainment and potential mortality. Powerhouse tailraces were sampled in 2003 and 2004 using fish netting. The tailraces at Big Creek Powerhouse 1, Big Creek Powerhouse 2A, Eastwood Power Station, and Mammoth Pool Powerhouse were sampled as part of the study. Other intakes in the “Big Creek chain” that re-entrain water originating from the reservoirs, such as the intakes at Powerhouse 2 Forebay (Dam 4), Powerhouse 8 Forebay (Dam 5), and Powerhouse 3 Forebay (Dam 6) were not selected for sampling. Relative numbers of previously unentrained fish available to entrainment is low at these medium-sized impoundments because most flow originates from upstream powerhouse tailraces (Table CAWG 9 ES-1).

No fish were captured during the tailrace sampling at the selected tailrace sampling sites. The low densities of fish observed near the powerhouse intakes, and the lack of fish encountered as part of the tailrace sampling surveys suggest that the potential for entrainment at the Big Creek ALP Project powerhouses is generally low.

Small diversion entrainment sampling occurred at Balsam and Rock Creek diversions. This was accomplished by means of a trap net placed immediately upstream of the diversion pools during near-peak (spring) and early summer run-off events. Three fish were collected, a brown trout and a rainbow trout in Rock creek and a rainbow trout in Balsam Creek. The fish were alive and in good condition. The low densities of fish moving downstream into the diversion pools and the low velocities near the diversion intakes suggest that the potential for entrainment at the small diversions also is low.

1.0 INTRODUCTION

Hydroelectric power generation potentially can result in the entrainment and subsequent mortality or injury of fish due to rapidly changing pressures in the hydraulic systems of penstocks and powerhouses or to physical trauma caused by turbine passage. The principal objective of the CAWG 9 study is to characterize entrainment mortality at power diversions (SCE 2001a). To meet this objective, the following general approach was implemented:

1. **Literature Review:** Review appropriate scientific literature addressing potential turbine mortality associated with turbine-types used at Big Creek power generation facilities.

2. **Initial Evaluation of Vulnerability to Entrainment:** Evaluate the potential for entrainment mortality based on power intake design, location, depth, velocities, and presence of potentially vulnerable fish.

3. **Sampling and Evaluation of Selected Intakes:** Evaluate entrainment rates at power intakes identified as having a higher potential for significant fish mortality using hydroacoustics at intakes, fish netting at powerhouse tailraces, or other appropriate techniques.

2.0 STUDY IMPLEMENTATION AND STATUS

The status of each of the elements of the CAWG 9 Study Plan (SCE 2001) is as follows:

Study Element	Status
1. Review appropriate scientific literature addressing potential turbine mortality associated with turbine-types used at Big Creek power generation facilities.	Study element completed.
2. Evaluate the potential for entrainment mortality based on power intake design, location, depth, velocities, and presence of potentially vulnerable fish.	Study element completed.
3. Evaluate entrainment rates at power intakes identified as having a potential for significant fish mortality using hydroacoustics at intakes, fish netting at powerhouse tailraces, or other appropriate techniques.	Study element completed.

3.0 METHODS

3.1 GENERAL APPROACH AND STUDY AREA

The CAWG 9 study elements were implemented in a three tiered process as follows:

1. **Literature Review:** A review of scientific literature was conducted to: 1) assess fish vulnerability to entrainment at intakes by species and life history stage, and 2) review turbine mortality for turbine types similar to those in use in the Big Creek system. The results of this review are presented in Section 4 of this report.

2. **Initial Evaluation of Vulnerability to Entrainment:** Using information from the literature review and information available for the Big Creek system, the potential for entrainment at all major Big Creek intakes was evaluated. Waterbodies and associated powerhouses were prioritized with respect to the vulnerability of fish to entrainment. The results of this evaluation were presented to the CAWG and are presented in Section 5 of this report. The evaluation focused on intakes in large reservoirs that may entrain fish and result in turbine passage, the primary source of entrainment mortality. The potential for entrainment at smaller diversions, which may result in fish relocation or potential turbine passage, also was evaluated.

3. **Sampling and Entrainment Evaluation at Selected Intakes:** In consultation with the CAWG, high-priority powerhouse intake locations were identified and a sampling program was implemented for these locations. Results are presented in Section 5.

Project facilities in the Big Creek Hydroelectric System are shown in Map CAWG 9-1. A schematic profile of the Big Creek system is presented in Figure CAWG 9-1. In the initial evaluation, the potential for entrainment was evaluated at major Project intakes and operating small diversions that are part of the Big Creek ALP. Major impoundments (and their intakes) include Florence Lake (Ward tunnel intake), Huntington Lake (Tunnels 1 and 7 intakes), Shaver Lake (Powerhouse 2A intake), and Mammoth Pool (Mammoth Pool Powerhouse intake). Medium-sized impoundments include Balsam Meadow Forebay (Eastwood Power Station intake), Powerhouse 2 Forebay (Powerhouse 2 intake), Powerhouse 8 Forebay (Powerhouse 8 intake), and Powerhouse 3 Forebay (Powerhouse 3 intake).

3.2 METHODS

3.2.1 LITERATURE REVIEW AND INITIAL EVALUATION OF VULNERABILITY TO ENTRAINMENT

In order to evaluate the vulnerability of fish to entrainment, we needed to compare the swimming capabilities of the fish species and lifestages present with the velocities they could be exposed to at the intakes being evaluated. The scientific literature was reviewed to identify swimming speed for fish species and life history stages potentially vulnerable to Project intakes. The life stages of target fish species identified from fish sampling programs (SCE 2003a) and found to occur near Project intakes were the focus of the literature search. Fish species present in the Project area, and their status, are listed in Table CAWG 9-1.

The literature review also focused on previous studies of turbine mortality conducted for hydroelectric units employing turbine types similar to those in use in the Big Creek system at similar levels of head. For each powerhouse, we tabulated the turbine type and head and summarized available turbine mortality information from the scientific literature.

Vulnerability to entrainment was assessed based on two sets of information: 1) data on the design of the intake (including small diversions) and physical conditions in the intake vicinity; and 2) data on fish vulnerability and their use of the area near the intake face. Information about fish vulnerability to Project intakes was drawn from a review of pertinent scientific literature (see Section 4) and field measurements.

Information about the design of the intakes was obtained from a review of design drawings (see CAWG 9 Appendix A). The intake and diversion designs were reviewed for the depth and surface area of the intake, the exclusion capability of any screens present, and the presence of potential escape routes for fish. Data also were compiled concerning intake capacities, locations, and records of operations and flows drawn through the intakes. Approach velocities to the intakes were calculated from operation records and drawings for typical, high, and low flow conditions (median, 20 and 80 percent exceedance flows based on USGS gaging records). Where necessary, flow velocities near the intake faces were verified by *in situ* measurements. For small diversions, velocity measurements were made at a representative subset of the diversions twice during the runoff period to verify velocities at different flows.

Field data were collected to evaluate the presence of fish near the Project intake structures, in coordination with the CAWG 7 fish population sampling program (SCE 2003a). Hydroacoustic surveys were conducted to characterize the abundance and distribution of fish near major intakes in the larger Project reservoirs, including Shaver Lake, Huntington Lake, Florence Lake, and Mammoth Pool Reservoir (SCE 2003a). This characterization included both quantitative vertical and horizontal distributions of fish in relationship to intake locations and the elevations of project intakes. The ability to sample Florence Lake was limited during fall because of low lake level[1].

As part of the CAWG 7 fish characterization studies (SCE 2003a), gill nets set near intakes were used to characterize the species and life history stages of fish present. Gill nets and minnow traps set at various locations in Project impoundments collected data used to characterize the fish species and life stages present.

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[1] The Ward Tunnel intake in Florence Lake was not submerged within the lake in the late fall. There was very little flow from the South Fork San Joaquin River upstream and the residual lake was located well upstream of the intake. Flow to the intake during October is through a shallow, slow moving stream and must pass over a weir to reach the intake (Figure CAWG 9 Appendix A-3).

3.2.1.1 Small Diversions

The small diversions were reviewed and classified by elevation, stream, type of diversion, fish present and volume diverted. Photographs and drawings of diversions are presented in CAWG 9 Appendix A (specific diversion photographs and drawings are discussed in Section 5.1.2 of this report).

3.2.1.2 Reservoirs and Associated Powerhouses

The vulnerability of fish to entrainment was prioritized by waterbody, focusing on those intakes in large reservoirs with larger numbers of fish present that may have higher potentials to entrain significant numbers of fish and result in turbine passage, the primary source of entrainment mortality.

Lake Thomas A. Edison and the Portal Powerhouse were previously evaluated as part of traditional relicensing processes (SCE 2001b and SCE 2003c, respectively) and are not discussed in this report. A summary of the fish entrainment results from the Portal Powerhouse is included in Appendix C of this report.

3.2.2 Sampling and Entrainment Evaluation at Selected Intakes

3.2.2.1 Small Diversions

Balsam Diversion in the Big Creek Watershed, located near the town of Big Creek, and Rock Creek Diversion, west and downstream of Mammoth Pool Dam on the San Joaquin River, were selected, in consultation with the CAWG, for more detailed evaluation. Much of the flow in Balsam Creek, outside of the runoff period, is derived from releases made from Balsam Forebay. Rock Creek is a tributary to the San Joaquin River.

3.2.2.1.1 Small Diversion Sampling

The sampling approach used in the two small diversions was dependent upon their designs and capacities. A stationary trawl with a livecar was placed immediately upstream of the diversion pool. The net was set to sample 100 percent of flow upstream of the diversion. Livecars and nets were checked twice daily. Flows were recorded between the upper and lower portion of the trawl net. Flows were measured by a current meter attached to the net frame and by using a velocity meter to measure flow in a standard cross-section of the stream. Water velocities and temperatures were measured. These locations were sampled twice during the runoff period, once near the peak run-off and once later in the season.

Sampled fish were identified to the lowest taxonomic level feasible, based on size and condition of the specimen. Fish lengths were measured and recorded as Standard Length (SL). The general condition and physical appearance of the fish also were recorded. All fish were immediately returned to the waterbody after they were identified, measured and inspected.

3.2.2.2 Reservoirs and Associated Powerhouses

Upon completion of the initial evaluation of fish vulnerability to entrainment at Project intakes, locations with a higher likelihood of either fish entrainment or mortality of entrained fish were selected for further evaluation. An initial summary evaluation was presented to the CAWG in 2003. The selection of locations to be monitored was made in consultation with the CAWG and with CAWG approval. The basis for these selections is described in Sections 4 and 5. The four Project powerhouses sampled were Big Creek Powerhouse 1 (BC1), Big Creek Powerhouse 2A (BC2A), Mammoth Pool Powerhouse (MPPH), and Eastwood Power Station (Eastwood).

3.2.2.3 Powerhouse Entrainment Sampling

For selected study locations, the intake and tailrace were evaluated to determine which of two monitoring approaches (hydroacoustics or net sampling) would be appropriate. Hydroacoustic monitoring at the intakes was determined to be less effective due to the configuration of the intakes and lack of information on species, lifestage, and condition of entrained fish. Therefore, the selected powerhouse tailraces were sampled with nets that could capture fish for identification and examination.

Tailrace sampling was conducted using a stationary net positioned in the outflow from the powerhouse under study, utilizing methods that were successfully employed for other hydropower relicensing (such as the Portal Hydroelectric Power Project [FERC Project No. 2174] [SCE 2003c] and the Pit 3, 4, and 5 Hydroelectric Project [FERC Project No. 233] [PG&E 2004]), among others. Beginning in the summer of 2003 and continuing into 2004, Kodiak trawl nets were set in the tailraces of the four Project powerhouses selected for sampling: Big Creek Powerhouse 1 (BC1), Big Creek Powerhouse 2A (BC2A), Mammoth Pool Powerhouse (MPPH), and Eastwood Power Station (Eastwood).

The trawl nets, both custom-designed nets and standard Kodiak trawls, have been successfully used for this purpose (Figure CAWG 9-2a). A livecar for holding fish was attached to the cod end of the net (Figure CAWG 9-2b). The purpose of the livecar is to allow fish to be collected from the net and held without inducing injury or mortality due to holding. An identical system for tailrace sampling was successfully used to collect fish passing through the Pit 3 Powerhouse in 2002 and 2003, and the Pit 4 Powerhouse in 1999 and 2000 by members of the same field crew. The Pit 3 Powerhouse was sampled as part of the relicensing process for the Pit 3, 4, and 5 Hydroelectric Project (FERC No. 233) (PG&E 2004). Contents captured in the net were thoroughly sorted to locate all fish or fish parts, otherwise hidden in the debris.

Flows were estimated using a General Oceanics (GO) Model 2030R velocity meter suspended between the upper and lower portion of the trawl net, just inside of the net mouth. Powerhouse flows for the days of tailrace sampling were provided by SCE at the conclusion of each sampling period. The flowmeter provided information on the amount of water that was sampled by the trawl net assemblage, and in combination with the powerhouse flow information, the percentage of total flow through the powerhouse that was sampled was calculated.

The net was scheduled to be fished bimonthly during the warmer months and quarterly during the colder months, with the exception of EPS. Eastwood was only scheduled to be sampled during warmer months due to the difficulty of access during the winter. All sampling was subject to powerhouses being online, and the availability of outages for safe access to install, service, and remove nets. Outages and the availability of units required changes in the original schedule. Nets were fished for a 48-hour period and generally were checked on a 12- to 24-hour basis (depending upon powerhouse operations) and statewide power conditions (ISO "no touch days," which prevented SCE from providing the needed outages).

3.3 APPROACH TO ANALYSIS

The volume of water sampled by the net was calculated by multiplying the area of the net face by the mean velocity of water measured entering the net over time. The density of fish (fish/1,000 cubic feet [cf]) collected by the net was estimated by dividing the number of collected fish by the volume of water that passed through the net, (in units of 1,000 cf). The number of fish passing through the turbines was estimated by multiplying the density of fish in the sampled tailrace water by the volume of water that passed through the powerhouse, as a whole.

number of fish passing through turbines =
estimated density of fish sampled X volume of water through unit

where

estimated density of fish sampled (fish/1,000 cf) =
number of fish captured ÷ volume through net mouth (1,000 cf)

and

volume through net mouth (1000 cf) =
area of net face (ft^2) X mean velocity through net (ft/sec) X time sampled

The volume of water passing through the powerhouse was calculated by multiplying the mean flow (in cubic feet per second [cfs]) for the powerhouse units studied during the sampling period by the amount of time sampled, multiplied by the inverse of the fraction of total units sampled. Units 1 and 2 were sampled at Big Creek Powerhouse 1, Big Creek Powerhouse 2A, and Mammoth Pool Powerhouse during each sampling event. The only unit at Eastwood Power Station was sampled during each sampling event.

4.0
LITERATURE REVIEW

Section 4 presents the results of a review of scientific literature addressing potential turbine mortality associated with the types of turbines used at Big Creek power generation facilities. This section also presents a review of pertinent scientific literature and field measurements that were used to characterize fish vulnerability for each life history stage of target fish species documented in the vicinity of Project intakes.

4.1 TURBINE MORTALITY

Turbine-related injury and mortality to fish can occur by several mechanisms, including rapid and extreme water pressure changes, cavitation, shear, turbulence, and mechanical injuries (USACE 1995 cited in Cada et al. 1997). Although mortality may not occur immediately, fish may be physiologically stressed, disoriented, or disabled, making them more susceptible to predation or indirect mortality. In a review of literature related to turbine-passage injury, Cada et al. (1997) described the following factors that may be important in turbine-passage mortality:

1. **Pressure** increases found in hydroelectric turbines are unlikely to directly injure or kill entrained fish, but may alter their behavior. Rapid and brief pressure reductions are more likely to damage fish, particularly fish with swim bladders. If a fish is drawn from deep water into a surface intake or subject to rapid pressure reduction within the turbine and draft tube, its swim bladder will expand, potentially to the point where it will burst. Physostomous fish (with open swim bladders), such as salmon, trout and minnows, can adjust to changes in pressure more rapidly than physoclistous fish (with closed swim bladders) such as perch, bass, crappie and sunfish, although physostomous fish may suffer pressure-related mortality. Sculpins do not have swim bladders. Death also may be caused by minute gas emboli that form following decompression.

2. **Cavitation** is the process of formation of water vapor bubbles in a liquid caused by a localized reduction in pressure, e.g. downstream of turbine blades. The violent collapse of cavitation bubbles creates shock waves that may injure nearby fish.

3. **Shear stress** is a force (fluid or mechanical) that acts parallel to a surface. Fish or fish eggs subjected to shear zones can be disoriented or experience direct injury, and loss of mucous coating or scales can result in increased susceptibility to fungus.

4. **Turbulence** can cause localized injuries or cause disorientation that may leave turbine-passed fish more susceptible to predation. Turbulence in the draft tube and tailrace is of particular concern.

5. **Mechanical Effects** include **strike** and **grinding**. The probability of a fish being injured or killed by a collision with turbine structures (strike) is a function of fish

characteristics (size, condition, behavior), turbine characteristics (number of runner blades, size of openings between vanes and blades, sharpness of blade edges, revolution rate, blade velocity), and the relationship between the fish and turbine structures (e.g. region of passage, orientation, and relative velocity). Grinding occurs when fish are squeezed through narrow openings or gaps.

Major points of discharge and associated turbine types for large and medium-sized Project reservoirs are listed in Table CAWG 9-2. The types of turbines used in the Big Creek hydroelectric system are Impulse (Pelton), Francis Vertical Reaction, and Francis Reaction/Pump Turbine. Head height for the powerhouses varies between 230 ft and 2,418 ft.

Pressure regimes, shear regimes, and probabilities of strike vary between turbine designs. A summary of potential turbine mortality by turbine type used in the Big Creek system is presented in Table CAWG 9-3.

Characterization of passage survival is better for juvenile fish, especially salmonids, than for adults, about which less is known. Pelton turbines, a small turbine designed for high-head installation, most likely cause complete mortality for juvenile and larger fish, while turbine types with larger water passages, such as the Francis, have survival rates of 70 percent or greater for small fish (Cada 2001).

4.1.1 Pelton Turbines

Impulse turbines utilize the energy of a high-velocity jet of water on relatively small buckets or blades mounted on a wheel (Ruggles et al. 1981). Due to the design of impulse turbines, they have a high potential to cause injury or mortality to fish passing through them. Typical of authors who have reviewed the effects of turbine passage on fish, Cada (2001) has characterized high head turbines, such as the Pelton type, as most likely causing total mortality. Cada et al. (1997), in their review, identified that high-velocity water jets alone can result in high mortality of clupeids (members of the herring and shad family), while having less effect on other groups of fish. Blade strikes are another source of this mortality.

The Big Creek Project employs Pelton impulse-turbines at Big Creek Powerhouse 1, Big Creek Powerhouse 2A and at Big Creek Powerhouse 2, with heads of 2,131, 2,418, and 1,858 feet, respectively (Table CAWG 9-2). Therefore, it is very likely that if fish were entrained in these turbines, they would experience significant trauma or mortality.

4.1.2 Francis Turbines

The Project also employs Vertical Francis, Francis Reaction, and Francis Vertical Reaction turbines, with head ranging from 230 to 1,338 feet (Table CAWG 9-2). Francis turbines are known to support relatively high levels of fish survival. Head is generally not considered to be a mortality factor for Francis turbines, but higher head units are generally associated with faster rotation speeds, and higher runner peripheral velocities, which are correlated with higher mortality rates (EPRI 1987).

Several reviews of turbine survival studies have examined the effect of different characteristics of Francis turbines on fish survival. A review by Eicher et al. (1987) indicated that survival was related to several characteristics, including head and rpm of the turbine. The studies reviewed primarily focused on juvenile anadromous salmonids. Odeh (1999), Cook et al. (1997), and Franke et al. (1997) variously reported on a review of fish entrainment and mortality studies by EPRI (1992). This review included data involving riverine fish species in addition to anadromous fish throughout the U.S. The findings indicated that estimated mortality averaged 20 percent (80 percent survival) for Francis turbines and that a wide variety of species have similar mortality rates from turbine passage. A conclusion from some of these studies was that there were lower rates of mortality for naturally entrained fish compared to fish that were artificially introduced into a turbine system for testing. The reviews also suggest that smaller fish tend to have greater survival rates than larger fish and that survival improves with higher turbine operating efficiency.

A study of turbine survival for a vertical Francis turbine was conducted by CDFG and Pacific Gas and Electric (PG&E) at the Hat Creek No. 1 Powerhouse (PG&E 1998). The Hat Creek turbine operates at a maximum head of 212.6 ft. The results of that study indicated a survival rate of approximately 99 percent for rainbow trout. In addition, a longer-term study of tagged fish that passed through the powerhouse with similarly tagged fish released at the tailrace resulted in no significant difference in angler returns. This suggested that long term survival was similar.

4.2 FISH VULNERABILITY

Fish species present in waterbodies containing specific diversions and intakes in the Big Creek system are listed in Table CAWG 9-4. Pertinent scientific literature and field measurements were reviewed used to characterize fish vulnerability for each life history stage of target fish species documented in the vicinity of Project intakes. Swimming capabilities are summarized and information on habitat utilization is presented.

4.2.1 SWIMMING CAPABILITIES

To help evaluate fish vulnerability to entrainment, the swimming capability of these species (where data were available) or appropriate other fish species were reviewed for each life history stage.

Fish swimming speeds are related to fish length for a given species. Fish are capable of short bursts at high speeds, in contrast to speeds they can maintain for longer periods. Such burst or darting speeds are used to escape predators or to negotiate rapid currents in rivers (Beamish 1978). Swimming speed capabilities are defined (Bell 1990) as follows:

- Cruising – a speed that can be maintained for long periods of time (hours).
- Sustained – a speed that can be maintained for minutes.

- Darting (burst) – a single effort, not sustainable.

Water temperature generally affects maximum speed. Fish also tend to have greater swimming capabilities at warmer temperatures.

The swimming capabilities of fish associated with Project waters from the available data are presented in Table CAWG 9-5. This information shows that

- Most adults can achieve velocities in excess of 3 feet per second (ft/sec), and
- Most juveniles can achieve velocities of 1 ft/sec or greater, for short periods.

Based on these swimming capabilities, intake velocities of less than 1 ft/sec are defined as low, 1 to 3 ft/sec are defined as medium, and greater than 3 ft/sec are defined as high in terms of potential vulnerability to entrainment for this report.

4.2.2 Habitat Utilization

Habitat utilization can affect fish vulnerability to entrainment. Habitat requirements and preferences of the various life history stages of resident species will affect the distribution of fish within an impoundment. This section summarizes life history factors that are likely to affect fish vulnerability to entrainment. Detailed species accounts for fish species present in the Project Area, as well as phenologies for key fish species, are presented in Appendix B of the CAWG 7 Technical Study Report (SCE 2003a).

Within the large reservoirs, fish species and life history stages that inhabit deep water near Project intakes are more vulnerable than fish that inhabit littoral or epilimnetic habitat. Fry and juvenile fish, which have lower swimming capabilities than adult fish, may nevertheless be less vulnerable to entrainment because they seldom utilize habitat near deepwater Project intakes.

Moyle (2002) describes the habitat of typical mid-elevation, Central Valley reservoirs into four broad habitats, each with its own fish assemblage: 1) littoral, 2) epilimnetic, 3) hypolimnetic, and 4) deepwater benthic. He describes these reservoirs as often supporting warmwater fish species in surface and edge waters and salmonids in deeper, cooler water. Warmwater species can include, among others, bass and other centrarchids.

Rainbow trout are stream spawners, and after emergence from gravel redds, fry may move downstream to a lake during the first or subsequent growing seasons (Raleigh et al. 1984). In reservoirs, younger trout are generally found in shallower water, close to cover, which is likely to make them less vulnerable to entrainment in Big Creek reservoirs. Factors affecting depth distribution of adult lake-dwelling trout include dissolved oxygen, temperature, and food. Adult rainbow trout in lakes remain at depths less or equal to the 18°C isotherm at dissolved oxygen levels of greater than 3 mg/l (May 1973, Hess 1974, cited in Raleigh et al. 1984). Juvenile temperature and oxygen requirements are assumed similar to that of adults. Adult rainbow trout may occupy cool (less than 20°C), hypolimnetic habitat (when a reservoir has a thermocline), and often enter the epilimnion (above the thermocline) in the evening or at night to forage for smaller fish (Moyle 2002).

Brown trout normally are stream spawners, but have been known to spawn in seepage areas of lakes (Raleigh et al. 1986). For a period, typically June through October, fry inhabit quiet water close to banks among large rocks or overhanging vegetation. Young trout typically rear in streams for several years (Moyle 2002). Adult brown trout generally occupy a wider range of lake habitats than juveniles. Depending upon water temperatures, they are often found in the upper layers of large reservoirs (Haugen and Rygg 1996, Linlokken 1988, and Halvorsen et al. 1997, cited in Devine Tarbell & Associates, Inc. 2004). The optimal temperature range for adults is 12 to 19°C, with a tolerance for a range of 0 to 27°C (Raleigh et al. 1986.) During summer, adults may seek deeper cooler waters. In winter, hiding behavior is triggered by low temperatures (4 to 8°C) and adults move to deep, low-velocity water (Raleigh et al. 1986).

Brook trout is a stream-spawning species that also can utilize upwelling areas of lake habitats for reproduction. Brook trout are among the most cold tolerant of salmonids (Moyle 2002), with a temperature range for adult brook trout of 0 to 24°C, and an optimal range of 11 to 16°C (Raleigh 1982). Brook trout normally require high dissolved oxygen levels (Raleigh 1982). In streams and lakes, fry move to the shallow edges among vegetation or backwater areas for cover (Moyle 2002). Lake dwelling brook trout juveniles feed in the littoral zone.

Kokanee, the landlocked form of sockeye salmon, is primarily a planktonic feeder that prefers well-oxygenated, open water of reservoirs with temperature ranges of 10 to 15°C. If surface water temperatures increase in the summer, they move to deeper, hypolimnetic water (Moyle 2002). Kokanee spawn in streams, but may spawn in gravel beds of lakes close to shore. Fry move downstream immediately after emergence (Moyle 2002). However, kokanee in Huntington and Shaver Lakes primarily originate from CDFG stocking rather than natural reproduction (SCE 2003a).

Prickly sculpin and Sacramento sucker may be found in deepwater, benthic habitat, below the thermocline (Moyle 2002). Adults are bottom feeders, and move to shallow water at night to feed. Prickly sculpin larvae are pelagic until juveniles settle onto the bottom, move into inshore areas to rear, shift into offshore areas as they become larger, but move inshore at night to feed (Broadway and Moyle 1978, cited in Moyle 2002).

Sacramento suckers primarily spawn in tributaries, although shoreline spawning has been known to occur (Moyle 2002). Larval suckers swim up in the water column, assuming a benthic orientation as they grow larger. Juveniles that were spawned in tributary streams may spend two to three years in some streams before moving to a large river or reservoir during high flows. Juvenile suckers in the Project Area were more commonly found in tributary streams where they hatched than in reservoirs and downstream areas (SCE 2003a). Juvenile suckers, like other juvenile fish species, utilize shallow water and therefore are not likely to be entrained by deepwater intakes.

Smallmouth bass prefer waters with abundant cover, summer water temperatures of approximately 20 to 27°C, and are rarely found where water temperatures do not exceed 19°C in the summer for extended periods (Moyle 2002). Adult bass have small home ranges. In reservoirs, they are most abundant near the upstream end, and concentrate in narrow bays or in areas along shore where rocky shelves project underwater, at depths of 1 to 10 meters (3.3 to 32.8 feet) (Moyle 2002).

5.0 RESULTS

In this section are presented the results of implementing the following study elements:

- Initial Evaluation of Vulnerability to Entrainment - Evaluate the potential for entrainment mortality based on power intake design, location, depth, velocities, and presence of potentially vulnerable fish.
- Sampling and Entrainment Evaluation at Selected Power Intakes - Evaluate entrainment rates at power intakes identified as likely to result in significant fish mortality using hydroacoustics at intakes, fish netting at powerhouse tailraces, or other appropriate techniques.

5.1 INITIAL EVALUATION OF VULNERABILITY TO ENTRAINMENT

Entrainment vulnerability was evaluated at all major Big Creek intakes and small diversions in the Project area, and prioritized by waterbody to assist in selecting sampling locations. This evaluation was based on the following:

- The design of the intake,
- Fish vulnerability and their use of the area near the intake face, and
- Information on turbine mortality (see results of literature review in Section 4).

Design drawings of Project intakes were reviewed to determine intake depth and surface area. The surface area of the intake, combined with flow data, allows calculation of approach velocities at the intake. Large surface area generally results in low approach velocities. The depths and surface areas for Project intakes are presented in Table CAWG 9-6. Intake depth, when combined with hydroacoustic data (SCE 2003a), yields information on fish use of the area near the intake face. Comparisons of fish distribution with depth and water temperature in major Project reservoirs are presented in CAWG 9 Appendix B. Reservoir daily volumes and corresponding surface areas for representative water year types were presented in the CAWG 1 Technical Study Report (SCE 2003b).

Fish vulnerability to entrainment also is related to the species of fish, their swimming capability, their life history stage, and their distribution in relation to the intake. Fish species present above each of the Project diversions and intakes are presented in Table CAWG 9-4. The swimming capability of fish associated with Project waters (where data was available) by life history stage was used as one of the factors to evaluate the relative fish vulnerability within each waterbody.

As discussed in Section 4, the potential for mortality and injury due to turbine passage was summarized from the available literature.

5.1.1 ENTRAINMENT VULNERABILITY AT MAJOR INTAKES

Table CAWG 9-7 summarizes information related to fish vulnerability to entrainment at the major Big Creek intakes. A summary of information and the rationale for these evaluations is provided in this section.

5.1.1.1 Florence Lake

Intake Summary

The intake in Florence Lake is connected to Ward Tunnel, which carries water from Florence Lake and diverted flow from tributaries to the South Fork San Joaquin River (Figures CAWG 9 Appendix A-1 through A-3). Flow from the Ward Tunnel is discharged through either an HB valve or Portal Powerhouse to Huntington Lake. No powerhouse exists upstream of Portal Powerhouse; therefore no source of turbine mortality exists upstream of that location. Entrainment mortality at Portal Powerhouse, which represents entrainment for the upper basin, was studied in support of the Portal Hydroelectric Power Project (FERC Project No. 2174) (SCE 2003c) and was found to be relatively low. A summary of the results from the Portal Powerhouse entrainment study is presented in CAWG 9 Appendix C. In Florence Lake, fish vulnerability to entrainment is considered to be low due to low intake velocities (less than 1.0 ft/sec) and low density of trout near the Ward Tunnel intake (Table CAWG 9-7).

The intake at Florence Lake is at an elevation of 7,200 feet above MSL, which is near the bottom of the lake. The intake is in a depth of 107 feet (32.6 m) of water when the lake is full, and discharges relatively cool water during the summer months when the lake is thermally stratified (SCE 2004a). A large surface area at the intake structure (3,325.5 square feet) results in low approach velocities. Based on flow records at the Ward Tunnel intake (USGS gage 11229500) between 1982 and 2002, the maximum monthly, 50 percent exceedance value of associated intake approach velocity was 0.17 ft/sec in July (Table CAWG 9-8). Monthly twenty percent exceedance values also were far below the maximum swimming capability of juvenile trout.

Fish Populations

Self-sustaining populations of brown trout, and potentially rainbow trout, are present in Florence Lake, with relatively high numbers of fish. Multiple age classes of brown trout were collected in 2002, most from age 4+ to 6+ (SCE 2003a). The reservoir usually begins to fill in the spring. By July, it is at its maximum volume, drops slowly from July to the beginning of September, falls quickly from September to November, and by December is usually at its minimum volume and surface area (SCE 2003b). Over a 21-year period of record (1980 to 2001), average maximum yearly storage volume was 60,096 acre-feet (7,323.0 feet above MSL) and the average minimum yearly storage volume was 1,008 acre-feet (7,230.8 feet above MSL) (Table CAWG 9-6). Florence

Lake was thermally stratified during the summer months and mixed in the fall (SCE 2004).

A hydroacoustic survey conducted in Florence Lake near the Ward Tunnel Intake in August of 2002 (SCE 2003a) showed that most fish were concentrated above a depth of 15.7 meters (50.5 feet) (Figure CAWG 9-3). Substantially lower densities were found near the depth of the intake. The fish in this deeper portion of the lake are more likely to be large-sized, rather than small, with greater swimming capability.

During October of 2002, there was very little flow from the South Fork San Joaquin River upstream and the residual lake was located well upstream of the intake. In October, flow to the intake flows through a shallow, slow moving stream and water must pass over a weir before reaching the intake (Figure CAWG 9 Appendix A-3). Nine brown trout and one rainbow trout were observed in the river channel upstream of the weir and none in the pool below the weir near the intake. Brown trout are likely to overwinter in deeper water in the lake.

<u>Potential for Turbine Mortality</u>

As noted above, in Florence Lake there were low approach velocities to the intake to Ward Tunnel. There were relatively high numbers of fish in the lake, however, there were low densities of larger (adult) fish near the depth of the intake. Portal Powerhouse (the only powerhouse directly connected to the Ward Tunnel intake) has a Vertical Francis turbine and low head (230 feet), therefore, if fish were entrained, the potential for turbine mortality would be low. During periods of high runoff, the majority of the flow passes through the HB valve. The general assessment was that there was a low potential for entrainment and mortality at the backcountry diversions and Portal Powerhouse. Studies of Portal Powerhouse are summarized in CAWG 9 Appendix C.

5.1.1.2 Huntington Lake

Flow from Huntington Lake is discharged to Big Creek Powerhouse 1 via Tunnel 1 (Figures CAWG 9 Appendix A-4 through A-5). Huntington Lake water also may be diverted through Balsam Meadow Forebay to Shaver Lake through Tunnel 7 (also known as the Huntington-Pitman Siphon) (Figure CAWG 9 Appendix A-6) to Eastwood Power Station (see Section 5.1.1.5 Balsam Meadow Forebay). Water from Huntington Lake also is released through Tunnel 7 to provide augmented flow to North Fork Stevenson Creek.

<u>Intake Summary</u>

Powerhouse 1. The intake to Big Creek Powerhouse 1 is on the bottom of Huntington Lake with an invert elevation of 6,821 feet above MSL, and discharges relatively cool water during the summer months when the lake is thermally stratified (SCE 2004a). Calculated approach velocities were low. Based on flow records at the Big Creek Powerhouse 1 at Big Creek Gage (USGS gage 11238100) between 1982 and 2002 (discontinuous record), the maximum monthly, 50 percent exceedance value of associated intake approach velocity was 0.45 ft/sec in June and July (Table CAWG 9-

9). Calculated intake velocities in October were generally lower than during the summer months. Monthly twenty percent exceedance values over the period of record were near 0.5 ft/sec during months of peak diversion. These calculated approach velocities put this intake in the category of low risk for vulnerability to entrainment.

Tunnel 7 Intake. Calculated approach velocities at the Tunnel 7 intake were low, based on flow records at the Huntington-Shaver Conduit at Huntington Lake Gage (USGS gage 11236080) for the period between 1974 and 1983. The maximum, monthly, the intake approach velocity associated with the 50 percent exceedance flow was 0.32 ft/sec in June. The 50 percent exceedance flow intake approach velocity in October was 0.00 ft/sec. Twenty percent exceedance flow intake velocities did not exceed 0.58 ft/sec (Table CAWG 9-10). This suggests that when fish are near the intake, their vulnerability to entrainment would be low. Fish entrained into Tunnel 7 from Huntington Lake to Balsam Meadow Forebay do not experience turbine passage, but subsequent entrainment to the Eastwood Power Station intake may have the potential to result in turbine passage.

Fish Populations

In Huntington Lake, self-sustaining populations of brown trout (11 percent), Sacramento sucker (39 percent), and prickly sculpin (40 percent) were documented during sampling conducted as part of the CAWG 7 technical study (SCE 2003a). Kokanee are stocked, and most of the rainbow trout collected were catchable-sized hatchery fish. Multiple age classes for all fish species were represented (SCE 2003a). The reservoir usually begins to fill in the spring, usually mid-April, by June is at its maximum volume, decreases in volume quickly from about mid-September through December, and by January is usually at its minimum volume and surface area. In some drier years, higher reservoir storage is maintained over the winter than in some wetter years (SCE 2003b). Over a 21-year period of record (1980 to 2001), average maximum yearly storage volume was 88,619 acre-feet (6,949.6 feet above MSL) and the average minimum yearly storage volume was 32,404 acre-feet (6,901.8 feet above MSL) (Table CAWG 9-6). Huntington Lake was thermally stratified during the summer months and mixed in the fall (SCE 2004a).

Hydroacoustic surveys were conducted in Huntington Lake in 2002 (SCE 2003a). The intake areas sampled were near all three of the dams that create the lake. In June, most fish were concentrated above a depth of 15.7 meters (50.5 feet), above the thermocline, and all fish were found above 19.6 meters (64.3 feet), well above the depth of the Tunnel 1 Intake (Figure CAWG 9-4). In October, when lake level is generally lower, low densities of the fish were found at depths corresponding to the depth of the intake, (Figure CAWG 9-5), but intake velocities are lower in October.

The Tunnel 7 intake, with an invert elevation of 6,885 feet above MSL, is located at a shallower depth than the intake to Tunnel 1. Hydroacoustic surveys conducted in 2002 showed that most fish were concentrated at depths shallower than the intake in June. In October, when calculated approach velocities were lower, a higher density of fish was found at depths similar to the intake (Figures CAWG 9-6 and 9-7).

Potential for Turbine Mortality

As noted above, in Huntington Lake there are two major intakes, the Tunnel 7 intake and the Powerhouse 1 intake. Big Creek Powerhouse 1 is the only powerhouse directly connected to the intakes in Huntington Lake[1]. Big Creek Powerhouse 1 has a Pelton Impulse turbine and a high head of 2,131 feet. Therefore if fish were entrained, the potential for turbine mortality would be high. There were relatively large numbers of fish in the lake, however, fish vulnerability to entrainment at the Tunnel 1 Intake is low because intake velocities are generally low and fish presence near the intake face is low (Table CAWG 9-7). The high potential for mortality if turbine passage occurs and the high abundance of fish in the reservoir were considered important in prioritizing this location. In addition, water passing through Powerhouse 1 constitutes almost all flow passing through Powerhouse 2 and a large portion of the water passing through other downstream powerhouses. Therefore, Powerhouse 1 was given a high priority and selected for further evaluation, to confirm the initial assessment of a low potential for entrainment mortality.

5.1.1.3 Shaver Lake

Water from Shaver Lake that is not released to Stevenson Creek is diverted through Tunnel 5 to Big Creek Powerhouse 2A (Figures CAWG 9 Appendix A-7 and A-8). Powerhouse 2A has a Pelton Impulse turbine and a high head of 2,418 feet, therefore if fish were entrained here, the potential for turbine mortality would be high. However, fish vulnerability to entrainment at the intake was assessed to be low because calculated intake velocities are low and fish presence near the intake face was low (Table CAWG 9-7). This location was selected for further evaluation to verify this assessment.

Intake Summary

The intake to Powerhouse 2A is at the bottom of the dam, with an invert elevation of 5,225 feet above MSL, and discharges relatively cool water when there are thermal gradients during the summer (SCE 2004a). The large surface area of the intake results in low approach velocities. Based on flow records at the Big Creek Powerhouse 2A Near Big Creek Gage (USGS gage 11238400) between 1982 and 2002 (discontinuous record), the maximum monthly intake approach velocity associated with the 50 percent exceedance flow was calculated to be 0.11 ft/sec in June through August (Table CAWG 9-11). Twenty percent exceedance values did not exceed 0.14 ft/sec. These low approach velocities put this intake in the category of very low risk for vulnerability to entrainment.

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[1] The Tunnel 7 intake can divert water to Balsam Meadow Forebay and Shaver Lake via North Fork Stevenson Creek. Entrainment vulnerability at intakes in Balsam Meadow Forebay and Shaver Lake are examined in subsequent sections of this report.

Fish Populations

In Shaver Lake, rainbow trout (37 percent), Sacramento sucker (three percent), kokanee (19 percent), smallmouth bass (27 percent), bluegill, crappie, unidentified centrarchids, and a carp were collected in 2002. Other species have been introduced to the lake and are still found there, although in lower numbers. Multiple age classes were represented for most species. Rainbow trout and kokanee are likely of hatchery origin (SCE 2003a). The reservoir is deepest near the dam. Artificial, shallow-water habitat was constructed by SCE near the lake margin to provide additional habitat for bass. The lowest water surface elevations usually occur in the spring and the reservoir is usually at its maximum volume in the summer, typically around July (SCE 2003b). Over a 21-year period (1980 to 2001), average maximum yearly storage volume was 113,884 acre-feet (5,359.8 feet above MSL) and the average minimum yearly storage volume was 48,875 acre-feet (5,321.5 feet above MSL) (Table CAWG 9-6). Shaver Lake was thermally stratified during the summer months and mixed in the fall (SCE 2004a).

A hydroacoustic survey conducted in July of 2002 (SCE 2003a) showed most fish at the dam end were concentrated in the upper layers of the lake above depth of 21.6 meters (70.9 feet). There were much lower fish densities in the deeper, cooler depths between 21.6 and 41.2 meters (70.9 to 135.2 feet) (Figure CAWG 9-8). The intake depth was 41.5 meters (136 ft) when sampling was conducted. Low fish densities were found at deep depths near the intake, and these fish are likely to be large-sized rather than small, with good swimming capabilities. A hydroacoustic survey conducted in October of 2002 showed all fish were at depths shallower than the intake (Figure CAWG 9-9).

Potential for Turbine Mortality

As noted above, water from Shaver Lake that is not released to Stevenson Creek may be temporarily pumped back to Balsam Forebay during pumpback operations (SCE 1992, 2005), or more likely, diverted through Tunnel 5 to Big Creek Powerhouse 2A. Powerhouse 2A has a Pelton Impulse turbine and a high head of 2,418 feet. Therefore if fish were entrained, the potential for turbine mortality would be high. There were relatively high numbers of fish in the lake. However, fish vulnerability to entrainment at the intake is low because intake velocities are low and fish presence near the intake face was low. The high potential for mortality if turbine passage occurs and the high abundance of fish in the reservoir were considered important in prioritizing this location. Therefore, Powerhouse 2A was given a high priority and selected for further evaluation to verify the results of the initial analysis.

5.1.1.4 Mammoth Pool

Mammoth Pool Power Tunnel and a penstock connect Mammoth Pool Reservoir to Mammoth Pool Powerhouse (Figures CAWG 9 Appendix A-9 and A-10). The intake to the tunnel is controlled by a fixed-wheel gate powered by an electrically operated hoist. The powerhouse has two Francis Reaction turbines and high head of 1,100 feet, and therefore if fish were entrained, the potential for turbine mortality would be low to high. Fish vulnerability to entrainment at the intake is low to medium because intake velocities are low (less than 1 ft/sec) to medium (1 to 3 ft/sec). However, fish presence near the intake face was low, and fish in the depths near the intake are likely to be large-sized (Table CAWG 9-7). This location was selected for further evaluation.

Intake Summary

The intake to Mammoth Pool Powerhouse is near the bottom of the reservoir, with an invert elevation of 3,100 feet above MSL. Based on flow records at the Mammoth Pool Powerplant Near Big Creek Gage (USGS gage 11235100) between 1982 and 2002 (discontinuous record), intake approach velocity associated with the maximum, monthly, 50 percent exceedance flow value was calculated as 0.73 ft/sec in May (Table CAWG 9-12). Twenty percent exceedance values did not exceed 0.81 ft/sec (Table CAWG 9-12). This suggests that when fish are near the intake, their vulnerability to entrainment would be low.

Fish Populations

Sampling in Mammoth Pool Reservoir in 2002 indicates there are self-sustaining populations of brown trout (71 percent) present. Rainbow trout (29 percent) collected were likely of hatchery origin. No brown trout under age 3+ were collected (SCE 2003a). Spawning and rearing may occur in tributaries or the San Joaquin River upstream of the reservoir. During normal water years, the reservoir usually begins to fill in the spring, by June is at its maximum volume, and drops to the annual minimum level by the beginning of November. There are clear differences in seasonal storage, as well as between water year types. Reservoir elevation rises and falls a few times in the winter, and the cycle begins again usually in April (SCE 2003b), depending upon runoff patterns. Over a 21-year period of record (1980 to 2001), average maximum yearly storage volume was 114,922 acre-feet and average minimum yearly storage volume was 12,764 acre-feet, corresponding to approximately 3,325.3 and 3,175.7 feet above MSL, respectively (Table CAWG 9-6). Mammoth Pool Reservoir was thermally stratified during the summer months and mixed in the fall (SCE 2004a).

A hydroacoustic survey conducted in September of 2002 (SCE 2003a) showed most fish were concentrated above a depth of 39.5 meters (129.6 feet), which is shallower than the intake (Figure CAWG 9-10). Low fish densities were found at deep depths near the intake, and these fish are likely to be large-sized, with good swimming capabilities.

Potential for Turbine Mortality

As noted above, water from Mammoth Pool that is not released to the San Joaquin River is diverted through a water conduit, consisting of the Mammoth Pool Power Tunnel and a penstock that connects Mammoth Pool to Mammoth Pool Powerhouse. Mammoth Pool Powerhouse has two Francis Reaction turbines and is of high head design at 1,100 feet. Therefore if fish were entrained, the potential for turbine mortality can would be low to high. Fish vulnerability to entrainment at the intake is low with low intake velocities (less than 1 ft/sec) and low fish presence near the intake face. The variable potential for mortality if turbine passage occurs and the abundance of fish in the reservoir were considered important in prioritizing this location. Therefore, Mammoth Pool Powerhouse was given a high priority and selected for further evaluation.

5.1.1.5 Balsam Meadow Forebay

Balsam Meadow Forebay is a medium-sized waterbody (1,547 acre-feet) that is impounded by Balsam Meadow Dam on Balsam Creek 2.7 miles upstream of the confluence with Big Creek (Figures CAWG 9 Appendix A-11 and A-12). Water is diverted to the forebay by the Balsam Meadow Diversion Conduit, a shunt of Tunnel 7 that carries water from Huntington Lake and Pitman Diversion to the forebay and to North Fork Stevenson Creek. The majority of flow from Balsam Meadow Forebay is routed through Eastwood Power Station and discharged to Shaver Lake. Eastwood Power Station also may operate in pumpback mode at night to supplement peak generation during the day. The water pumped from Shaver Lake passes through Eastwood Power Station Tunnel, the same conduit that draws water from Balsam Meadow Forebay. Only a small ephemeral stream flows into the forebay.

Intake Summary

The Eastwood Power Station intake area is located on the north side of the forebay and contains suitable habitat for fish, but the small amount of shallow water habitat is indicative of the small size and relatively steep shoreline of the reservoir (SCE 2003b). Water surface elevation in the forebay varies daily, but generally is higher in the summer than in the winter. At a normal annual maximum lake elevation of around 6,662 feet above MSL, reservoir volume is 1,247 acre-feet (Table CAWG 9-6). When the forebay reaches a normal annual minimum elevation of 6,639 feet, reservoir volume drops to 326 acre-feet (Table CAWG 9-6) (SCE 2003b). The intake has an invert elevation of 6,600 feet above MSL. Although the reservoir can be thermally stratified during the summer, thermal stratification is not often likely to occur or persist (SCE 2004a).

Based on flow records at the Eastwood Power Station between 1987 and 2002, the monthly, 50 percent exceedance value flows have associated intake approach velocities of 0.15 to 0.67 ft/sec, falling into the low vulnerability category. The highest monthly value occurs in June (Table CAWG 9-13). Velocities resulting from 20 percent exceedance flows were 1.06 ft/sec (June) or less.

Fish Populations

Fish species collected during sampling conducted for the CAWG 7 technical study (SCE 2003a) included brown trout (two percent), rainbow trout (seven percent), Sacramento sucker (19 percent), and prickly sculpin (41 percent). This was the only medium-sized impoundment where kokanee (28 percent) and smallmouth bass (three percent) were collected. Most of these species likely originated from Huntington or Shaver Lakes through diversion or pumpback and historically did not occur in Balsam Creek. Multiple age classes, including younger fish, were represented among the sampled fish, except for brown trout. The relative numbers of fish were low to medium.

Potential for Turbine Mortality

As noted above, the majority of flow from Balsam Meadow Forebay is routed through Eastwood Power Station and discharged to Shaver Lake. The Eastwood Power Station has a Francis Reaction/pump turbine and a high head of 1,338 feet. If fish were entrained, the potential for turbine mortality would be low to high. Fish vulnerability to entrainment at the intake is low to medium because intake velocities are low, fish presence near the intake face is low, and fish near the intake are likely to be larger-sized (Table CAWG 9-7). In consultation with the CAWG, the Eastwood Power Station was given a high priority for turbine passage sampling. Pumpback entrainment was studied previously (SCE 1992, 2005).

5.1.1.6 Powerhouse 2 Forebay (Dam 4)

Dam 4, located at Big Creek RM 5.9, forms a medium-size impoundment (60 acre-feet) in Big Creek (Figure CAWG 9 Appendix A-13). Inflow to the forebay comes from the Big Creek Powerhouse 1 tailrace, Big Creek upstream of Big Creek Powerhouse 1, and Pitman Creek. Water entering the forebay is diverted through Tunnel 2 to Powerhouse 2 located upstream of Dam 5 (Big Creek RM 1.65). Additional flow in Tunnel 2 is fed into the tunnel through diversions in Balsam Creek and Ely Creek. The water surface elevation of the Powerhouse 2 Forebay rises and falls a few times over the year, but remains near 4,808 feet above MSL for most of the year (SCE 2004a).

Intake Summary

The design of the Tunnel 2 intake at Dam 4 is shown in Figure CAWG 9 Appendix A-13. The intake is a horizontal opening located behind a trash rack. The intake is located on the north side of the forebay and the area contains suitable habitat for fish (SCE 2003b). The intake has an invert elevation of 4,776.5 feet above MSL. The normal annual maximum forebay elevation is 4,808 feet above MSL (49.3 acre-feet) but occasionally drops to elevations as low as 4,799 feet above MSL (23.4 acre-feet) (Table CAWG 9-6) (SCE 2003b). Due to the small size of the forebay and the large volumes of water that pass through it during the summer months, thermal stratification is not likely to occur during the summer months (SCE 2004a). Based on the geometry of the intake, and on flow records from the Big Creek Powerhouse 2 Near Big Creek Gage (USGS gage 11238380) between 1982 and 2002 (discontinuous record), the corresponding monthly 50 percent exceedance intake approach velocity ranged from 0.39 to 0.98 ft/sec, with the highest monthly value in July (Table CAWG 9-14). Monthly twenty percent exceedance intake velocities values ranged from 0.80 to 1.08 ft/sec, just above the low risk entrainment vulnerability category limit.

Fish Populations

Fish species collected during sampling in 2002 included brown trout (21 percent), rainbow trout (46 percent), and prickly sculpin (33 percent). Multiple age classes of trout, including young-of-the-year fish, were collected (SCE 2003a). In the reach of Big Creek from Dam 1 to upstream of Big Creek Powerhouse 1, brown trout and prickly sculpin were the only species collected (SCE 2003a).

Potential for Turbine Mortality

Almost all flow reaching Powerhouse 2 originates from the Powerhouse 1 tailrace, therefore most fish present in this flow would have passed through the Powerhouse 1 turbines. Due to the principal source of flow and the small size of the forebay, the relative numbers of additional fish vulnerable to entrainment in the source waterbody is low. Big Creek Powerhouse 2 has a Pelton Impulse turbine and a high head of 1,858 feet, and therefore if fish were entrained, the potential for turbine mortality would be high. Intake velocities are generally low. During typical operation of Big Creek Powerhouse 1, the volume of water in the forebay is replaced many times in a single day, and in this part of the "Big Creek chain", fish presence near the intake face is rated low. Therefore, overall (previously unentrained) fish vulnerability to entrainment at the intake is low (Table CAWG 9-7). Since the relative numbers of additional fish vulnerable to entrainment in Powerhouse 2 Forebay is low, Powerhouse 2 was given a low priority, and was not selected for further evaluation.

5.1.1.7 Powerhouse 8 Forebay (Dam 5)

Dam 5, located at Big Creek RM 1.65, forms a medium-sized impoundment (49 acre-feet) in Big Creek (Figure CAWG 9 Appendix A-14). Most of the inflow is from Huntington Lake via Big Creek Powerhouse 2 (derived from the tailrace at Powerhouse 1 at Dam 4) and Shaver Lake via Big Creek Powerhouse 2A. Water impounded behind Dam 5 is diverted through Tunnel 8 to Big Creek Powerhouse 8 near the confluence with the San Joaquin River, but some of the water is released into Big Creek downstream of Dam 5. Water surface elevation rarely varies significantly over the year and remains near 2,942 feet above MSL for most of the year.

Intake Summary

The normal annual maximum forebay elevation is 2,942 feet above MSL (43.4 acre-feet) but occasionally drops to elevations as low as 2,938 feet above MSL (31.5 acre-feet) (Table CAWG 9-6) (SCE 2003b). The intake has an invert elevation of 2,921.5 feet above MSL (Figure CAWG 9 Appendix A-14). Thermal stratification is not likely to occur in the forebay due to the high volume of water that passes through its relatively small volume (SCE 2004a). Based on flow records at the Big Creek Powerhouse 8 Near Big Creek Gage (USGS gage 11238550) between 1982 and 2002, the associated monthly 50 percent exceedance value of intake approach velocities ranged from 0.48 to 1.04 ft/sec, with the highest monthly value in July (Table CAWG 9-15). Monthly twenty percent exceedance values ranged from 0.62 to 1.36 ft/sec.

Fish Populations

Fish species collected during sampling in 2002 included brown trout (84 percent), one rainbow trout (eight percent), and one prickly sculpin (eight percent). Multiple age classes of trout, but no age 0+ or 1+ trout, were represented in the sampled fish (SCE 2003a). The relative numbers of fish in the source waterbody was low due to most flow originating from upstream powerhouse tailraces. In the reach of Big Creek from Dam 4 to upstream of Big Creek Powerhouse 2, brown trout and rainbow trout were collected, but at lower densities than in upstream and downstream reaches (SCE 2003a).

Potential for Turbine Mortality

Almost all water flows to this part of the “Big Creek chain” are primarily from Big Creek Powerhouses 2 and 2A. Therefore, almost all flow passing through the powerhouse turbines has passed through one or more other powerhouses. Few additional fish would be vulnerable to entrainment from this source. Therefore, the majority of the water present in Powerhouse 8 Forebay has already passed through the Powerhouse 1, 2 and 2A turbines. Due to the principal source of flow and the small size of the forebay, the relative numbers of additional fish vulnerable to entrainment in the source waterbody is low. Big Creek Powerhouse 8 has a Francis Vertical Reaction turbine and a head of 713 feet. If fish were entrained, the potential for turbine mortality would be low to high. Intake velocities are generally low. Fish presence near the intake face is rated low. Overall fish vulnerability to entrainment at the intake and powerhouse is low (Table CAWG 9-7). Since the relative numbers of additional fish vulnerable to entrainment in Powerhouse 8 Forebay is low, Powerhouse 8 was given a low priority, and not selected for further evaluation.

5.1.1.8 Powerhouse 3 Forebay (Dam 6)

The Big Creek Powerhouse 3 forebay (993 acre-feet) is located behind Dam 6 at San Joaquin RM 17.0 (Figure CAWG 9 Appendix A-15). Water from the forebay is diverted through Tunnel 3 to Big Creek Powerhouse 3 upstream of Redinger Lake. The tunnel has an invert at the bottom of the impoundment. Inflow to the Big Creek Powerhouse 3 forebay includes flows from the Mammoth Pool Powerhouse (MPPH), Big Creek Powerhouse 8, and to a lesser extent the San Joaquin River upstream of MPPH and Big Creek upstream of Powerhouse 8. Most of the inflow to this forebay is from the Mammoth Pool Powerhouse tailrace and Big Creek Powerhouse 8.

Intake Summary

Water surface elevation in the forebay, which rarely varies significantly, remains near 2,229 feet above MSL (964 acre-feet) for most of the year, but occasionally drops to elevations as low as 2,214 feet above MSL (587 acre-feet) (Table CAWG 9-6) (SCE 2003b). The intake has an invert elevation of 2,151 feet above MSL. The forebay was thermally stratified in the summer months and mixed in the fall (SCE 2004a).

Based on flow records at the Big Creek Powerhouse 3 Near Shaver Lake Gage (USGS gage 11241800) between 1982 and 2002 (discontinuous record), the approach velocities corresponding to the monthly 50 percent exceedance flow ranged from 0.21 to 0.88 ft/sec. The highest monthly value occurred in May (Table CAWG 9-16). Monthly twenty percent exceedance values ranged from 0.34 to 1.00 ft/sec.

Fish Populations

Fish species collected during sampling in 2002 included Sacramento sucker (79 percent), brown trout (15 percent), and rainbow trout (six percent). Multiple age classes for all age classes were represented, but no trout under age 2+ were found (SCE 2003a). The relative number of fish in the impoundment was low.

Potential for Turbine Mortality

Almost all water in the Dam 6 impoundment passes through Mammoth Pool Powerhouse and Powerhouse 8 (except during spill). Therefore, almost all flow passing through the powerhouse turbines has passed through one or more other powerhouses. Few fish would be vulnerable to entrainment from this source. Due to the principal source of flow, the relative numbers of additional fish vulnerable to entrainment in the source waterbody is low. Big Creek Powerhouse 3 has five Francis Vertical Reaction turbines and a higher head of 827 feet (Figure CAWG 9 Appendix A-16). If fish were entrained, the potential for turbine mortality would be low to high. Intake velocities are generally low. Fish presence near the intake face is rated low. Overall fish vulnerability to entrainment at the intake is low (Table CAWG 9-7). Since the relative numbers of additional fish vulnerable to entrainment in Powerhouse 3 Forebay is low, Powerhouse 3 was given a low priority and not selected for further evaluation.

5.1.1.9 Summary of Entrainment Vulnerability at Major Intakes

The Pelton Impulse turbines at Big Creek Powerhouse 1 (intake in Huntington Lake) and Big Creek Powerhouse 2A (intake in Shaver Lake) have a high potential for turbine mortality if fish are entrained. However, fish vulnerability to entrainment is rated low (Table CAWG 9 ES-1). Approach velocities at the intake are low (less than 1 ft/sec). Hydroacoustic sampling in the lakes (SCE 2003a) indicated most fish are not near the deep-water intakes, and if fish are present, they are likely to be larger fish with greater swimming capabilities. The Francis Reaction turbines used at Mammoth Pool Powerhouse (intake in Mammoth Pool) and Eastwood Power Station (intake in Balsam Meadow Forebay) have a lower potential for turbine mortality than do Pelton Impulse Turbines. However, head at these locations is relatively high and potential turbine mortality would be low to high, if fish were entrained. Fish vulnerability to entrainment is rated low to medium. Intake velocities are generally low (less than 1 ft/sec), occasionally reaching the medium (1 to 3 ft/sec) range, and fish presence near the intakes is low. Based on the initial evaluations, little to no fish entrainment was expected through these powerhouses, but these were selected for sampling with the CAWG's concurrence to verify the evaluations.

5.1.2 Entrainment Vulnerability at Small and Medium Sized Diversions

A summary of small and medium sized diversions and fish species present during CAWG 7 sampling (SCE 2003a) is presented in Tables CAWG 9-17 and 9-18.

In the larger creeks, such as Bear and Pitman Creeks, most water was generally diverted for some part of the year in all water year types. Mono Creek is a somewhat different case, in that it is part of the conveyance system for moving Lake Edison water to the Ward Tunnel. In the small creeks, such as Hooper and Bolsillo Creeks, flows are diverted during runoff. There is frequently no flow diverted in late summer, fall, and winter in most water year types. In wet water year types, flow often is not diverted until later summer. Most diversions on small creeks are turned out (not diverting) during winter (SCE 2004b).

5.1.2.1 Upper Basin Small Diversions

The upper basin diversions are located on tributaries to the South Fork San Joaquin River (SFSJR). Five diversions in the upper basin divert water to Florence Lake, which feeds Ward Tunnel; these include Tombstone, South Slide, North Slide, Hooper, and Crater Creeks (Figures CAWG 9 Appendix A-17 through A-21). The other upper basin small diversions divert water directly to Ward Tunnel. These include Camp 62 Creek, Chinquapin Creek, and Bolsillo Creek diversions (Figures CAWG 9 Appendix A-22, A-23, and A-24, respectively).

Tombstone Creek

Tombstone Creek is not currently operational. The diversion was out of service during the study period and no fish was observed above the diversion. Tombstone has a horizontal intake with a 14-inch diameter conduit controlled by a head gate, which diverts water through a natural channel to Florence Lake (Figure CAWG 9 Appendix A-17). Fish were not observed above the diversion. Only brown trout were observed below the diversion (SCE 2003a).

South Slide Creek

The South Slide Creek diversion is not currently operational. The diversion was out of service during the study period and no fish were observed above or below the diversion (SCE 2003a). South Slide Creek has a horizontal intake with an eight-inch diameter conduit controlled by a head gate, which diverts water to the Hooper Creek conduit (Figure CAWG 9 Appendix A-18), which discharges to Florence Lake.

North Slide Creek

North Slide Creek diversion is not currently operational. The diversion was out of service during the study period and no fish were observed above or below the diversion (SCE 2003a). North Slide Creek has a horizontal intake with an eight-inch diameter conduit controlled by a head gate, which diverts water through the Hooper Creek conduit to Florence Lake (Figure CAWG 9 Appendix A-19).

Hooper Creek

Flow from Hooper Creek is diverted through a 34-inch diameter pipe to Florence Lake, which is controlled by a head gate (Figure CAWG 9 Appendix A-20). Multiple age classes of rainbow trout that showed signs of rainbow/golden trout hybridization were observed upstream and downstream of the diversion (SCE 2003a).

Crater Creek

Flow from Crater Creek is diverted through a man-made ditch and natural channel to Florence Lake (Figure CAWG 9 Appendix A-21). Multiple age classes of brook trout were observed upstream and downstream of the diversion (SCE 2003a).

Camp 62 Creek

Flow from Camp 62 Creek is diverted through a 24-inch diameter pipe to Ward Tunnel Adit No 1, controlled by a head gate (Figure CAWG 9 Appendix A-22). Multiple age classes of brook trout were observed upstream and downstream of the diversion (SCE 2003a).

Chinquapin Creek

Chinquapin Creek is a tributary of Camp 62 Creek. Flow from Chinquapin Creek is diverted through a 24-inch diameter pipe to Ward Tunnel Adit No 1, controlled by a head gate (Figure CAWG 9 Appendix A-23). Multiple age classes of brook trout were observed upstream and downstream of the diversion (SCE 2003a).

Bolsillo Creek

Flow from Bolsillo Creek is diverted through a vertical bore hole into Ward Tunnel. The flow into Ward Tunnel is not controlled by a valve (Figure CAWG 9 Appendix A-24). Multiple age classes of brook trout were observed upstream and downstream of the diversion (SCE 2003a).

5.1.2.2 Upper Basin – Medium Sized Diversions

Bear Creek

Bear Creek Diversion forms an impoundment on Bear Creek and diverts water to the Mono-Bear Siphon, which conveys water to Ward Tunnel. Bear Creek Diversion is a constant-radius, concrete arch diversion, 55 feet high. Diverted water is conveyed through a seven-foot cross section, 7,596-foot-long tunnel through granite into the Mono-Bear Siphon. Flow through the conduit is controlled by a manually operated 7.5-foot-wide by 15-foot-high radial gate, located in the outlet works on the right abutment of the diversion (Figure CAWG 9 Appendix A-25).

Based on flow records at the Bear Creek Conduit near Lake Thomas A Edison Gage (USGS gage 11230520) between 1983 and 2002, the monthly, 50 percent exceedance value flow has an associated intake approach velocity of 0.05 to 1.00 ft/sec, in the low vulnerability category. The highest monthly value occurs in May (Table CAWG 9-19). Calculated velocities resulting from 20 percent exceedance flow values were 1.50 ft/sec (May) or less.

Multiple age classes of brown trout were observed upstream and downstream of the diversion (SCE 2003a). Rainbow trout were observed in the Bear Creek Diversion Dam Forebay (SCE 2003a).

<u>Mono Creek</u>

Mono Creek Diversion forms an impoundment on Mono Creek and diverts water to the Mono Bear Siphon, which conveys flow to Ward Tunnel. Mono Creek upstream of the diversion is used in the conveyance of stored water at Lake Edison to the Ward Tunnel and Huntington Lake. The Mono Creek Diversion is a constant-radius, concrete arch diversion, 64 feet high. Diverted water from Mono Creek is conveyed through a 92-inch-diameter, 4,538-foot-long, steel pipe, an eight-foot to 9.5-foot cross section, 3,933-foot-long, bore through granite, and a 102-inch, 13,806-foot-long, steel pipe into Ward Tunnel Adit No. 1. Flow through the conduit is controlled by a manually operated six by nine-foot slide gate, located in the outlet works on the left abutment of the diversion (Figure CAWG 9 Appendix A-26).

Based on flow records at the Mono Creek Conduit near Mono Hot Springs Gage (USGS gage 11231550) between 1983 and 2002, the monthly, 50 percent exceedance value flow has an associated intake approach velocity of 0.05 to 1.05 ft/sec, with the highest value only slightly higher than the low vulnerability category. The highest monthly value occurs in August (Table CAWG 9-20). Velocities resulting from 20 percent exceedance flow values were 1.48 ft/sec (August) or less.

Brown trout and rainbow trout were observed upstream and downstream of the diversion (SCE 2003a). Brown trout and hatchery-raised rainbow trout were observed in the Mono Creek Diversion Dam Forebay (SCE 2003a).

5.1.2.3 Pitman Creek and Tributaries to Big Creek - Small Diversions

<u>Pitman Creek</u>

Pitman Creek is a tributary of Big Creek (Big Creek RM 6.3). Flow from Pitman Creek is diverted through Tunnel 7 (also known as the Huntington-Pitman siphon), which also transports water from Huntington Lake to Balsam Meadow Forebay and North Fork Stevenson Creek. The diversion has a vertical bore intake into Tunnel 7, and has vertical and horizontal trash grids (not included in CAWG 9 Appendix A; no current photos available).

Rainbow trout (73 percent) dominated the sampled fish community upstream of Pitman Creek Diversion, with smaller components of brown and brook trout. Multiple age classes, including age 0+ trout, were collected and the populations appear to be self-sustaining (SCE 2003a).

<u>Balsam Creek</u>

Balsam Creek, a small, steep, bedrock stream, has its confluence with Big Creek in the Dam 4 to Powerhouse 2 reach (Big Creek RM 4.9) (Figure CAWG 9 Appendix A-27).

An instream flow release from Balsam Meadow Forebay is made to the creek at Balsam Dam at Balsam Creek RM 2.75. Flow from the Balsam Creek diversion (0.7 miles upstream of the confluence with Big Creek) is diverted to Tunnel 2 where it flows to Powerhouse 2. The diversion has a horizontal intake and a 12-inch diameter conduit to Tunnel 2, controlled by an upstream gate valve.

Multiple age classes of rainbow trout, including age 0+, were collected upstream of the diversion during the CAWG 7 sampling program (SCE 2003a). Fish density (1,335 fish/km) and biomass (171.6 kg/ha) were high. Numerous natural barriers throughout Balsam Creek are likely to fragment habitat in Balsam Creek.

<u>Ely Creek</u>

Ely Creek is a very steep, bedrock/boulder stream with its confluence with Big Creek (Big Creek RM 3.32) within the Dam 4 to Powerhouse 2 reach (Figure CAWG 9 Appendix A-28). The diversion is located approximately 1.1 miles upstream of the confluence with Big Creek. The diversion has a horizontal intake and a 12-inch diameter conduit to Tunnel 2, controlled by an upstream gate valve.

Only rainbow trout aged 3+ and older were collected from Ely Creek upstream of the diversion, which may be due to the limited availability of suitable spawning and rearing habitat (SCE 2003a).

<u>Adit 8 Creek</u>

Adit 8 Creek has its confluence with Big Creek at Big Creek RM 2.6 (Figure CAWG 9 Appendix A-29). Although currently not in use, the Adit 8 Diversion can be used to divert Tunnel 5 water (from Shaver Lake) into Tunnel 2 (to Powerhouse 2). The diversion has not been operated in many years. The stream above the diversion was not surveyed because it could not be safely accessed. Adit 8 was evaluated downstream of the diversion, much of the creek was dry, and no fish was observed.

5.1.2.4 Tributaries to San Joaquin River Mammoth Reach - Small Diversions

<u>Rock Creek</u>

Rock Creek (SJR RM 22.55) is a steep, bedrock/boulder stream (Figure CAWG 9 Appendix A-30). Flow is diverted into the Mammoth Pool Power Tunnel. The intake is a horizontal conduit to a vertical borehole. Flow is diverted through a 20-inch diameter pipe to a vertical borehole to the Mammoth Pool Power Tunnel. The diversion is controlled by a head gate. Rock Creek is designed to operate passively and at very low flows does not divert water.

Brown and rainbow trout were collected upstream of Rock Creek Diversion (Rock Creek RM 0.4). Multiple age classes of brown and rainbow trout, including age 0+ fish, were collected. The presence of rainbow trout smaller than the catchable-sized hatchery fish planted suggests rainbow trout reproduction occurs in Rock Creek or its tributaries.

Trout densities (241 to 930 fish/km) and biomass (29.0 to 91.5 kg/ha) were relatively high (SCE 2003a).

Ross Creek

Ross Creek (SJR RM 18.7) is intermittent even in wet years (Figure CAWG 9 Appendix A-31). At the time of the first habitat survey for the CAWG 1 technical study in (SCE 2003b), the upstream reach was dry. Flow, when available, is diverted into the Mammoth Pool Power Tunnel.

5.2 SAMPLING AND ENTRAINMENT EVALUATION AT SELECTED POWER INTAKES

5.2.1 SMALL DIVERSION SAMPLING

5.2.1.1 Sampling Prioritization

In order to assess the potential entrainment vulnerability of the small diversions within the Project area, a sub-sample of select small diversions was chosen. All of the upper basin diversions divert water into Ward Tunnel, which in turn, discharges through the HB valve (which does not have an associated turbine) or through Portal Powerhouse (which was studied as part of the Portal traditional license application [SCE 2003c]). Therefore, the upper basin diversions were not considered a high priority for entrainment sampling.

The Big Creek and Mammoth reach small diversions, on the other hand, lead to powerhouses and turbines. Therefore, these reaches were recommended as a high priority for entrainment sampling. It was decided, with the concurrence of the CAWG, that sampling should occur at two small diversions, one creek in each of the reaches, by netting incoming flow to the diversion pools.

Balsam and Rock Creek diversions were chosen from the Big Creek and Mammoth reaches, respectively, as the representative small diversions. Entrainment sampling occurred twice, once during near-peak (spring) run-off, and once later, during early summer run-off. A complete list of the sample periods for the small diversion entrainment study is shown in Table CAWG 9-21.

5.2.1.2 Capture Results

Three fish were collected at Rock and Balsam Creeks during the small diversion entrainment study. At Rock Creek one brown trout (168 mm SL) was captured in the trap net during the May sampling period. There were no fish captured at Balsam Creek in May. During the July sampling period, one rainbow trout was collected at both Balsam and Rock Creeks. The length of the rainbow trout collected at Balsam Creek was 138 mm SL and the rainbow trout collected at Rock Creek was 134 mm SL. The estimated density of fish moving downstream into the Rock and Balsam Creek Diversion pools is presented in Table CAWG 9-22.

The three fish collected at Balsam and Rock Creeks in May and July 2003 all were alive and were returned to the stream after capture. The fish were all collected during the nighttime sampling periods and were actively swimming in the livecar when collected.

In May 2003, stream flow in Balsam Creek was about six cfs, and stream flow in Rock Creek was about 18 cfs (Table CAWG 9-23). In July 2003, the stream flow in Balsam Creek was about three cfs, and the stream flow in Rock Creek was about five cfs (Table CAWG 9-23). The nets covered the width of the sampled streams, therefore, most of the flow traveled through the nets. However, volume calculations based on measurements made by the GO meter installed in the face of the net are presented in Table CAWG 9-22. In Balsam Creek, over one million cf of water were sampled in May 2003, and more than five hundred thousand cf of water were sampled in July 2003 (Table CAWG 9-22). In Rock Creek, close to three million cf of water were sampled in May 2003, and close to eight hundred thousand cf of water were sampled in July 2003 (Table CAWG 9-22).

5.2.1.3 Velocities

Water velocities were recorded in the diversion pool to assess potential entrainment of fish near the small diversion intakes. Velocity data collected during the May and July sampling trips at Balsam and Rock Creek diversions are presented in Tables CAWG 9-24 and 9-25. Velocities were measured at a number of different locations at varying distances, between one and seven feet, from the intake face. The highest velocities recorded in Balsam Creek and Rock Creek Diversions were 0.44 and 0.41 ft/sec, respectively, which is well below the maximum swimming capacity of the juvenile fish species that may be present.

5.2.1.4 Water Quality

Water quality measurements taken during sampling are presented in Table CAWG 9-26. Water temperatures ranged from a low of 14.3°C in May 2003 at Balsam Creek to a high of 16.7°C in May 2003 at Rock Creek.

During the study, DO measurements were relatively high, ranging from 7.4 mg/L in July 2003 at Balsam Creek to 8.3 mg/L in May 2003 also at Balsam Creek. Oxygen percent saturation was calculated for both creeks sampled, and ranged from 88 percent to 97 percent.

5.2.2 Powerhouse Entrainment (Tailrace) Sampling

5.2.2.1 Sampling Prioritization

As stated in Section 5.1.1, Powerhouse 1, Powerhouse 2A, Mammoth Pool Powerhouse, and Eastwood Powerhouse were selected for additional sampling. Sampling at these powerhouses began in the summer of 2003 and was completed in the summer of 2004. A complete list of the sample periods is shown in Tables CAWG 9-27 through 9-30.

Entrainment and subsequent turbine passage from intakes in Huntington and Shaver Lakes were identified for sampling because fish populations documented in these reservoirs (SCE 2003a) could potentially be passed through turbines with potentially high mortality rates (Section 5.1.1). Sampling was not conducted at powerhouses further downstream in this "chain" that re-entrain water originating from these same reservoirs after passing through Big Creek Powerhouses 1 and 2A, respectively. Since flow through these powerhouses represented the vast majority of flow passing through downstream powerhouses and there was no information to suggest the presence of significant additional sources of fish at these downstream powerhouses, additional sampling was determined to not be necessary. Fish populations documented in Mammoth Pool Reservoir are potentially vulnerable to entrainment mortality and this location was identified for further study. Eastwood Power Station was identified for further study by the CAWG. The tailrace of the Eastwood Power Station located in Shaver Lake was sampled. The intake for the Eastwood Power Station is in Balsam Meadow Forebay[2].

In the upper Big Creek basin (upstream of Huntington Lake), no powerhouse exists upstream of Portal Powerhouse; therefore no source of turbine mortality exists upstream of that location. Potential mortality or injury of fish through entrainment in the upper basin was examined by sampling within the Portal Powerhouse tailrace. The flow from the Ward Tunnel is discharged through the Portal Powerhouse and the adjacent HB valve. During runoff, much or all of the flow may bypass the powerhouse through the HB valve. The focus was on sampling fish that passed through the powerhouse turbine, which provided an estimate of fish entrainment losses from all intakes in the Project's upper basin. Portal Powerhouse tailrace was sampled as part of the traditional license process for the Portal Hydroelectric Power Project (FERC Project No. 2174) (SCE 2003c). A summary of the results from the entrainment studies at Portal Powerhouse is presented in CAWG 9 Appendix C.

5.2.2.2 Operations

The flows released from the powerhouses varied between sampling events, depending on water availability and system energy demand. The mean discharges for each of the sampling events at the units sampled at each of the powerhouses sampled are presented in Tables CAWG 9-31 through 9-34.

The range of daily mean flows at each powerhouse were compared to the available period of record to examine whether the flows observed during the study were typical of recent operations (Tables CAWG 9-35 through 9-38).

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[2] Eastwood Power Station may operate in generation or pumpback mode. During generation flows are withdrawn from Balsam Forebay and discharged through Eastwood Power Station to Shaver Lake. During pumpback, water is pumped from Shaver Lake to Balsam Meadow Forebay. Entrainment related to the pumpback operation was evaluated in previous studies related to the Balsam Meadow Pumped Storage Project (FERC No. 67) (SCE 19922005), in which it was determined that entrainment of fish was relatively low.

Big Creek Powerhouse 1

Units 1 and 2 of Powerhouse 1 were sampled during each sampling event. In general, Units 1 and 2 represent 50 percent of the flow capacity of the four units present at the powerhouse. During sampling events, daily mean flows through Powerhouse 1 ranged from 136 to 470 cfs (Table CAWG 9-35). These flows were compared to exceedance flows for the available period of record. The observed mean daily flow at Powerhouse 1 was lower than the 50 percent exceedance flows in July 2003, December 2003, June 2004, and August 2004. However, the observed mean daily flows for all sampling trips were within the range of the 20 percent exceedance flows and the 80 percent exceedance flows (Table CAWG 9-35). Therefore, the operation of the powerhouse over the course of the study was generally typical, compared to the period of record.

Big Creek Powerhouse 2A

Units 1 and 2 were sampled at Big Creek Powerhouse 2A during each sampling event. Units 1 and 2 represent all of the flow at Powerhouse 2A. During sampling events, daily mean flows through Powerhouse 2A ranged from 117 to 488 cfs (Table CAWG 9-36). These flows were compared to exceedance flows for the available period of record. The mean daily flow at Powerhouse 2A was lower than the 50 percent exceedance flows in February 2004, June 2004 and August 2004. However, the mean daily flows were mostly within the range of the 20 percent exceedance flows and the 80 percent exceedance flows (Table CAWG 9-36). Therefore, the operation of the powerhouse over the course of the study was generally typical compared to the period of record.

Mammoth Pool Powerhouse

Units 1 and 2 were sampled at MPPH during each sampling event. Units 1 and 2 represent all of the flow at MPPH. During sampling events, daily mean flows through MPPH ranged from 136 to 1,664 cfs (Table CAWG 9-37). These flows were compared to exceedance flows for the available period of record. The mean daily flow at MPPH was lower than the 50 percent exceedance flows in December 2003, February 2004, June 2004 and August 2004. However, the observed mean daily flows were mostly within the range of the 20 percent exceedance flows and the 80 percent exceedance flows (Table CAWG 9-37). Therefore, the operation of the powerhouse over the course of the study was generally typical compared to the period of record.

Eastwood Power Station

Unit 1 was sampled at Eastwood Power Station during each sampling event. Unit 1 represents all of the flow at the powerhouse. During sampling events, daily mean flows through Eastwood ranged from 85 to 732 cfs (Table CAWG 9-38). These flows were compared to exceedance flows for the available period of record 8. The mean daily flow observed at Eastwood was lower than the 50 percent exceedance flows in June 2004. However, the observed mean daily flows for the other sampling trips were greater than or within the range of the 20 percent exceedance flows and the 50 percent exceedance flows (Table CAWG 9-38). Therefore, the operation of the powerhouse over the course of the study was generally typical to or greater than the period of record.

5.2.2.3 Fish Capture Results

5.2.2.3.1 Big Creek Powerhouse 1

Physical and water quality conditions in the Big Creek Powerhouse 1 tailrace are reported in Table CAWG 9-39. Water temperatures at BC1 ranged from a low of 10.1°C in February 2004 to a high of 16.3°C in August 2004. Dissolved oxygen measurements were relatively high, ranging from 8.0 mg/L in September 2003 to 8.6 mg/L in both July 2003 and June 2004. Dissolved oxygen percent saturation ranged from 88 to 99 percent.

Table CAWG 9-31 presents the volume of water sampled by the Kodiak net and the estimated volume discharged at Big Creek Powerhouse 1 (BC1) through powerhouse units 1 and 2. Over 52 million cf of water were sampled over the course of the study and over 134 million cf of water passed through units 1 and 2. No fish were collected at BC1 over the course of the study.

5.2.2.3.2 Big Creek Powerhouse 2A

Physical and water quality conditions in the Big Creek Powerhouse 2A tailrace are reported in Table CAWG 9-39. Water temperatures at BC2A ranged from a low of 10.8°C in February 2004 to a high of 17.2°C in September 2003. Dissolved oxygen measurements were relatively high, ranging from 8.1 mg/L in both September 2003 and August 2004, to 9.3 mg/L in both December 2003 and February 2004. Dissolved oxygen percent saturation ranged from 93 to 98 percent.

The volume of water sampled by the Kodiak net and the estimated volume discharged at Big Creek Powerhouse 2A (BC2A) (through both powerhouse units 1 and 2) are presented in Table CAWG 9-32. Over 97 million cf of water were sampled over the course of the study and over 311 million cf of water passed through the powerhouse. There were no fish collected at BC2A over the course of the study.

5.2.2.3.3 Mammoth Pool Powerhouse

Physical and water quality conditions in the Mammoth Pool Powerhouse tailrace are reported in Table CAWG 9-40. Water temperatures at MPPH ranged from a low of 11.1°C in February 2004 to a high of 19.7°C in August 2004. Dissolved oxygen measurements were relatively high, ranging from 8.0 mg/L in September 2003, to 9.1 mg/L in both December 2003. Dissolved oxygen percent saturation ranged from 89 to 96 percent.

Table CAWG 9-33 presents the volume of water sampled by the Kodiak net and the estimated volume discharged at Mammoth Pool Powerhouse 1 through powerhouse units 1 and 2. Over 102 million cf of water were sampled over the course of the study and over 566 million cf of water passed through the powerhouse. No fish were collected at MPPH over the course of the study.

5.2.2.3.4 Eastwood Power Station

Physical and water quality conditions in the EPS tailrace are reported in Table CAWG 9-40. Water temperatures at Eastwood ranged from a low of 19.6°C in June 2004 to a high of 21.2°C in August 2003. Dissolved oxygen measurements were relatively high, ranging from 7.1 mg/L in both August 2003 and June 2004, to 7.2 mg/L in both September 2003 and August 2004. Dissolved oxygen percent saturation ranged from 95 to 97 percent.

The volume of water sampled by the Kodiak net and the estimated volume discharged at Eastwood Power Station (Eastwood) is presented in Table CAWG 9-34. Over 65 million cf of water were sampled over the course of the study and over 292 million cf of water passed through the powerhouse. There were no fish collected at Eastwood over the course of the study.

5.2.2.4 Summary

The lack of fish collected at Project powerhouses was expected. Few fish, if any, were expected to be captured at the tailraces sampled as part of this study because the initial evaluation indicated a low potential entrainment vulnerability, based on the intake depths and fish densities near powerhouse intakes. Higher potential entrainment vulnerability was expected at Portal powerhouse, where a few fish were collected during tailrace entrainment sampling (CAWG 9 Appendix C).

The trawl nets did not capture all flow that was released through the Project powerhouses, but did sample large volumes of water during fairly typical powerhouse operations. Collection gear performance was not considered to be an issue since reasonably high volumes of water were filtered through the nets and identical nets have efficiently collected fish at other tailraces, where the likelihood of entrainment was higher[3].

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[3] The identical net assemblage and some of the same crewmembers were involved in the Pit 3 and Pit 4 Powerhouse sampling events where hundreds of fish were captured in the net/livecar assemblage (PG&E 2004).

6.0 SUMMARY

An initial evaluation of entrainment potential was based on location, depth, design, and intake velocity of the intakes, as well as the distribution and vulnerability of fish to entrainment. Vulnerability to entrainment was considered low based on the low powerhouse intake velocities, the low densities of fish present near the powerhouse intakes, and the swimming speed capabilities of the fish likely near the intakes. This initial evaluation was confirmed by the results of the entrainment sampling. No fish were collected during the entrainment sampling at the Project powerhouse tailraces for Big Creek 1, Big Creek 2A, Mammoth Pool Powerhouse and Eastwood Power Station. Other large powerhouses in the Big Creek ALP, including Big Creek 2, Big Creek 8, and Big Creek 3 largely re-entrain water that has passed through one or more of the above powerhouses. This results in little potential for additional entrainment losses from these sources.

During the small diversion sampling, three fish were captured in trap nets placed upstream of the diversion pools. All three of the fish were captured during the nighttime sampling periods, and two of the three fish were captured during the summer, lower flow periods. No fish was observed to pass through the intakes at either diversion pool. The intake velocities at both diversion pools were lower than the swimming speed capability of the fish species present in the streams. Neither of the diversion pools evaluated was screened; however, potential fish entrainment vulnerability appears to be low.

7.0
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8.0
GLOSSARY OF HYDROPOWER TERMS

cavitation - The process of formation of water vapor bubbles in a liquid caused by a localized reduction in pressure, e.g. downstream of turbine blades. Noise or vibration results when the bubbles collapses as they pass into regions of higher pressure.

decompression – A lowering of pressure from the pressure that a fish is acclimated to. Sudden decreases of pressure may result in swim bladder rupture or embolism.

draft tube – A water conduit that maintains a column of water from the turbine outlet and the downstream water level.

Francis Reaction Turbine – A reaction turbine with a runner with nine or more fixed buckets (vanes). The flow through the runner is radial to the shaft.

head – The vertical change in elevation between the head water level and the tailwater level. The height of standing water.

Impulse turbine – A turbine that uses the velocity of the water to move the runner and discharges to atmospheric pressure. The water hits each bucket on the runner and there is no suction on the downstream side of the turbine. An impulse turbine is generally suitable for high head, low flow applications. The two types of impulse turbines include the Pelton and the cross-flow.

indirect mortality – Mortality of fish that experience sublethal levels of physical stress as they pass a dam, but subsequently die due to increased susceptibility to disease or predation.

Pelton Impulse Turbine – A pelton wheel has one or more free jets discharging water into an aerated space and impinging on the buckets of a runner.

pressure – Water pressure (expressed in kilopascals, where 101.3 kPa = 1 atmosphere = 14.73 psi) increases with water depth at a rate 1 atmosphere for every 34 feet. Fish residing deep in a reservoir become acclimated to high water pressures, while fish residing in surface waters are surface-acclimated. When entrained in a turbine, fish may experience rapid pressure increases and decreases of a greater magnitude than exists in nature, with the potential for physiological effects.

reaction turbine – Develops power from the combined action of pressure and moving water. A reaction turbine is generally used for sites with lower head and higher flows than impulse turbines.

runner – The rotating part of the turbine that converts the energy of falling water into mechanical energy.

shear stress – A localized force (fluid or mechanical) that acts parallel to a surface.

strike and grinding – A collision with turbine structures (strike), which is a function of fish characteristics (size, condition, behavior), turbine characteristics (number of runner blades, size of openings between vanes and blades, sharpness of blade edges, revolution rate, blade velocity), and the relationship between the fish and turbine structures (e.g. region of passage, orientation, and relative velocity). Grinding occurs when fish are squeezed through narrow openings or gaps between turbine components.

swim bladder – Internal gas bladder with a hydrostatic function (weight-regulating) in bony fish species.

tailrace – A channel that carries water away from a dam.

turbulence – Secondary, irregular motion within moving water that results in hydraulic forces on fish. Turbulence in the draft tube and tailrace is of particular concern.

TABLES

Table CAWG 9 ES-1. Potential Turbine Mortality at Major Project Intakes.

Reservoir	Major Point of Discharge	Sampled Fish Species (SCE 2003a)	Potential Turbine Mortality if Entrained	Relative Numbers of Fish in Source Waterbody	Fish Presence Near Intake Face	Intake Velocities[1]	Fish Vulnerability to Entrainment at Intake[2]	Entrainment Sampling Conducted
LARGE RESERVOIRS								
Florence Lake	Portal Powerhouse[3]	Brown trout, rainbow trout	Low	High	Low[4]	Low	Low	Yes
	HB Valve		None	-	-	-	-	No
Huntington Lake	Big Creek Powerhouse 1	Brown trout, rainbow trout, kokanee, Sacramento sucker, prickly sculpin	High	High	Low[4, 5]	Low	Low	Yes
Shaver Lake	Big Creek Powerhouse 2A	Trout, kokanee, smallmouth bass, crappie, other centrarchids, Sacramento sucker, carp	High	High	Low[4]	Low	Low	Yes
	HB Valve (Minor)		None	-	-	-	-	No
Mammoth Pool Reservoir	Mammoth Pool Powerhouse	Brown trout, rainbow trout, Sacramento sucker	Low to High	High	Low[4, 5]	Low - Medium	Low to Medium	Yes

Table CAWG 9 ES-1. Potential Turbine Mortality at Major Project Intakes (continued).

Reservoir	Major Point of Discharge	Sampled Fish Species (SCE 2003a)	Potential Turbine Mortality If Entrained	Relative Numbers of Fish in Source Waterbody	Fish Presence Near Intake Face	Intake Velocities[1]	Fish Vulnerability to Entrainment at Intake[2]	Entrainment Sampling Conducted
MEDIUM RESERVOIRS								
Balsam Meadow Forebay	Eastwood Power Station	Trout, kokanee, Sacramento sucker, prickly sculpin	Low to High	Low to Medium	Low	Low	Low to Medium	No
Powerhouse 2 Forebay (Dam 4)	Big Creek Powerhouse 2	Brown trout, rainbow trout, prickly sculpin	High	Low[6]	Big Creek Chain Discharge of PH 1 and Low	Low - Medium	Low	No
Powerhouse 8 Forebay (Dam 5)	Big Creek Powerhouse 8	Brown trout, rainbow trout, prickly sculpin	Low to High	Low[6]	Big Creek Chain Discharge of PH 2 and 2A and Low	Low - Medium	Low	No
Powerhouse 3 Forebay (Dam 6)	Big Creek Powerhouse 3	Sacramento sucker, brown trout, rainbow trout	Low to High	Low to Medium[6]	Big Creek Chain Discharge of PH 8 and MPPH and Low	Low - Medium	Low	No

[1] Velocities: Low = ≤ 1 ft/s, Medium = 1 –to 3 ft/s, High = ≤ 3 ft/s.

[2] Based on potential fish presence near intake and swimming capability of fish to escape intake velocities.

[3] Portal Hydroelectric Project addressed under a separate traditional relicensing application.

[4] Likely to be larger fish.

[5] Indicates increased numbers near intake only likely during months with very low water surface elevations.

[6] Relative numbers of fish available to entrainment is low due to most flow originating from upstream powerhouse tailrace(s).

Table CAWG 9-1. The Status of Fish Species of Waters within the Big Creek System.

Common Name	Scientific Name	Status[1]	Special Status
Hardhead	*Mylopharodon conocephalus*	N	CSC, USFS
Sacramento pikeminnow	*Ptychocheilus grandis*	N	
Carp	*Cyprinus carpio*	I	
Sacramento sucker	*Catostomus occidentalus*	N	
Kokanee	*Oncorhynchus nerka*	I	
Rainbow trout	*Oncorhynchus mykiss*	N/I[2]	
Golden trout	*Oncorhynchus mykiss aguabonita*	N/I	FSC, CSC[3]
Brown trout	*Salmo trutta*	I	
Brook trout	*Salvelinus fontinalis*	I	
Bluegill	*Lepomis macrochirus*	I	
Crappie	*Pomoxis spp.*	I	
Smallmouth bass	*Micropterus dolomieui*	I	
Prickly sculpin	*Cottus asper*	N	

[1] N= Native, I= Introduced, FSC = Federal Species of Concern, CSC = California Species of Special Concern, USFS = Sensitive Species.

[2] Rainbow trout are native to California, and were historically absent from the upper-most reaches of the South Fork San Joaquin River. Spawning anadromous rainbow trout (steelhead) may have migrated up the San Joaquin River into the lower reaches of the Project area prior to the installation of dams. Stocking of rainbow trout into the Project area included a variety of genetic strains of fish, including Kamloops, B.C., Whitney, and Coleman.

[3] The special status of golden trout is only applicable to populations in their native range, the South Fork Kern River.

Table CAWG 9-2. Major Points of Discharge and Associated Turbine Types for Large and Medium Reservoirs

	Storage (Acre-feet)	Major Point of Discharge	Head (ft)	Turbine Type
LARGE RESERVOIRS				
Florence Lake	64,406	Ward Tunnel (discharge from Ward Tunnel may be through the Portal Powerhouse or HB valve	230	Vertical Francis (Portal Powerhouse[1])
		HB Valve	-	None
Huntington Lake	89,166	Big Creek Powerhouse 1	2,131	Impulse (Pelton)
		North Fork Stevenson Creek/ Balsam Meadow Forebay	-	None
Shaver Lake	135,568	Big Creek Powerhouse 2A	2,418	Impulse (Pelton)
		HB Valve (Minor)	-	None
Mammoth Pool Reservoir	119,940	Mammoth Pool Powerhouse	1,100	Francis Reaction
MEDIUM RESERVOIRS				
Balsam Meadow Forebay	1,547	Eastwood Power Station	1,338	Francis Reaction/Pump Turbine
Powerhouse 2 Forebay (Dam 4)	60	Big Creek Powerhouse 2	1,858	Impulse (Pelton)
Powerhouse 8 Forebay (Dam 5)	49	Big Creek Powerhouse 8	713	Francis Vertical Reaction
Powerhouse 3 Forebay (Dam 6)	993	Big Creek Powerhouse 3	827	Francis Vertical Reaction

[1] Included in Traditional Relicensing.

Table CAWG 9-3. Summary of Potential Turbine Mortality by Turbine Type.

Turbine Type	Head	Literature Mortality Characterization	Likely Injury Mechanisms	Factors
Vertical Francis	Low head (<250 ft)	Low	Strikes	Rotation speed[1], fish size
Francis Reaction	Medium head (250-500 ft)[2]	Low to medium	Strikes, turbulence, release from deep water	Rotation speed[1], internal design, efficiency, depth of intake, fish size
Francis Reaction	Higher head (>500 ft)[2]	Low to high	Strikes, turbulence, release from deep water	Rotation speed[1], internal design, efficiency, depth of intake, fish size
Impulse (Pelton)	High head	High	Strikes, turbulence, shear, cavitation, release from deep water	Head, jet velocity, internal design, depth of intake

[1] Rotation speed associated with peripheral velocity, which is better correlated with injury.

[2] Head is generally not considered to be a factor for Francis Turbines, but higher head units are generally associated with faster rotation speeds.

Table CAWG 9-4. Fish Species Present[1] above Diversions and Intakes.

Study Reach	Species Present
SFSJR and Tributaries	Brown trout, brook trout, rainbow trout, rainbow x golden trout hybrids
Mammoth/SJR	Brown trout, rainbow trout, Sacramento sucker
Huntington Lake	Trout, kokanee (sockeye salmon), Sacramento sucker, prickly sculpin
Big Creek	Brown trout, rainbow trout
Shaver Lake	Trout, kokanee, smallmouth bass, crappie, other centrarchids, Sacramento sucker, carp
Balsam Meadow Forebay	Brown trout rainbow trout, kokanee, Sacramento sucker, smallmouth bass and prickly sculpin.

[1] Fish species information summarized from the CAWG 7 Fish Characterization Report (SCE 2003a).

Table CAWG 9-5. Swimming Capabilities of Fish Species Present in the Big Creek System.

Fish Species	Life Stage	Size Range (inches)	Longer-Term Swimming Velocities (Sustained)[1] (ft/s)	Short-Term Swimming Velocities (Darting or Burst) (ft/s)	Reference
Brown Trout	Adult		4-6	> 12	Bell 1986
		10		11.5	Beamish 1970
		5.1-14.6		4.5-10	Beamish 1970
Brook Trout	Juvenile	3 - 5	< 2		Bell 1986
		4.4		3.1	Beamish 1970
Sockeye (Kokanee)	Adult		4-11		Bell 1986
	Juvenile	5	<1.75	1.9-2.1	Bell 1986
Rainbow Trout	Adult	10		11.5	Beamish 1970
		8	1.6-2.3		Beamish 1970
		5.6			Beamish 1970
		4.29	2.2		Beamish 1970
		3.5	1.2		Beamish 1970
		2.2-2.4	0.8-1.4		Beamish 1970
Suckers	Adult		3-5	5-10	Bell 1986
Longnose sucker (*Catastomus catastomus*)		4-16	> 3		
White sucker (*Catastomous commersoni*)	Adult		3.15[2]		Bunt et al. 1999
Smallmouth Bass	Adult		1.6 to 3.9		Bunt et al. 1999
	Adult		3.25*		Bunt et al. 1999
	Fry		0.2-0.98		Larimore and Duever 1968
Carp		13.8		7.7	Beamish 1970
		5.3	5.6		Beamish 1970

[1] Sustained velocities including critical velocities when time is greater than five minutes, frequently much longer.

[2] Maximum velocity used in passage.

Table CAWG 9-6. Depth and Surface Area of Project Intakes[1].

Site	Average Yearly Water Surface Elevation[2] (feet above MSL)		Intake Invert Elevation (feet above MSL)	Intake Surface Area (sq. ft.)
	Maximum	Minimum		
LARGE RESERVOIRS				
Florence Lake	7323.0	7230.8	7220.0	3,325.5
Huntington Lake (Tunnel 1)	6949.6	6901.8	6821.0	1,267.4
Huntington Lake (Tunnel 7)	6949.6	6901.8	6885.0	1,908.0
Shaver Lake	5359.8	5321.5	5225.0	4,282.0
Mammoth Pool	3325.3	3175.7	3100.0	2,904.0
MEDIUM RESERVOIRS				
Balsam Meadow Forebay	6662.0	6639.0	6600.0	1,242
Powerhouse 2 Forebay (Dam 4)[3]	4808.0	4799.0	4776.5	558.3
Powerhouse 8 Forebay (Dam 5)[2]	2942.0	2938.0	2921.5	960.0
Powerhouse 3 Forebay (Dam 6)[2]	2229.0	2214.0	2151.0	3,318.0

[1] Information gathered from the *CAWG 1 Characterize Stream and Reservoir Habitats Technical Study Report* (2003b), and intake drawings.

[2] Based on flow record: 1980-2001 for large reservoirs; 2000-2002 for Dam 4 and Dam 5 Forebays, and 1999-2002 for Balsam Meadow Forebay and Dam 6 Forebay.

[3] Water Surface Elevation (WSE) rarely varies significantly over the year, but occasionally drops to the low elevation listed.

Table CAWG 9-7. Potential Turbine Mortality by Location.

Reservoir	Major Point of Discharge	Potential Turbine Mortality If Entrained[1]	Relative Numbers of Fish in Source Waterbody[2]	Fish Presence Near Intake Face[2]	Intake Velocities[3]	Fish Vulnerability to Entrainment at Intake[4]
LARGE RESERVOIRS						
Florence Lake	Portal Powerhouse[5]	Low	High	Low	Low	Low
	HB Valve	None	-	-	-	-
Huntington Lake	Big Creek Powerhouse 1	High	High	Low[6, 7]	Low	Low
Shaver Lake	Big Creek Powerhouse 2A	High	High	Low[6]	Low	Low
	HB Valve (Minor)	None	-	-	-	-
Mammoth Pool Reservoir	Mammoth Pool Powerhouse	Low to High	High	Low[6, 7]	Low	Low to Medium
MEDIUM RESERVOIRS						
Balsam Meadow Forebay	Eastwood Power Station	Low to High	Low to Medium	Low	Low	Low to Medium
Powerhouse 2 Forebay (Dam 4)	Big Creek Powerhouse 2	High	Low[8]	Big Creek Chain Discharge of PH 1& Low[8]	Low - Medium	Low
Powerhouse 8 Forebay (Dam 5)	Big Creek Powerhouse 8	Low to High	Low[8]	Big Creek Chain Discharge of PH 2 and 2A & Low[8]	Low - Medium	Low
Powerhouse 3 Forebay (Dam 6)	Big Creek Powerhouse 3	Low to High	Low to Medium[8]	Big Creek Chain Discharge of PH 8 and MPPH & Low[8]	Low - Medium	Low

1 From Tables CAWG 9-2 and 9-3.
2 See Figures CAWG 9-3 through 9-10 for density information for large reservoirs and large reservoir intakes.
3 Velocities: Low ≤ 1 ft/s, Medium = 1 to 3 ft/s, High ≥ 3 ft/s.
4 Based on potential fish presence near intake and swimming capability of fish to escape intake velocities.
5 Portal Hydroelectric Project addressed under a separate traditional relicensing application.
6 Likely to be larger fish.
7 Indicates increased numbers near intake only likely during months with very low water surface elevations.
8 Relative numbers of fish available to entrainment is low due to most flow originating from upstream powerhouse tailrace(s).

Table CAWG 9-8. Historical Exceedance Flows at Ward Tunnel at Intake at Florence Lake gage (USGS gage 11229500) and Corresponding Intake Approach Velocities.

Flow Exceedances (cfs)
Station: Ward Tunnel at Intake at Florence Lake (gage 11229500)
(10/1/1982 to 9/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	78	100	188	400	753	925	763	696	562	387	107	103
50	36	55	102	260	389	478	573	441	308	86	23	28
80	7	20	64	138	154	208	307	234	64	8	7	7

Associated Intake Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.02	0.03	0.06	0.12	0.23	0.28	0.23	0.21	0.17	0.12	0.03	0.03
50	0.01	0.02	0.03	0.08	0.12	0.14	0.17	0.13	0.09	0.03	0.01	0.01
80	0.00	0.01	0.02	0.04	0.05	0.06	0.09	0.07	0.02	0.00	0.00	0.00

Table CAWG 9-9. Historical Exceedance Flows at Big Creek Powerhouse 1 at Big Creek gage (USGS gage 11238100) and Corresponding Intake Approach Velocities at Tunnel 1 Intake in Huntington Lake.

Flow Exceedances (cfs)
Station: Big Creek Powerhouse 1 At Big Creek (11238100)
(10/01/1982 to 09/30/1983, 10/01/1984 to 09/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	517	542	575	592	665	669	615	598	580	464	436	455
50	227	228	315	403	555	566	564	545	463	294	212	256
80	67	73	123	180	294	301	354	317	226	116	108	101

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.41	0.43	0.45	0.47	0.52	0.53	0.49	0.47	0.46	0.37	0.34	0.36
50	0.18	0.18	0.25	0.32	0.44	0.45	0.45	0.43	0.37	0.23	0.17	0.20
80	0.05	0.06	0.10	0.14	0.23	0.24	0.28	0.25	0.18	0.09	0.09	0.08

Table CAWG 9-10. Historical Exceedance Flows at Huntington-Shaver Conduit at Huntington Lake gage (USGS gage 11236080) and Corresponding Intake Approach Velocities at Tunnel 7 Intake in Huntington Lake.

Flow Exceedances (cfs)
Station: Huntington-Shaver Conduit at Huntington Lake (gage 11236080)
(10/1/1974 to 9/30/1983)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	29	251	412	477	949	1110	645	584	74	3	1	1
50	1	1	2	13	393	607	283	2	2	1	1	1
80	0	0	0	1	5	1	1	1	1	1	0	0

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.02	0.13	0.22	0.25	0.50	0.58	0.34	0.31	0.04	0.00	0.00	0.00
50	0.00	0.00	0.00	0.01	0.21	0.32	0.15	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table CAWG 9-11. Historical Exceedance Flows at Big Creek Powerhouse 2A Near Big Creek gage (USGS gage 11238400) and Corresponding Powerhouse 2A Intake Approach Velocities in Shaver Lake.

Flow Exceedances (cfs)
Station: Big Creek Powerhouse 2a Near Big Creek (11238400)
(10/01/1982 to 09/30/1983, 10/01/1984 to 09/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	355	501	603	620	620	620	620	620	609	509	399	449
50	218	232	295	298	331	469	472	451	435	293	219	211
80	46	45	109	124	209	246	340	299	252	115	34	51

Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.08	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.12	0.09	0.10
50	0.05	0.05	0.07	0.07	0.08	0.11	0.11	0.11	0.10	0.07	0.05	0.05
80	0.01	0.01	0.03	0.03	0.05	0.06	0.08	0.07	0.06	0.03	0.01	0.01

Table CAWG 9-12. Historical Exceedance Flows at Mammoth Pool Powerhouse Near Big Creek gage (USGS gage 11235100) and Corresponding Intake Approach Velocities at the Mammoth Pool Powerhouse Intake in Mammoth Pool.

Flow Exceedances (cfs)
Station: Mammoth Pool Powerhouse Near Big Creek (11235100)
(10/01/1982 to 09/30/1983, 10/01/1984 to 09/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	960	1180	2270	2365	2365	2365	2110	1230	983	574	515	635
50	361	585	1180	1820	2130	1960	1020	777	514	260	221	217
80	131	210	725	1080	1240	842	630	494	239	43	11	51

Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.33	0.41	0.78	0.81	0.81	0.81	0.73	0.42	0.34	0.20	0.18	0.22
50	0.12	0.20	0.41	0.63	0.73	0.67	0.35	0.27	0.18	0.09	0.08	0.07
80	0.05	0.07	0.25	0.37	0.43	0.29	0.22	0.17	0.08	0.01	0.00	0.02

Table CAWG 9-13. Historical Exceedance Flows at Eastwood Power Station and Corresponding Intake Approach Velocities at Eastwood Power Station Tunnel Intake in Balsam Meadow Forebay.

Flow Exceedances (cfs)
Station: Eastwood Power Station
(10/01/1987 to 9/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	467	431	466	756	1260	1330	963	832	597	547	440	469
50	280	230	187	368	807	843	634	570	456	330	201	280
80	1	0	0	0	305	465	378	304	234	0	0	4

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.37	0.34	0.37	0.60	1.01	1.06	0.77	0.67	0.48	0.44	0.35	0.38
50	0.22	0.18	0.15	0.29	0.65	0.67	0.51	0.46	0.36	0.26	0.16	0.22
80	0.00	0.00	0.00	0.00	0.24	0.37	0.30	0.24	0.19	0.00	0.00	0.00

Table CAWG 9-14. Historical Exceedance Flows at Big Creek Powerhouse 2 Near Big Creek gage (USGS gage 11238380) and Corresponding Intake Approach Velocities at Dam 4.

Flow Exceedances (cfs)
Station: Big Creek Powerhouse 2 Near Big Creek (11238380)
(10/01/1982 to 09/30/1983, 10/01/1984 to 09/30/1994, 10/01/1995 to 09/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	543	507	594	600	603	601	602	594	594	475	447	489
50	223	217	304	378	493	519	546	529	453	311	229	279
80	69	73	125	180	291	295	348	299	217	115	129	139

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.97	0.91	1.06	1.07	1.08	1.08	1.08	1.06	1.06	0.85	0.80	0.88
50	0.40	0.39	0.54	0.68	0.88	0.93	0.98	0.95	0.81	0.56	0.41	0.50
80	0.12	0.13	0.22	0.32	0.52	0.53	0.62	0.54	0.39	0.21	0.23	0.25

Table CAWG 9-15. Historical Exceedance Flows at Big Creek Powerhouse 8 Near Big Creek gage (USGS gage 11238550) and Corresponding Intake Approach Velocities at Dam 5.

Flow Exceedances (cfs)
Station: Big Creek Powerhouse 8 Near Big Creek (11238550)
(10/01/1982 to 09/30/1983, 10/01/1984 to 09/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	716	892	1060	1180	1290	1310	1270	1220	1160	928	660	595
50	468	484	630	681	850	968	995	958	852	529	464	459
80	215	245	311	387	549	577	701	646	500	307	234	247

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.75	0.93	1.10	1.23	1.34	1.36	1.32	1.27	1.21	0.97	0.69	0.62
50	0.49	0.50	0.66	0.71	0.89	1.01	1.04	1.00	0.89	0.55	0.48	0.48
80	0.22	0.26	0.32	0.40	0.57	0.60	0.73	0.67	0.52	0.32	0.24	0.26

Table CAWG 9-16. Historical Exceedance Flows at Big Creek Powerhouse 3 Near Shaver Lake gage (USGS gage 11241800) and Corresponding Intake Approach Velocities at Dam 6.

Flow Exceedances (cfs)
Station: Big Creek Powerhouse 3 Near Shaver Lake (11241800)
(10/01/1982 to 09/30/1983, 10/01/1984 to 09/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	1610	2210	2960	3270	3320	3250	3240	2370	2140	1510	1140	1350
50	842	1120	1760	2650	2930	2680	1910	1720	1310	891	703	706
80	365	500	1280	1740	1860	1550	1420	1180	880	473	376	415

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.49	0.67	0.89	0.99	1.00	0.98	0.98	0.71	0.64	0.46	0.34	0.41
50	0.25	0.34	0.53	0.80	0.88	0.81	0.58	0.52	0.39	0.27	0.21	0.21
80	0.11	0.15	0.39	0.52	0.56	0.47	0.43	0.36	0.27	0.14	0.11	0.13

Table CAWG 9-17. Intake Description and Sampled Fish Species for Small and Medium Sized Diversions, Upper Basin Tributaries.

Diversion Name	Elevation (ft.)	Intake Orientation	Type of Diversion	Fish Present Above Diversion
SMALL SIZED UPPER BASIN TRIBUTARIES (WITH OUT-OF-SERVICE DIVERSIONS)				
Tombstone Creek[1]	7673	Horizontal	Combination 14-inch diameter conduit controlled by head gate and natural channel to Florence Lake.	No Fish Observed
South Slide Creek[1]	7501	Horizontal	8-inch diameter pipe to Hooper conduit, controlled by head gate.	No Fish Observed
North Slide Creek[1]	7501	Horizontal	8-inch diameter pipe to Hooper conduit, controlled by head gate.	No Fish Observed
SMALL SIZED UPPER BASIN TRIBUTARIES (WITH OPERATING DIVERSIONS)				
Hooper Creek	7507	Horizontal	34-inch diameter pipe to Florence Lake, controlled by head gate.	Golden x Rainbow Trout
Crater Creek	8764	Horizontal	Man made ditch and natural channel to Florence Lake.	Brook Trout
Camp 62 Creek	7257	Vertical	24-inch diameter pipe to Ward Tunnel Adit #1, controlled by head gate.	Brook Trout
Chinquapin Creek	7273	Vertical	24-inch diameter pipe to Ward Tunnel Adit #1, controlled by head gate.	Brook Trout
Bolsillo Creek	7538	Vertical	Vertical bore hole into Ward Tunnel, 66-inch diameter hole tapers to 10 inch granite hole, uncontrolled.	Brook Trout
MEDIUM SIZED UPPER BASIN TRIBUTARIES (WITH OPERATING DIVERSIONS)				
Bear Creek	7356	Horizontal	Seven by seven, cross section steel pipe, bore through granite into the Mono-Bear Siphon, controlled by a manually operated radial gate.	Brown Trout and Rainbow Trout (in the impoundment)
Mono Creek	7360	Horizontal	92-inch diameter pipe, bore through granite, and a 102-inch pipe into Ward Tunnel Adit #1, controlled by a slide gate.	Brown Trout and Hatchery Rainbow Trout (in the impoundment)

1. Not in operation.

Table CAWG 9-18. Intake Description and Sampled Fish Species for Small Diversions, Big Creek and Mammoth Reach Tributaries.

Diversion Name	Elevation (ft.)	Intake Orientation	Type of Diversion	Fish Present Above Diversion
BIG CREEK TRIBUTARIES				
Pitman Creek	6998	Vertical	Vertical bore hole into Tunnel #7, has vertical and horizontal trash grids.	Brook, Rainbow, and Brown Trout
Balsam Creek	4841	Horizontal	12-inch diameter conduit to Tunnel #2, controlled by upstream gate valve.	Rainbow Trout
Ely Creek	4845	Horizontal	12-inch diameter conduit to Tunnel #2, controlled by upstream gate valve.	Golden x Rainbow Trout and Rainbow Trout
Adit 8 Creek	4832	Horizontal	Vertical bore hole into tunnel #2.	No Fish Observed
MAMMOTH REACH TRIBUTARIES				
Rock Creek	3336	Horizontal conduit to vertical bore hole	20-inch diameter pipe to a vertical bore hole down to Mammoth Pool Power Tunnel, controlled by head gate.	Brown Trout and Rainbow Trout
Ross Creek	3359	Horizontal conduit to vertical bore hole	12-inch diameter pipe to a 10-inch vertical bore hole down to Mammoth Pool Power Tunnel.	No Fish Observed

Table CAWG 9-19. Historical Exceedance Flows at Bear Creek Conduit near Lake Thomas A Edison gage (USGS gage 11230520) and Corresponding Intake Approach Velocities at Bear Creek Diversion.

Flow Exceedances (cfs)
Station: Bear Creek Conduit near Lake Thomas A Edison (gage 11230520)
(10/1/1983 to 9/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	29	31	50	141	329	297	151	78	33	22	23	27
50	19	22	31	76	220	186	61	27	14	12	12	13
80	5	8	21	41	125	51	28	12	3	4	6	4

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.13	0.14	0.23	0.64	1.50	1.35	0.69	0.35	0.15	0.10	0.10	0.12
50	0.09	0.10	0.14	0.35	1.00	0.85	0.28	0.12	0.06	0.05	0.05	0.06
80	0.02	0.04	0.10	0.19	0.57	0.23	0.13	0.05	0.01	0.02	0.03	0.02

Table CAWG 9-20. Historical Exceedance Flows at Mono Creek Conduit near Mono Hot Springs gage (USGS gage 11231550) and Corresponding Intake Approach Velocities at Mono Creek Diversion.

Flow Exceedances (cfs)
Station: Mono Creek Conduit near Mono Hot Springs (gage 11231550)
(10/1/1983 to 9/30/2002)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	256	167	361	218	72	125	350	410	404	206	381	283
50	26	36	78	65	14	14	193	290	113	20	69	39
80	8	8	11	15	6	6	14	116	20	8	11	10

Intake Approach Velocities (ft/s)

Percent	January	February	March	April	May	June	July	August	September	October	November	December
20	0.92	0.60	1.30	0.79	0.26	0.45	1.26	1.48	1.46	0.74	1.37	1.02
50	0.09	0.13	0.28	0.23	0.05	0.05	0.70	1.05	0.41	0.07	0.25	0.14
80	0.03	0.03	0.04	0.05	0.02	0.02	0.05	0.42	0.07	0.03	0.04	0.04

Table CAWG 9-21. Daytime and Nighttime Sampling Periods for Small Diversions. Upstream of the Balsam Creek and Rock Creek Diversion Intakes, 2003.

Creek	Sample Period	Start Date	Start Time	End Date	End Time
Balsam	Night	28-May-03	18:07	29-May-03	10:15
Balsam	Day	29-May-03	10:15	29-May-03	17:13
Balsam	Night	29-May-03	17:13	30-May-03	12:35
Balsam	Day	30-May-03	12:35	30-May-03	16:57
Balsam	Night	01-Jul-03	16:33	02-Jul-03	9:40
Balsam	Day	02-Jul-03	9:40	02-Jul-03	15:16
Balsam	Night	02-Jul-03	15:16	03-Jul-03	10:15
Balsam	Day	03-Jul-03	10:15	03-Jul-03	17:45
Rock	Night	28-May-03	16:02	29-May-03	12:20
Rock	Day	29-May-03	12:20	29-May-03	15:54
Rock	Night	29-May-03	15:54	30-May-03	11:09
Rock	Day	30-May-03	11:09	30-May-03	14:10
Rock	Night	01-Jul-03	18:11	02-Jul-03	11:00
Rock	Day	02-Jul-03	11:00	02-Jul-03	16:24
Rock	Night	02-Jul-03	16:24	03-Jul-03	11:45
Rock	Day	03-Jul-03	11:45	03-Jul-03	16:00

Table CAWG 9-22. Estimated Fish Densities and Water Volume Sampled by the Nets for the Small Diversion Sampling Study at Balsam Creek and Rock Creek, 2003.

Stream	Period	Date	Time Sampled (hours)	Number of Fish Captured	Volume Through Net Mouth[1] (ft^3)	Estimated Sample Density ($fish/ft^3$)
Balsam	Night	28-May-03	16.13	0	379,575	0
Balsam	Day	29-May-03	6.97	0	169,565	0
Balsam	Night	29-May-03	19.37	0	461,983	0
Balsam	Day	30-May-03	4.37	0	105,066	0
Balsam	Night	01-Jul-03	17.12	0	184,920	0
Balsam	Day	02-Jul-03	5.60	0	59,013	0
Balsam	Night	02-Jul-03	18.98	1	207,605	$4.82x10^{-6}$
Balsam	Day	03-Jul-03	7.50	0	81,855	0
Rock	Night	28-May-03	20.30	0	1,279,547	0
Rock	Day	29-May-03	3.57	0	202,428	0
Rock	Night	29-May-03	19.25	1	1,281,035	$7.81x10^{-7}$
Rock	Day	30-May-03	3.02	0	208,005	0
Rock	Night	01-Jul-03	16.82	0	276,778	0
Rock	Day	02-Jul-03	5.40	0	93,251	0
Rock	Night	02-Jul-03	19.35	1	343,327	$2.91x10^{-6}$
Rock	Day	03-Jul-03	4.25	0	76,676	0

[1] The volumes calculated in this table are based on the velocities measured by the velocity meter installed in the face of the net. The nets covered the width of the sampled streams, therefore, most of the flow traveled through the nets. However, volume calculations based on measurements made by the velocity meter installed in the face of the net are potentially higher than the actual flow in the stream (velocities in the center of the stream [the center of the net face] are generally higher than at the sides of the stream).

Table CAWG 9-23. Stream Flow Measurements for Balsam and Rock Creeks, 2003.

Site	Date	Stream Flow (ft^3/sec)
Balsam Creek	May 29, 2003	6.5
Balsam Creek	May 30, 2003	6.8
Rock Creek	May 29, 2003	18.2
Rock Creek	May 30, 2003	18.6
Balsam Creek	July 2, 2003	3.0
Balsam Creek	July 3, 2003	2.8
Rock Creek	July 2, 2003	5.0
Rock Creek	July 3, 2003	4.6

Table CAWG 9-24. Velocity Measurements Around Intake Structures and Inside Diversion Pools for Balsam and Rock Creeks, May 29, 2003.

Balsam Creek

Orientation	Distance From Intake Face (ft)	Depth (ft)	Velocity (bottom) (ft/sec)	Velocity (middle) (ft/sec)	Velocity (top) (ft/sec)
Parallel to Intake Face	1.0	6.60	0.14	0.07	0.19
	4.0	6.30	0.22	0.01	0.01
	7.0	6.30	0.03	0.01	0.16
Left Side[1] of Intake Face	3.5	7.20	0.01	0.04	0.10
	6.5	7.30	0.18	0.06	0.24
Right Side[1] of Intake Face	3.5	6.70	0.00	0.00	0.00
	6.5	6.20	0.00	0.00	0.00

Rock Creek

Orientation	Distance From Intake Face (ft)	Depth (ft)	Velocity (bottom) (ft/sec)	Velocity (middle) (ft/sec)	Velocity (top) (ft/sec)
Parallel to Intake Face	4.0 [2]	5.80	0.05	0.27	0.41
	7.0	6.00	0.01	0.36	0.20
	10.0	5.25	0.00	0.33	0.41
Left Side[1] of Intake Face	3.5	4.20	0.03	0.12	0.19
	6.5	4.20	0.01	0.01	0.02
Right Side[1] of Intake Face	[3]	-	-	-	-

[1] Looking upstream.

[2] Closest point due to trash rack.

[3] Could not measure velocities on right side due to debris build-up.

Table CAWG 9-25. Velocity Measurements around Intake Structures and Inside Diversion Pools for Balsam and Rock Creeks, July 2, 2003.

Balsam Creek

Orientation	Distance From Intake Face (ft)	Depth (ft)	Velocity (bottom) (ft/sec)	Velocity (middle) (ft/sec)	Velocity (top) (ft/sec)
Parallel to Intake Face	1.0	6.00	0.00	0.02	0.44
	4.0	5.70	0.00	0.00	0.00
	7.0	-	-	-	-
Left Side[1] of Intake Face	3.5	6.60	0.07	0.00	0.00
	6.5	6.70	0.00	0.00	0.00
Right Side[1] of Intake Face	3.5	6.10	0.37	0.10	0.00
	6.5	5.60	0.00	0.00	0.00

Rock Creek

Orientation	Distance From Intake Face (ft)	Depth (ft)	Velocity (bottom) (ft/sec)	Velocity (middle) (ft/sec)	Velocity (top) (ft/sec)
Parallel to Intake Face	4.0 [2]	3.15	0.00	0.00	0.03
	7.0	3.35	0.00	0.05	0.04
	10.0	2.60	0.07	0.05	0.07
Left Side[1] of Intake Face	3.5	2.00	0.00	0.00	0.00
	6.5	2.00	0.00	0.00	0.00
Right Side[1] of Intake Face	[3]	-	-	-	-

[1] Looking upstream.

[2] Closest point due to trash rack.

[3] Could not measure velocities on right side due to debris build-up.

Table CAWG 9-26. Big Creek ALP Small Diversion Entrainment Study Water Quality Measurements, 2003.

Site	Date	Water Temperature (°C)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Percent Saturation
Balsam Creek	May 2003	14.3	7.59	0.031	8.3	97
Balsam Creek	July 2003	14.7	7.87	0.035	7.4	88
Rock Creek	May 2003	16.7	7.67	0.029	8.2	96
Rock Creek	July 2003	14.4	7.64	0.035	8.0	89

Table CAWG 9-27. Daytime and Nighttime Sampling Periods for Big Creek Powerhouse 1 (BC1), Big Creek ALP Powerhouse Tailrace Sampling, 2003-2004.

Powerhouse	Sample Period	Start Date	Start Time	End Date	End Time
BC1	Night	20-Jul-03	18:45	21-Jul-03	7:25
BC1	Day	21-Jul-03	7:25	21-Jul-03	18:45
BC1	Night	21-Jul-03	18:45	22-Jul-03	6:45
BC1	Day	22-Jul-03	6:45	22-Jul-03	17:30
BC1	Night	25-Sep-03	13:20	26-Sep-03	10:23
BC1	Day	26-Sep-03	10:23	26-Sep-03	16:33
BC1	Night	26-Sep-03	16:33	27-Sep-03	10:23
BC1	Day	27-Sep-03	10:23	27-Sep-03	16:48
BC1	Day/Night	22-Dec-03	10:28	23-Dec-03	9:36
BC1	Day/Night	23-Dec-03	9:36	24-Dec-03	7:57
BC1	Day	19-Feb-04	8:03	19-Feb-04	16:33
BC1	Night	19-Feb-04	16:33	20-Feb-04	7:27
BC1	Day	20-Feb-04	7:27	20-Feb-04	16:58
BC1	Night	20-Feb-04	16:58	21-Feb-04	7:48
BC1	Night	18-Jun-04	16:16	19-Jun-04	10:22
BC1	Day	19-Jun-04	10:22	19-Jun-04	16:39
BC1	Night	19-Jun-04	16:39	20-Jun-04	10:00
BC1	Day	20-Jun-04	10:00	20-Jun-04	16:42
BC1	Day	24-Aug-04	11:18	24-Aug-04	17:22
BC1	Night	24-Aug-04	17:22	25-Aug-04	10:00
BC1	Day	25-Aug-04	10:00	25-Aug-04	17:28
BC1	Night	25-Aug-04	17:28	26-Aug-04	7:36

Table CAWG 9-28. Daytime and Nighttime Sampling Periods for Big Creek Powerhouse 2A (BC2A), Big Creek ALP Powerhouse Tailrace Sampling, 2003-2004.

Powerhouse	Sample Period	Start Date	Start Time	End Date	End Time
BC2A	Day	29-Jul-03	8:25	29-Jul-03	19:38
BC2A	Night	29-Jul-03	19:38	30-Jul-03	7:29
BC2A	Day	30-Jul-03	7:29	30-Jul-03	19:45
BC2A	Night	30-Jul-03	19:45	31-Jul-03	7:48
BC2A	Day	23-Sep-03	9:15	23-Sep-03	16:25
BC2A	Night	23-Sep-03	16:25	24-Sep-03	7:30
BC2A	Day	24-Sep-03	7:30	24-Sep-03	16:20
BC2A	Night	24-Sep-03	16:20	25-Sep-03	7:23
BC2A	Day/Night	22-Dec-03	13:09	23-Dec-03	11:36
BC2A	Day/Night	23-Dec-03	11:36	24-Dec-03	10:28
BC2A	Night	16-Feb-04	14:12	17-Feb-04	7:32
BC2A	Day	17-Feb-04	7:32	17-Feb-04	14:38
BC2A	Night	17-Feb-04	14:38	18-Feb-04	7:38
BC2A	Day	18-Feb-04	7:38	18-Feb-04	14:12
BC2A	Day	21-Jun-04	8:14	21-Jun-04	16:27
BC2A	Night	21-Jun-04	16:27	22-Jun-04	7:28
BC2A	Day	22-Jun-04	7:28	22-Jun-04	16:28
BC2A	Night	22-Jun-04	16:28	23-Jun-04	8:10
BC2A	Day	22-Aug-04	8:13	22-Aug-04	14:39
BC2A	Night	22-Aug-04	14:39	23-Aug-04	7:31
BC2A	Day	23-Aug-04	7:31	23-Aug-04	17:25
BC2A	Night	23-Aug-04	17:25	24-Aug-04	7:55

Table CAWG 9-29. Daytime and Nighttime Sampling Periods for Mammoth Pool Powerhouse (MPPH), Big Creek ALP Powerhouse Tailrace Sampling, 2003-2004.

Powerhouse	Sample Period	Start Date	Start Time	End Date	End Time
MPPH	Day	22-Jul-03	13:00	22-Jul-03	20:35
MPPH	Night	22-Jul-03	20:35	23-Jul-03	9:15
MPPH	Day[1]	23-Jul-03	9:15	23-Jul-03	19:40
MPPH	Night	23-Jul-03	19:40	24-Jul-03	7:55
MPPH	Day	24-Jul-03	7:55	25-Jul-03	0:15
MPPH	Day	23-Sep-03	12:10	23-Sep-03	18:00
MPPH	Night	23-Sep-03	18:00	24-Sep-03	9:13
MPPH	Day	24-Sep-03	9:13	24-Sep-03	18:00
MPPH	Night	24-Sep-03	18:00	25-Sep-03	10:25
MPPH	Day/Night	29-Dec-03	11:39	30-Dec-03	10:36
MPPH	Day/Night	30-Dec-03	10:36	31-Dec-03	11:18
MPPH	Night	16-Feb-04	16:12	17-Feb-04	9:42
MPPH	Day	17-Feb-04	9:42	17-Feb-04	16:38
MPPH	Night	17-Feb-04	16:38	18-Feb-04	9:38
MPPH	Day	18-Feb-04	9:38	18-Feb-04	16:48
MPPH	Day	21-Jun-04	11:12	21-Jun-04	18:44
MPPH	Night	21-Jun-04	18:44	22-Jun-04	9:26
MPPH	Day	22-Jun-04	9:26	22-Jun-04	18:48
MPPH	Night	22-Jun-04	18:48	23-Jun-04	11:11
MPPH	Day	22-Aug-04	10:28	22-Aug-04	15:38
MPPH	Night	22-Aug-04	15:38	23-Aug-04	8:41
MPPH	Day	23-Aug-04	8:41	23-Aug-04	18:45
MPPH	Night	23-Aug-04	18:45	24-Aug-04	8:55

[1] The net became entangled on this day, an additional sampling day was added on July 24, 2003.

Table CAWG 9-30. Daytime[1] Sampling Periods for Eastwood Power Station (Eastwood), Big Creek ALP Powerhouse Tailrace Sampling, 2003-2004.

Powerhouse	Sample Period	Start Date	Start Time	End Date	End Time
Eastwood	Day	6-Aug-03	9:55	7-Aug-03	1:45
Eastwood	Day	7-Aug-03	10:15	7-Aug-03	23:55
Eastwood	Day	26-Sep-03	8:26	26-Sep-03	19:55
Eastwood	Day	27-Sep-03	9:15	27-Sep-03	20:15
Eastwood	Day	19-Jun-04	9:15	19-Jun-04	19:35
Eastwood	Day	20-Jun-04	9:23	20-Jun-04	19:23
Eastwood	Day	24-Aug-04	12:45	24-Aug-04	19:18
Eastwood	Day	25-Aug-04	8:21	25-Aug-04	19:16

[1] Eastwood Power Station was in generate mode during the daytime and pumpback at night. Sampling occurred, therefore, only during the daytime sampling period.

Table CAWG 9-31. Estimated Densities of Fish Collected, Volume Sampled by Kodiak Trawl Net, and Volume through Big Creek 1 Powerhouse, 2003-2004.

Period	Date	Time (hours)	Number of Fish Captured	Mean Flow Through Units 1 and 2[1] (cfs)	Volume of Water Through Net Mouth (1000 cf)	Estimated Density of Fish Sampled (fish/1000 cf)	Volume of Water Through Units 1 and 2[1] (1000 cf)	Percent of Volume[2] Sampled
Night	20-Jul-03	12.67	0	223	3,394	0	10,156	33.4
Day	21-Jul-03	11.33	0	226	3,113	0	9,219	33.8
Night	21-Jul-03	12.00	0	207	2,912	0	8,945	32.6
Day	22-Jul-03	10.75	0	219	2,820	0	8,472	33.3
Night	25-Sep-03	21.05	0	171	4,321	0	12,934	33.4
Day	26-Sep-03	6.17	0	206	1,655	0	4,579	36.1
Night	26-Sep-03	17.83	0	200	4,375	0	12,851	34.0
Day	27-Sep-03	6.42	0	176	1,459	0	4,068	35.9
Day/Night	22-Dec-03	23.13	0	78	2,674	0	6,518	41.0
Day/Night	23-Dec-03	22.35	0	107	3,404	0	8,615	39.5
Day	19-Feb-04	8.50	0	50	1,221	0	1,527	80.0
Night	19-Feb-04	14.90	0	58	2,373	0	3,091	76.8
Day	20-Feb-04	9.52	0	58	1,583	0	1,980	80.0
Night	20-Feb-04	14.83	0	58	2,344	0	3,090	75.9
Night	18-Jun-04	18.10	0	95	2,273	0	6,167	36.9
Day	19-Jun-04	6.28	0	192	1,629	0	4,346	37.5
Night	19-Jun-04	17.35	0	90	2,080	0	5,625	37.0
Day	20-Jun-04	6.70	0	152	1,396	0	3,669	38.0
Day	24-Aug-04	6.07	0	136	1,126	0	2,963	38.0
Night	24-Aug-04	16.63	0	87	2,244	0	5,203	43.1
Day	25-Aug-04	7.47	0	194	1,996	0	5,212	38.3
Night	25-Aug-04	14.13	0	113	2,278	0	5,732	39.7

[1] Kodiak trawl net was set up to sample units 1 and 2 at the Big Creek Powerhouse 1. Units 3 and 4 were not sampled and are therefore not included in output flow value.

[2] Volume of water through units 1 and 2 only.

Table CAWG 9-32. Estimated Densities of Fish Collected, Volume Sampled by Kodiak Trawl Net, and Volume through Big Creek 2A Powerhouse, 2003-2004.

Period	Date	Time (hours)	Number of Fish Captured	Mean Flow Through Powerhouse[1] (cfs)	Volume of Water Through Net Mouth (1000 cf)	Estimated Density of Fish Sampled (fish/1000 cf)	Volume of Water Through Powerhouse[1] (1000 cf)	Percent of Volume Sampled
Day	29-Jul-03	11.22	0	582	7,375	0	23,503	31.4
Night	29-Jul-03	11.85	0	438	4,660	0	18,681	24.9
Day	30-Jul-03	12.27	0	593	6,541	0	26,173	25.0
Night	30-Jul-03	12.05	0	338	4,613	0	14,655	31.5
Day	23-Sep-03	7.17	0	571	4,427	0	14,741	30.0
Night	23-Sep-03	15.08	0	448	7,129	0	24,328	29.3
Day	24-Sep-03	8.83	0	556	5,275	0	17,667	29.9
Night	24-Sep-03	15.05	0	395	6,510	0	21,401	30.4
Day/Night	22-Dec-03	22.45	0	268	7,006	0	21,638	32.4
Day/Night	23-Dec-03	22.87	0	293	7,471	0	24,126	31.0
Night	16-Feb-04	17.33	0	169	3,287	0	10,524	31.2
Day	17-Feb-04	7.10	0	61	784	0	1,554	50.5
Night	17-Feb-04	17.00	0	171	3,472	0	10,457	33.2
Day	18-Feb-04	6.57	0	93	1,606	0	2,187	73.4
Day	21-Jun-04	8.22	0	249	3,670	0	7,374	49.8
Night	21-Jun-04	15.02	0	344	5,869	0	18,614	31.5
Day	22-Jun-04	9.00	0	501	5,082	0	16,229	31.3
Night	22-Jun-04	15.70	0	313	5,330	0	17,673	30.2
Day	22-Aug-04	6.43	0	67	672	0	1,552	43.3
Night	22-Aug-04	16.87	0	138	2,531	0	8,357	30.3
Day	23-Aug-04	9.90	0	111	1,359	0	3,950	34.4
Night	23-Aug-04	14.50	0	125	2,533	0	6,523	38.8

[1] Kodiak Trawl Net was set up to sample units 1 and 2 at the Big Creek 2A Powerhouse. Powerhouse 2A consists entirely of units 1 and 2, both units are, therefore, included in the output flow value.

Table CAWG 9-33. Estimated Densities of Fish Collected, Volume Sampled by Kodiak Trawl Net, and Volume through Mammoth Pool Powerhouse, 2003-2004.

Period	Date	Time (hours)	Number of Fish Captured	Mean Flow Through Powerhouse[1] (cfs)	Volume of Water Through Net Mouth (1000 cf)	Estimated Density of Fish Sampled (fish/1000 cf)	Volume of Water Through Powerhouse[1] (1000 cf)	Percent of Volume Sampled
Day	22-Jul-03	7.58	0	1,150	6,414	0	31,406	20.4
Night	22-Jul-03	12.67	0	369	2,416	0	16,829	14.4
Day[2]	23-Jul-03	10.42	0	1,495	10,300	0	56,079	18.4
Night	23-Jul-03	12.25	0	520	3,720	0	22,934	16.2
Day	24-Jul-03	16.33	0	1,310	12,219	0	77,011	15.9
Day	23-Sep-03	5.83	0	506	1,035	0	10,632	9.7
Night	23-Sep-03	15.22	0	157	1,031	0	8,580	12.0
Day	24-Sep-03	8.78	0	725	4,368	0	22,916	19.1
Night	24-Sep-03	16.42	0	2	52	0	130	40.0
Day/Night	29-Dec-03	22.95	0	164	5,912	0	13,571	43.6
Day/Night	30-Dec-03	24.70	0	291	6,253	0	25,903	24.1
Night	16-Feb-04	17.50	0	523	5,924	0	32,979	18.0
Day	17-Feb-04	6.93	0	26	53	0	655	8.1
Night	17-Feb-04	17.00	0	176	1,821	0	10,762	16.9
Day	18-Feb-04	7.17	0	2	24	0	57	42.1
Day	21-Jun-04	7.53	0	1,302	6,776	0	35,300	19.2
Night	21-Jun-04	14.70	0	929	8,065	0	49,175	16.4
Day	22-Jun-04	9.37	0	1,248	8,788	0	42,082	20.9
Night	22-Jun-04	16.38	0	871	8,635	0	51,376	16.8
Day	22-Aug-04	5.17	0	347	1,120	0	6,446	17.4
Night	22-Aug-04	17.05	0	358	2,906	0	21,946	13.2
Day	23-Aug-04	10.07	0	473	2,480	0	17,144	14.5
Night	23-Aug-04	14.17	0	245	1,952	0	12,506	15.6

[1] Kodiak Trawl Net was set up to sample units 1 and 2 at the Mammoth Pool Powerhouse. Mammoth Pool Powerhouse consists entirely of units 1 and 2, both units are, therefore, included in the output flow value.
[2] The net became entangled on this day, an additional sampling day was added on July 24, 2003.

Table CAWG 9-34. Estimated Densities of Fish Collected, Volume Sampled by the Kodiak Trawl Net, and Volume through Eastwood Power Station, 2003-2004.

Period	Date	Time (hours)	Number of Fish Captured	Mean Flow Through Powerhouse[1] (cfs)	Volume of Water Through Net Mouth (1000 cf)	Estimated Density of Fish Sampled (fish/1000 cf)	Volume of Water Through Powerhouse (1000 cf)	Percent of Volume Sampled
Day	6-Aug-03	15.83	0	895	12,372	0	51,012	24.3
Day	7-Aug-03	13.67	0	1,083	10,996	0	53,282	20.6
Day	26-Sep-03	11.48	0	943	8,708	0	38,988	22.3
Day	27-Sep-03	11.00	0	992	8,411	0	39,302	21.4
Day	19-Jun-04	10.33	0	21	29	0	769	3.8
Day	20-Jun-04	10.00	0	961	8,142	0	34,595	23.5
Day	24-Aug-04	6.55	0	1,570	9,165	0	37,013	24.8
Day	25-Aug-04	10.92	0	962	7,980	0	37,819	21.1

[1] Kodiak Trawl Net was set up to sample all flow at the Eastwood Power Station. Eastwood Power Station consists solely of unit 1; therefore, flow through unit 1 equals the output flow value.

Table CAWG 9-35. Comparison of Mean Daily Flows During Each Sampling Trip (2003-2004) to the 20, 50 and 80 Percent Exceedances, at Big Creek Powerhouse 1.

Date	Range of Mean Daily Flows Through Powerhouse[1] (cfs)	Exceedance Flows		
		80 Percent	50 Percent	20 Percent
July 2003	436-462	354	564	675
September 2003	430-470	226	463	580
December 2003	147-217	101	256	455
February 2004	136-232	73	228	542
June 2004	278-373	301	566	669
August 2004	256-302	317	545	598

[1] Mean daily flow through the powerhouse.

Table CAWG 9-36. Comparison of Mean Daily Flows During Each Sampling Trip (2003-2004) to the 20, 50 and 80 Percent Exceedances, at Big Creek Powerhouse 2A.

Date	Range of Mean Daily Flows Through Powerhouse[1] (cfs)	Exceedance Flows		
		80 Percent	50 Percent	20 Percent
July 2003	485-486	340	472	620
September 2003	485-488	252	435	609
December 2003	257	51	211	449
February 2004	127-164	45	232	501
June 2004	332-389	246	469	620
August 2004	117-129	299	451	620

[1] Mean daily flow through the powerhouse.

Table CAWG 9-37. Comparison of Mean Daily Flows During Each Sampling Trip (2003-2004) to the 20, 50 and 80 Percent Exceedances, at Mammoth Pool Powerhouse.

Date	Range of Mean Daily Flows Through Powerhouse[1] (cfs)	Exceedance Flows		
		80 Percent	50 Percent	20 Percent
July 2003	1291-1807	630	1020	2110
September 2003	453-552	239	514	983
December 2003	136-183	51	217	635
February 2004	253-355	210	585	1180
June 2004	1020-1060	842	1960	2365
August 2004	171-211	494	777	1230

[1] Mean daily flow through the powerhouse.

Table CAWG 9-38. Comparison of Mean Daily Flows During Each Sampling Trip (2003-2004) to the 20, 50 and 80 Percent Exceedances, at Eastwood Power Station.

Date	Range of Mean Daily Flows Through Powerhouse[1] (cfs)	Exceedance Flows		
		80 Percent	50 Percent	20 Percent
August 2003	596-615	304	570	832
September 2003	583-704	234	456	597
June 2004	85-523	465	843	1330
August 2004	583-732	304	570	832

[1] Mean daily flow through the powerhouse on the days sampled.

Table CAWG 9-39. Big Creek ALP Powerhouse Tailrace Water Quality Measurements at Big Creek Powerhouse 1 (BC1) and Big Creek Powerhouse 2A (BC2A), 2003-2004.

Site	Date	Water Temperature (°C)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Percent Saturation
BC1	July 2003	11.6	6.68	0.016	8.6	94
BC1	September 2003	16.2	6.72	0.016	8.0	97
BC1	December 2003	10.2	6.75	0.017	8.5	90
BC1	February 2004	10.1	6.78	0.016	8.4	88
BC1	June 2004	12.9	6.79	0.017	8.6	97
BC1	August 2004	16.3	6.80	0.016	8.2	99
BC2A	July 2003	12.3	6.59	0.017	8.9	93
BC2A	September 2003	17.2	6.67	0.017	8.1	94
BC2A	December 2003	10.9	6.71	0.016	9.3	94
BC2A	February 2004	10.8	6.76	0.017	9.3	94
BC2A	June 2004	13.1	6.73	0.017	9.2	98
BC2A	August 2004	17.1	6.78	0.016	8.1	94

Table CAWG 9-40. Big Creek ALP Powerhouse Tailrace Water Quality Measurements at Mammoth Pool Powerhouse (MPPH) and Eastwood Power Station (Eastwood), 2003-2004.

Site	Date	Water Temperature (°C)	pH	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Percent Saturation
MPPH	July 2003	15.0	6.59	0.021	8.9	96
MPPH	September 2003	19.3	6.96	0.032	8.0	94
MPPH	December 2003	11.9	6.78	0.024	9.1	92
MPPH	February 2004	11.1	6.84	0.026	9.0	89
MPPH	June 2004	14.8	6.83	0.028	8.5	91
MPPH	August 2004	19.7	6.88	0.029	8.2	96
Eastwood	August 2003	21.2	7.15	0.018	7.1	97
Eastwood	September 2003	19.9	7.18	0.017	7.2	96
Eastwood	June 2004	19.6	7.11	0.017	7.1	95
Eastwood	August 2004	20.3	6.99	0.018	7.2	97

MAP

Placeholder for Map CAWG 9-1

Non-Internet Public Information

This Map has been removed in accordance with the Commission regulations at 18 CFR Section 388.112.

This Map is considered Non-Internet Public information and should not be posted on the Internet. This information is provided in Volume 4 of the Application for New License and is identified as "Non-Internet Public" information. This information may be accessed from the FERC's Public Reference Room, but is not expected to be posted on the Commission's electronic library, except as an indexed item.

FIGURES

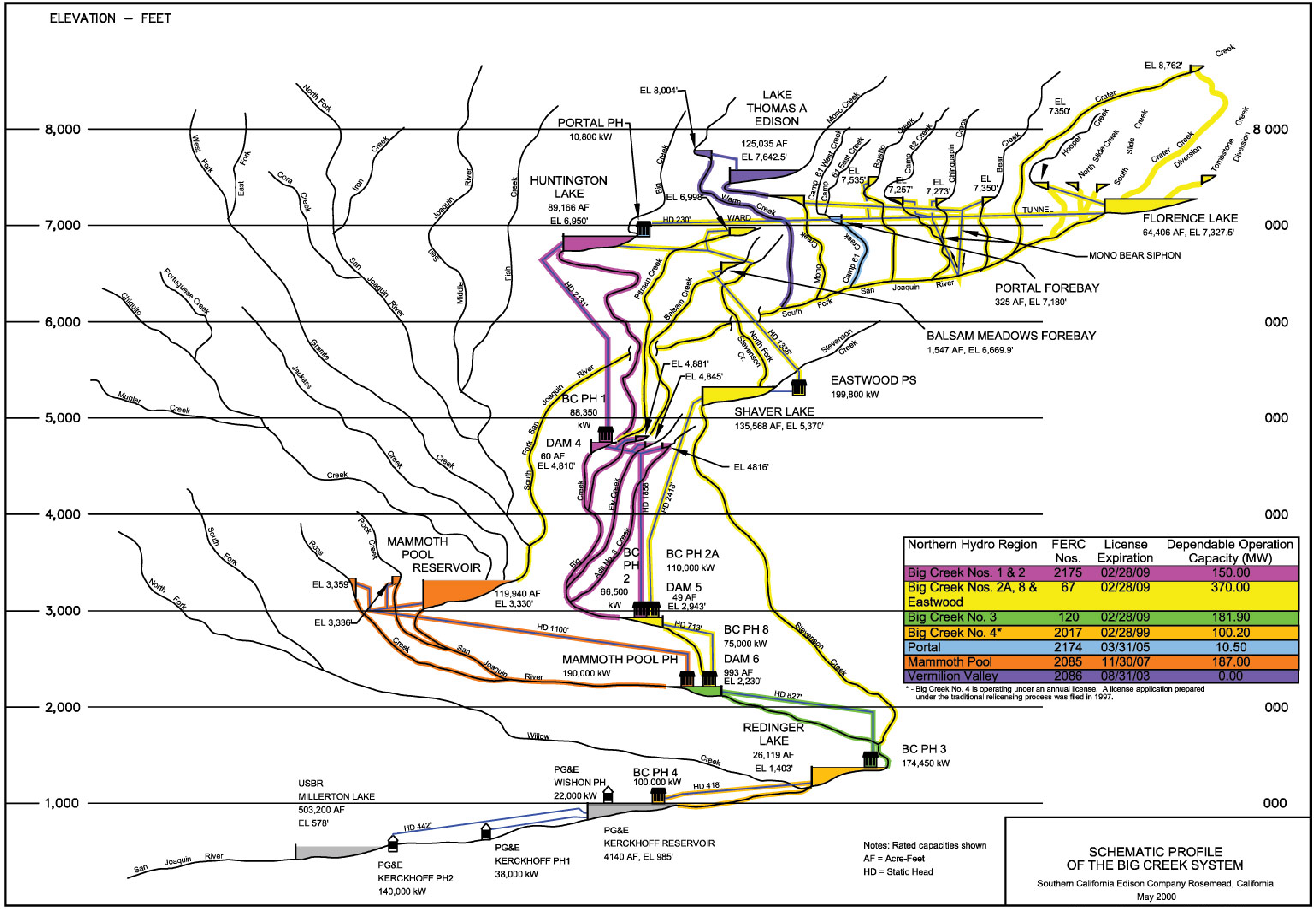


Figure CAWG 9-1. Schematic Profile of the Big Creek System.

Placeholder for Figures CAWG 9-2 through CAWG 9-10

Critical Energy Infrastructure Information (Non Public)

These Figures have been removed in accordance with the Commission regulations at 18 CFR Section 388.113.

These Figures are considered Critical Energy Infrastructure Information (CEII). This information is provided in Volume 7 of the Application for New License and is identified as "Critical Energy Infrastructure Information-Do Not Release." Volume 7 is exempt from the mandatory disclosure requirements of the Freedom of Information Act (FOIA) and is withheld from public disclosure. This information is not available in FERC's Public Reference Room, and is not available on the Commission's electronic library, except as an indexed item.

APPENDIX A

DESIGN DRAWINGS AND PHOTOGRAPHS OF PROJECT POWERHOUSE INTAKES

Placeholder for Appendix A

Design Drawings and Photographs of Project Powerhouse Intakes

<u>Critical Energy Infrastructure Information (Non Public)</u>

Appendix A has been removed in accordance with the Commission regulations at 18 CFR Section 388.113.

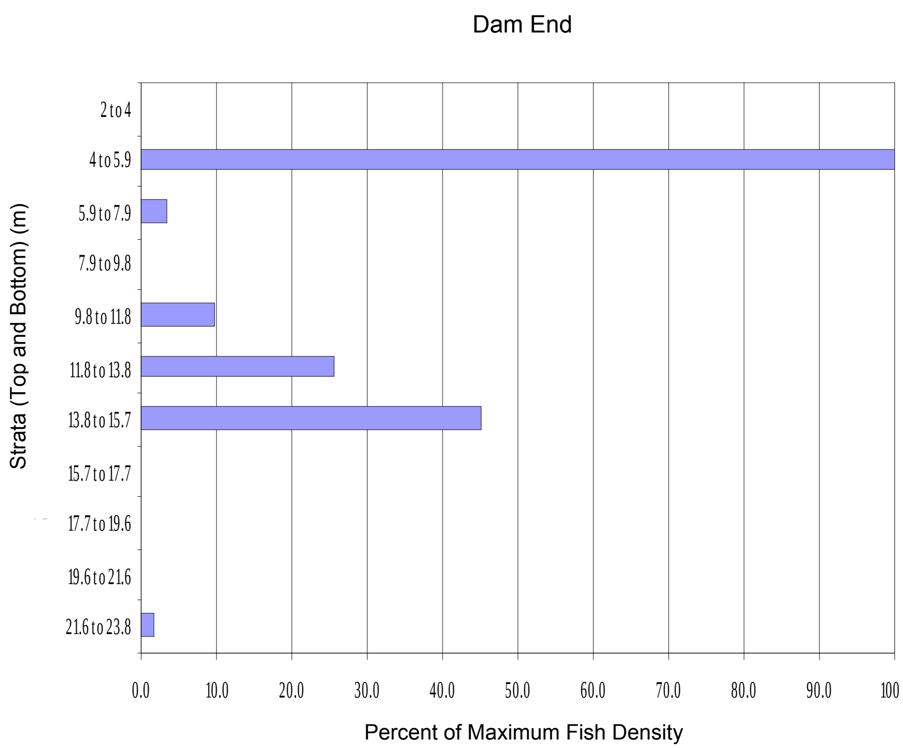
Appendix A is considered Critical Energy Infrastructure Information (CEII). This information is provided in Volume 7 of the Application for New License and is identified as "Critical Energy Infrastructure Information-Do Not Release." Volume 7 is exempt from the mandatory disclosure requirements of the Freedom of Information Act (FOIA) and is withheld from public disclosure. This information is not available in FERC's Public Reference Room, and is not available on the Commission's electronic library, except as an indexed item.

APPENDIX B

COMPARISON OF FISH DISTRIBUTION WITH DEPTH AND WATER TEMPERATURE IN LARGE PROJECT RESERVOIRS

APPENDIX B
COMPARISON OF FISH DISTRIBUTION WITH DEPTH AND WATER TEMPERATURE IN LARGE PROJECT RESERVOIRS

As part of the *CAWG 7 Characterize Fish Populations* technical study plan (SCE 2003a), hydroacoustic surveys were conducted to characterize overall fish density and evaluate depth distribution of fish abundance near Project intakes in large reservoirs. These reservoirs included Florence Lake, Huntington Lake, Shaver Lake, and Mammoth Pool Reservoir. This appendix presents comparisons of fish distribution with depth and water temperature near project intakes in these reservoirs.



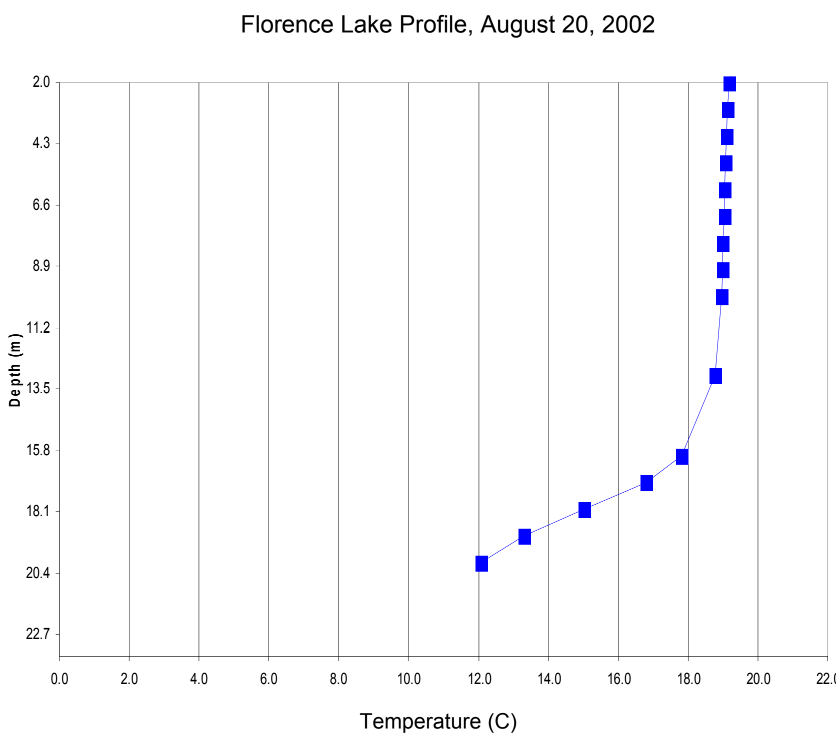


Figure CAWG 9 Appendix B-1. Comparison of Fish Distribution with Depth and Water Temperature, Florence Lake, August 2002.

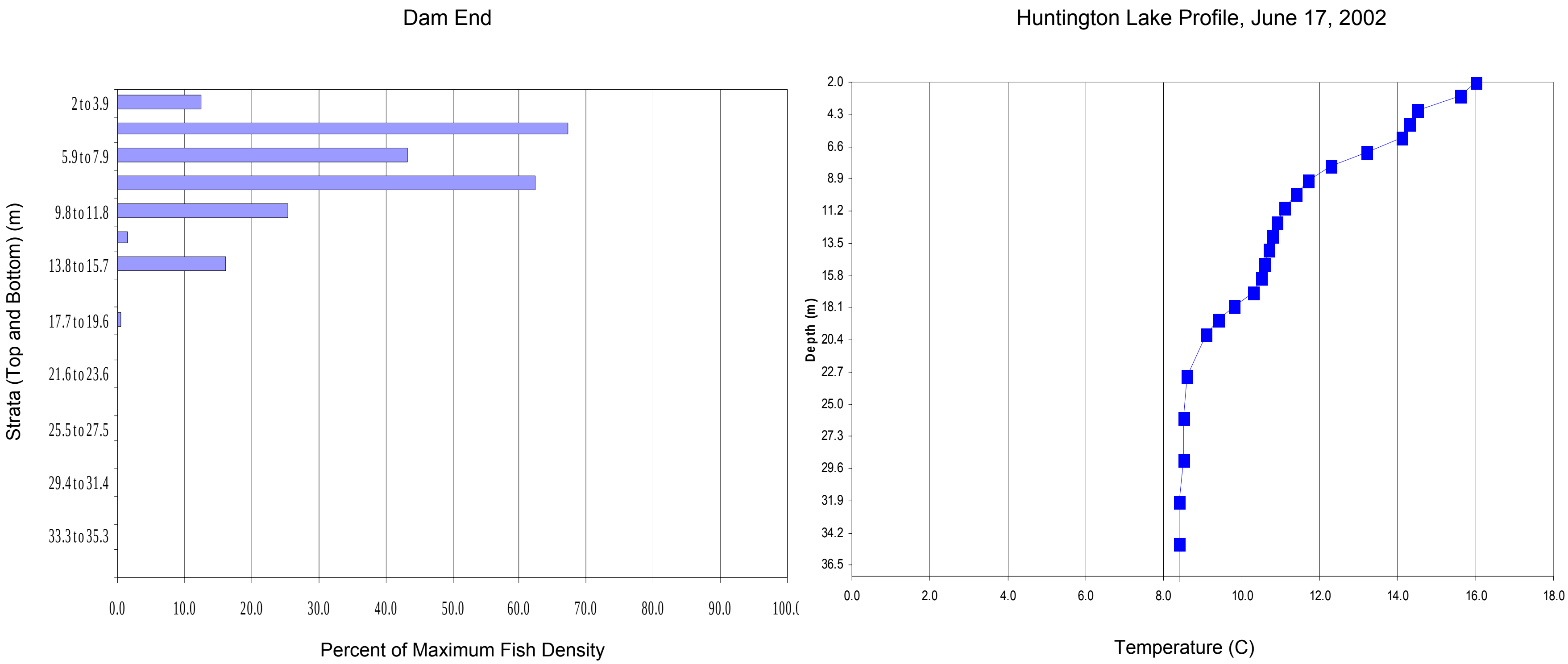
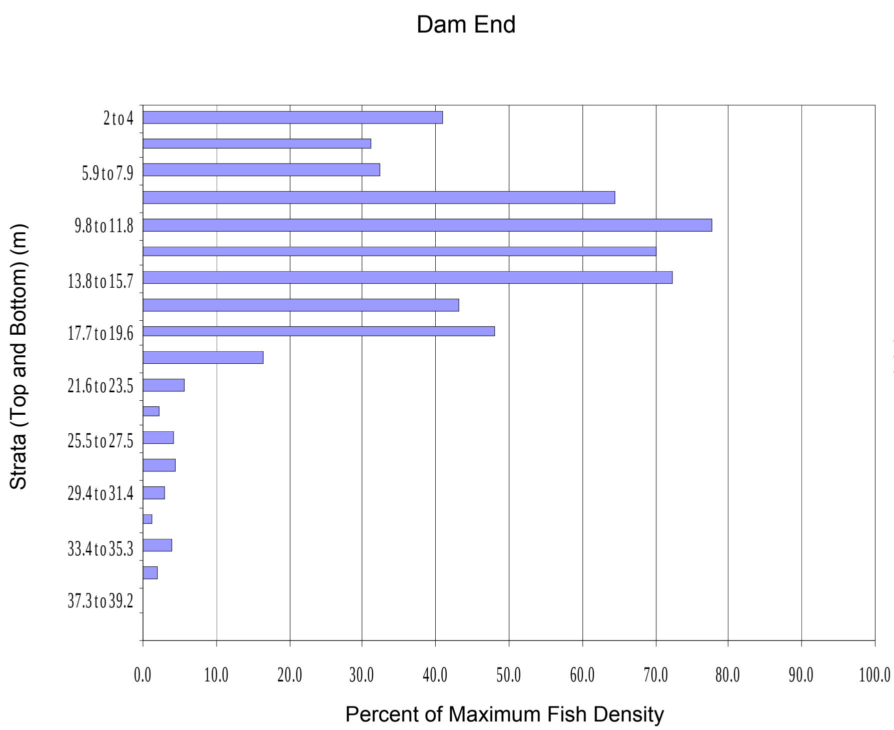


Figure CAWG 9 Appendix B-2. Comparison of Fish Distribution with Depth and Water Temperature, Huntington Lake, June 2002.



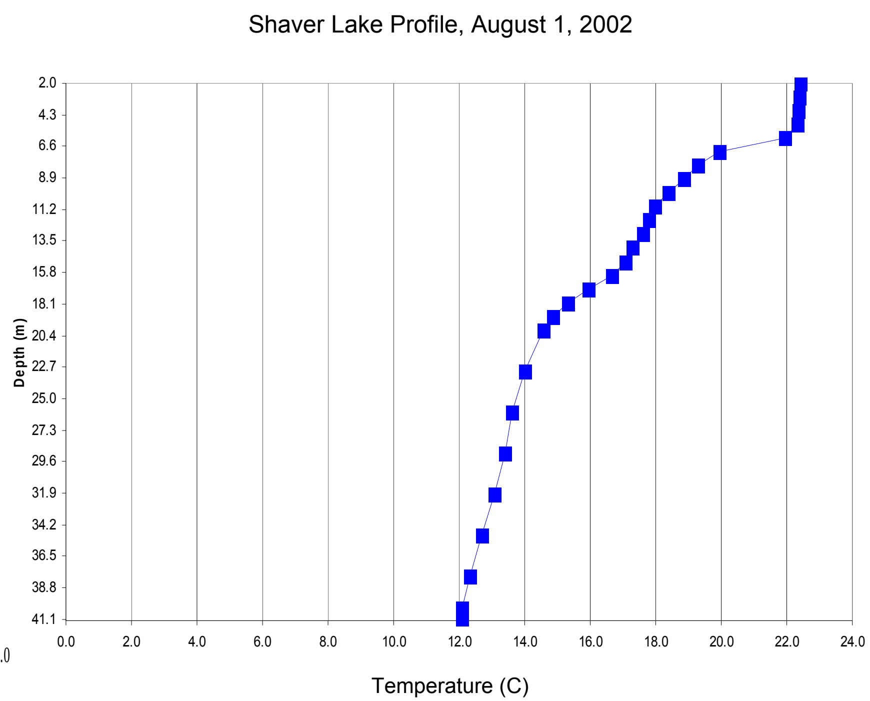
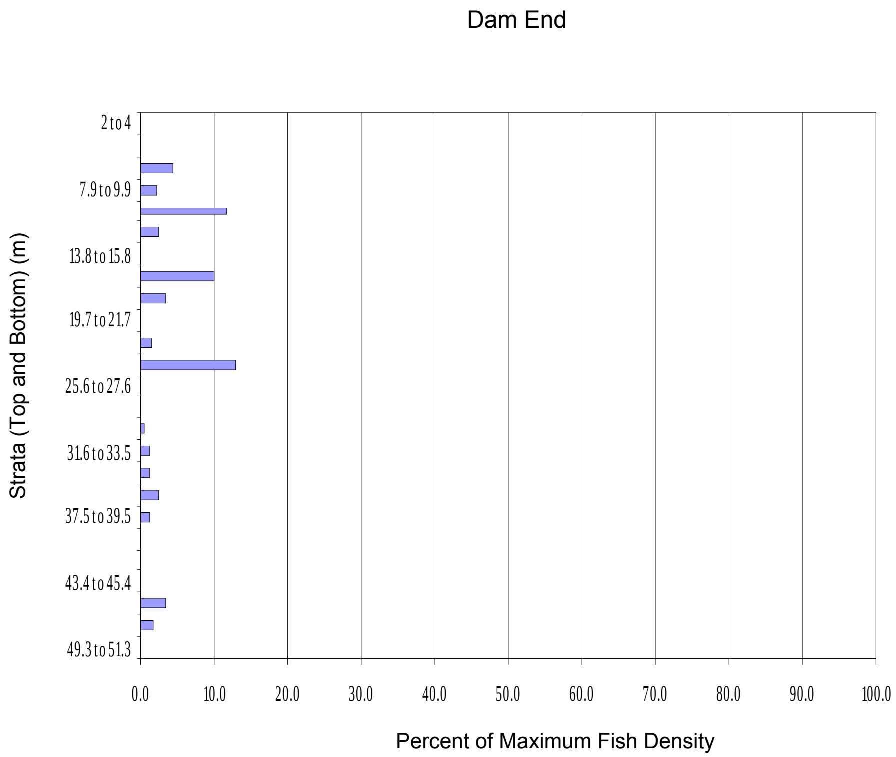


Figure CAWG 9 Appendix B-3. Comparison of Fish Distribution with Depth and Water Temperature, Shaver Lake, July/August 2002.



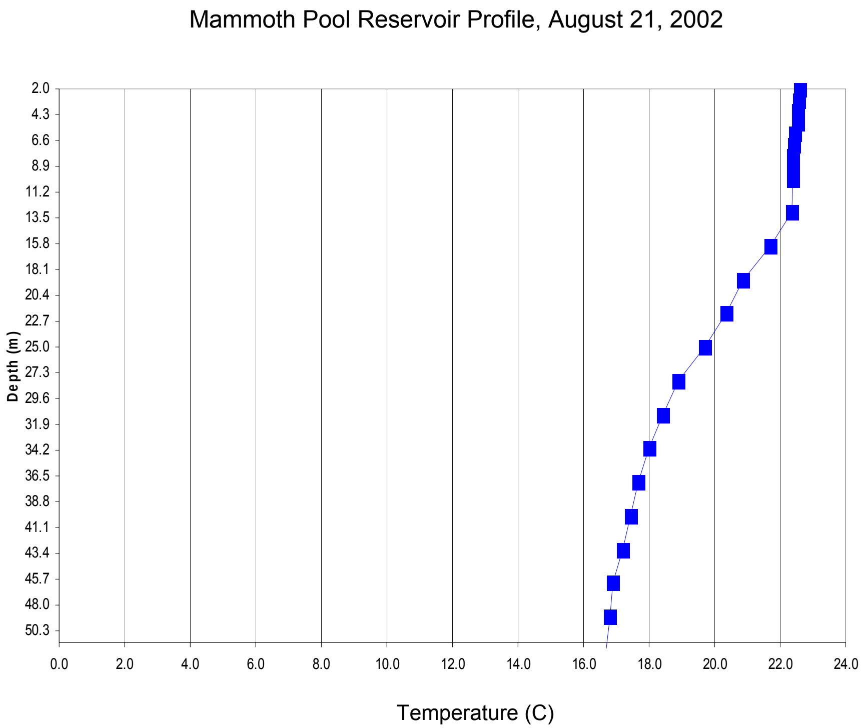


Figure CAWG 9 Appendix B-4. Comparison of Fish Distribution with Depth and Water Temperature, Mammoth Pool Reservoir, September 2002.

APPENDIX C

PORTAL POWERHOUSE ENTRAINMENT SAMPLING SUMMARY

APPENDIX C
Portal Powerhouse Entrainment Sampling Summary

The following report describes the entrainment studies in the waters of the Portal Project (Project) area.

1.0 METHODS

Entrainment potential was evaluated by sampling the tailrace immediately below the Portal Powerhouse.

1.1 FISH ENTRAINMENT

The potential impact on fish due to entrainment is dependent on several factors. These factors include the sizes and lifestages of fish present near the intake structure, the physical condition of fish present near the intake, and the potential for turbine mortality at the powerhouse.

Fish entrained through the Portal Powerhouse may originate from diversions into Ward Tunnel from backcountry reservoirs and stream, or Portal Forebay. Fish entrainment in the Portal Project was evaluated by sampling the tailrace of the Portal Powerhouse for fish passing through the powerhouse. The fish community of the forebay was sampled in June 2002 as part of the fish abundance and distribution study to characterize fish potentially vulnerable to entrainment when the Project operates from stored water in the forebay. The Portal Powerhouse Tailrace was sampled in January, March, and July of 2002, as well as August and September of 2003. An initial visit was made in December 2001 to determine an effective net configuration for sampling the tailrace. Portal Powerhouse may operate continuously early or late in the runoff period. During the principal run-off period, powerhouse operations may be greatly curtailed in favor of flow releases made through the HB valve located at the powerhouse. During the winter, the powerhouse may be operated for short periods by drawing down Portal Forebay and then allowing it to refill over a period of hours to days.

Ward Tunnel, part of FERC Project No. 67, begins at Florence Lake and terminates in lower Rancheria Creek, just upstream of Huntington Lake. Before the water is released into Huntington Lake, it passes either though the Portal Powerhouse or the HB valve. This analysis only addresses the effect of the Project powerhouse on fish. Water (and fish) passing through the Portal Powerhouse were sampled at the outlet of the powerhouse.

Entrainment sampling was conducted using a custom framed net measuring 10 feet high by 10 feet wide at the mouth, and 60 feet in length from the center of the mouth to the cod end of the bag. The mesh size on the net measured one inch at the mouth and 0.25 inches at the cod end. A framed livecar was used to minimize the trauma on captured fish. A flow meter was attached inside the mouth of the net to estimate the volume of water sampled by the net.

The net and livecar were checked once in the morning and once during the late afternoon, before dusk. At the end of each sampling period, an outage took place (flow through the powerhouse was shut off) to allow personnel to enter the tailrace. All captured materials retrieved from the net and livecar were placed in a five-gallon bucket(s) filled with water. The net was then redeployed and the crew returned to the bank to analyze the captured contents. After the crew was safely out of the water, the powerhouse was returned to normal operation.

Contents captured in the net were thoroughly sorted in an attempt to locate all fish otherwise hidden by debris. Once all specimens were found, fish were identified to the species level to the extent feasible, based on size and condition. Fish lengths were measured and recorded as Fork Length (FL). The general condition and physical appearance of the fish also were recorded. Notes were made of the abrasion, loss of scales, hemorrhaging, “pop-eye” and fin condition. All fish were immediately returned to the river after they were identified, measured and inspected for general condition.

Data from fish capture and flowmeter measurements were analyzed to determine the catch per unit effort (CPUE, number of fish caught per hour) and to estimate volume of water sampled by the net. These data provided information on the rate of entrainment and the density of fish collected (fish per unit flow) for comparison between night and day and between seasons.

2.0 RESULTS

2.1 FISH PRESENT UPSTREAM

Fish potentially vulnerable to entrainment through the Portal Powerhouse must pass through the segment of Ward Tunnel located between the Portal Forebay and the "Y" branch in the penstock upstream of the Portal Powerhouse. Fish may originate from the Portal Forebay or from flow diverted to Ward Tunnel from SCE's upstream reservoirs or stream diversions. Fish species present upstream include brown trout, brook trout, rainbow trout, and rainbow x golden trout hybrids.

2.2 PROJECT TAILRACE

The powerhouse outlet was sampled in December, January, March and July of 2002, and in August and September of 2003. Results of the sampling are shown Table CAWG 9 Appendix C-1. During the months of December and January of 2002 the sampling was curtailed due to limited water volume available for generation and repairs required at the powerhouse. A complete sample period was not achieved in December, due to net tangling. In January, only one sampling period was completed; a single fish in an advanced stage of decomposition was collected in the net (Table CAWG 9 Appendix C-1). The fish appeared to be a kokanee carcass that may have been introduced to the net from the pool near the tailrace when the powerhouse was restarted. Several kokanee carcasses were observed on the bottom of the tailrace channel near the net. Kokanee are known to spawn in the powerhouse tailrace and are not found upstream of the Portal Powerhouse tailrace.

In March of 2002, limited flow was available for generation. Under these conditions, the forebay is allowed to fill and then the powerhouse generates until the forebay is drawn down. This process is repeated and generation occurs as frequently as inflow allows. Therefore, the tailrace was sampled during two daytime periods and one nighttime period. No fish was captured in March (Tables CAWG 9 Appendix C-1 and C-2).

During the May through June runoff period of 2002, operation of the HB valve prevented sampling of the powerhouse tailrace. With decreased operation of the HB valve, sampling was feasible during July. During this sampling period, powerhouse generation was continuous.

In July of 2002, the powerhouse tailrace was sampled during two daytime and two nighttime periods. Only one rainbow trout was captured in each of the daytime sets (Table CAWG 9 Appendix C-2). Both rainbow trout were hatchery fish and did not show visible signs of damage; only one was captured alive. It is unclear whether the observed mortality was related to turbine passage or holding in the sample net. Portal Forebay and Mono Creek downstream of Vermilion Valley Dam and upstream of the Mono Diversion are stocked with catchable hatchery rainbow trout, which may be diverted through the Ward Tunnel to the Portal Powerhouse tailrace. The CPUE for the daytime sampling periods of the 17th and 18th of July were 0.13 and 0.11 fish per hour, respectively. The density of fish captured in the net for the 17th and 18th was 3.0 x 10^{-6} and 3.2 x 10^{-6} fish per cubic meter, respectively. Based on operations data from the Portal Powerhouse, the percentage of the total volume sampled by the net was calculated and presented in Table CAWG 9 Appendix C-1. During the two daytime samplings, 75 percent and 52 percent of the total outflow was sampled, respectively. CPUE and catch density were adjusted to reflect estimated total entrainment in Table CAWG 9 Appendix C-1.

In the first nighttime sample period, brown trout parts were collected by the net. The fish parts were identified by the color and pattern observed on patches of intact skin (red spots with a faint halo on a brown background). Brown trout are present in Portal Forebay and also may be diverted to Ward Tunnel from upstream diversions. During the second nighttime sampling period, additional flow was released from Ward Tunnel through the HB valve, which caused the net to collapse, tangle, and rip; no valid information could be collected under these conditions. The CPUE for the nighttime sample period was 0.07 fish per hour; the density of fish captured in the net was 1.7 x 10^{-6} fish per cubic meters. During the first nighttime sampling period, 67 percent of the total powerhouse outflow was sampled. CPUE and catch density were adjusted to reflect estimated total entrainment.

Additional sampling was scheduled for winter 2002-2003, but a combination of inclement weather (with consequent safety concerns) and the lack of sufficient powerhouse generation availability prevented collection of additional samples. Repairs at the powerhouse delayed the completion of the sampling until August and September of 2003.

Table CAWG 9 Appendix C-1. Portal Powerhouse Entrainment Sampling Results.

Start Date	Start Time	Finish Date	Finish Time	SET	Number of Fish	CPUE (fish/hour)	Volume Sampled by Net (m^3)	Catch Density (fish/m^3)	Percent Total Volume Sampled	CPUE Corrected by Percent Flow Sampled (fish/hr)	Flow Corrected Catch Density (fish/ m^3)
12-Dec-01	11:30	12-Dec-01	12:00	24 Hr.	0	**0**	-	-	-	-	-
10-Jan-02	10:00	10-Jan-02	16:30	Daytime	0(1)*	**0(0.15)**	**-**	**-**	-	-	-
05-Mar-02	10:00	05-Mar-02	17:00	Daytime	0	**0**	**-**	**-**	-	-	-
05-Mar-02	17:00	06-Mar-02	8:00	Nighttime	0	**0**	325,243	**0**	100	0	0
06-Mar-02	8:30	06-Mar-02	16:30	Daytime	0	**0**	45,805**	**0**	29	0	0
17-Jul-02	10:00	17-Jul-02	17:30	Daytime	1	**0.13**	333,463	**3.0 x 10E-06**	75	0.17	4.00E-06
17-Jul-02	18:00	18-Jul-02	7:55	Nighttime	1	**0.07**	586,356	**1.7 x 10E-06**	67	0.10	2.52166E-06
18-Jul-02	8:30	18-Jul-02	17:50	Daytime	1	**0.11**	316,171	**3.2 x 10E-06**	52	0.21	6.17504E-06
7-Aug-03	20:50	8-Aug-03	07:18	Nighttime	0	**0**	549,608	**0**	82	0	0
8-Aug-03	07:18	8-Aug-03	15:29	Daytime	0	**0**	311,188	**0**	87	0	0
8-Aug-03	15:29	9-Aug-03	08:12	Nighttime	0	**0**	890,706	**0**	78	0	0
9-Aug-03	08:12	9-Aug-03	18:00	Daytime	0	**0**	445,357	**0**	82	0	0
3-Sep-03	08:38	3-Sep-03	17:02	Daytime	0	**0**	391,626	**0**	83	0	0
3-Sep-03	17:02	4-Sep-03	08:35	Nighttime	0	**0**	783,041	**0**	84	0	0
4-Sep-03	08:35	4-Sep-03	17:08	Daytime	0	**0**	443,861	**0**	86	0	0
4-Sep-03	17:08	5-Sep-03	08:55	Nighttime	0	**0**	784,098	**0**	79	0	0

* One decayed kokanee carcass collected in net, source was likely spawned-out carcasses present in tailrace prior to start of netting.
** Meter affected by debris in net, underestimate of flow sampled.

Table CAWG 9 Appendix C-2. Entrainment Sampling Periods and Fish Capture at Portal Powerhouse, 2002.

Period	Start		Finish		Fish Capture		
	Date	Time (24:00 Hrs)	Date	Time (24:00 Hrs)	Species	FL (mm)	Condition
Daytime	5-Mar-02	10:00	5-Mar-02	17:00	-	-	No fish captured
Nighttime	5-Mar-02	17:00	6-Mar-02	8:00	-	-	No fish captured
Daytime	6-Mar-02	8:30	6-Mar-02	16:30	-	-	No fish captured
Daytime	17-Jul-02	10:00	17-Jul-02	17:30	RT	224	Alive, no visible damage, Hatchery fish
Nighttime	17-Jul-02	18:00	18-Jul-02	7:55	BN	-	Pieces of brown trout (skin, tissue, bone)
Daytime	18-Jul-02	8:30	18-Jul-02	17:50	RT	245	Dead, no visible damage, Hatchery fish
Nighttime	7-Aug-03	20:50	8-Aug-03	07:18	-	-	No fish captured
Daytime	8-Aug-03	07:18	8-Aug-03	15:29	-	-	No fish captured
Nighttime	8-Aug-03	15:29	9-Aug-03	08:12	-	-	No fish captured
Daytime	9-Aug-03	08:12	9-Aug-03	18:00	-	-	No fish captured
Daytime	3-Sep-03	08:38	3-Sep-03	17:02	-	-	No fish captured
Nighttime	3-Sep-03	17:02	4-Sep-03	08:35	-	-	No fish captured
Daytime	4-Sep-03	08:35	4-Sep-03	17:08	-	-	No fish captured
Nighttime	4-Sep-03	17:08	5-Sep-03	08:55	-	-	No fish captured

Species Code: RT = Rainbow trout; BN = Brown trout

In August 2003, the powerhouse tailrace was sampled for two daytime and two nighttime periods. During the two daytime samplings, 87 percent and 82 percent of the total outflow was sampled. During the two nighttime samplings, 82 percent and 78 percent of the total outflow was sampled. No fish was collected was collected during the August 2003 sampling event.

The powerhouse tailrace was sampled for two daytime and two nighttime periods, again in September 2003. During the two daytime samplings, 83 percent and 86 percent of the total outflow was sampled. During the two nighttime samplings, 84 percent and 79 percent of the total outflow was sampled. No fish was collected was collected during the September 2003 sampling event.

Overall, during the sampling period, there were few fish collected. None was collected during the winter period, when the powerhouse was operated by drawing down Portal Forebay. During the July sampling, the powerhouse was operating at about 82 percent of maximum capacity. The total flow-adjusted weighted entrainment rate was 0.15 fish/hour including both trout species. No fish were collected during the March, August and September sampling periods.

2.3 FLOW AND POWERHOUSE OPERATIONS

Flow from Ward Tunnel, when reaching the "Y" branch in the penstock can pass through the Portal Powerhouse, the HB valve, located at the powerhouse, or both. The Portal Powerhouse can utilize flows of up to 746 cfs. At greater flows, flows in excess of 746 cfs are passed through the HB valve. When flows in the penstock reach about 1,500 cfs, all flow bypasses the powerhouse and is passed through the HB valve instead. During periods when the powerhouse is off line, flow may be passed through the HB valve. The HB valve has a 90-inch diameter. Flow associated with the HB valve is released as part of FERC Project No. 67.

During drier periods, flow from Ward Tunnel may be used to fill the Portal Forebay over a period of hours to days. The forebay may then be drawn down to provide generation for a short period (hours). This process may then be repeated. This type of operation took place during the March sampling period.

2.4 POTENTIAL FOR TURBINE MORTALITY

The Project employs a single vertical Francis turbine with a maximum head of about 230 ft. Francis turbines are known to support relatively high levels of fish survival.

A study of turbine survival for a vertical Francis turbine was conducted by CDFG and PG&E at the Hat Creek No. 1 Powerhouse (PG&E 1998). The turbine installed at the Hat Creek No. 1 Project is similar to that at the Portal Project. The Hat Creek turbine operates at a similar maximum head of 212.6 ft. The results of that study indicated a survival rate of approximately 99 percent for rainbow trout. In addition, a longer-term study of tagged fish that passed through the powerhouse with similarly tagged fish released at the tailrace resulted in no significant difference in angler returns. This suggested that long term survival was similar.

Several reviews of turbine survival studies have examined the effect of different characteristics of Francis turbines on fish survival. A review by Eicher et al. (1987) indicated that survival was related to several characteristics, including head and rpm of the turbine. The studies reviewed primarily focussed on juvenile anadromous salmonids, and while the characteristics of the turbines studied encompassed the characteristics of the Portal Powerhouse, none was as similar as the Hat Creek unit. Based on the relationships derived by Eicher et al. (1987), fish survivals of between 70 and 80 percent would be expected at Portal Powerhouse. Odeh (1999), Cook et al., (1997), and Franke et al. (1997) variously reported on a recent review of fish entrainment and mortality studies by EPRI (1992). This review included data involving riverine fish species in addition to anadromous fish throughout the U.S. The findings indicated that estimated mortality averaged 20 percent (80 percent survival) for Francis turbines and that a wide variety of species have similar mortality rates from turbine passage. A conclusion from some of these studies was that there were lower rates of mortality for naturally entrained fish compared to fish that were artificially introduced into a turbine system for testing. The reviews also suggest that smaller fish tend to have greater survival than larger fish and that survival improves with higher turbine operating efficiency.

Sampling conducted resulted in the collection of three fish. One was a severely damaged brown trout. The other two were hatchery rainbow trout, which were collected without visible damage. Of the two rainbow trout, one was collected alive. It is unclear whether the mortality of the other trout was due to the effect of being held in the collection net or turbine passage.

3.0 SUMMARY

The potential for entrainment impact to Project fish resources through the Project powerhouse is low. The Project Forebay is small and provides a relatively small area to hold fish. Sampling of the forebay for fish during Licensee's studies confirmed that relatively few fish were present and that many of these were stocked hatchery fish. During the winter, when the powerhouse is operated through drawing down and refilling the forebay, no fish were collected through the powerhouse.

Fish also may reach the powerhouse through Ward Tunnel from water originating from a large number of SCE reservoirs and diversions associated with other FERC-licensed projects. Highest flows through Ward Tunnel occur during spring-summer runoff, when much or all of the flow may bypass the powerhouse through the HB valve. When this occurs, there is decreased likelihood of turbine passage by fish. During late summer and early fall, more of the flow passes through the powerhouse. Fish passing through the powerhouse from Ward Tunnel have been lost to their original populations once they were diverted. Therefore, the level of survival through the Portal Powerhouse has no bearing on the original population. During July, when the powerhouse was operating at about 80 percent of maximum, fish turbine passage was estimated to be 0.15 fish/hr. Of the three fish collected, two were of hatchery origin.

The Project utilizes a Francis turbine, with relatively low head, for generation. A study by PG&E (1998) for a similar turbine design and relevant literature suggest that there is limited mortality with the design used at this Project. The literature suggests that when Francis turbines are operating at high efficiency, during periods of high diversion, survival is increased. Therefore, during periods of increased likelihood of entrainment, potential survival may be increased. Fish surviving turbine passage are conducted through the powerhouse tailrace to Huntington Lake. Overall, information on the operation of the Project powerhouse and potential for mortality suggests that the effect of fish entrainment on the fish community by the Project is limited.

APPENDIX D

CONSULTATION DOCUMENTATION

Agenda
Big Creek Combined Aquatic Working Group

Meeting at Courtyard by Marriott in Modesto
1720 Sisk Road, Modesto, CA
April 18, 2001, 0900-1700 hrs".

Teleconference Call-in number: 1-800-569-0883
Tell Operator: SCE Aquatic Working Group Call
Moderator: Wayne Lifton

- Review Notes of March 15, 2001 CAWG meeting
- Review comments on revised draft study plans
  - CAWG-13 Water Use
  - CAWG-6 Hydrology
  - CAWG-4 Water Quality
  - CAWG-2 Sediment
  - CAWG-16 Volcanic and Seismic
- Lunch break at noon

Comments on the following two plans will be reviewed during the afternoon following the lunch break.

  - CAWG-8 Amphibians and Reptiles
  - CAWG-11 Riparian
  - CAWG-5 Water Temperature
  - CAWG-9 Entrainment

- Day's Wrap Up/Review Action Items

Big Creek Collaborative
Combined Aquatic Resources Working Group

April 18, 2001

Draft Meeting Notes

Time:	9:00 AM to 5:00 PM	**Moderator:**	Wayne Lifton
Location:	Courtyard by Marriot Modesto, CA	**Facilitator**:	**Bill Pistor**
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Ed Bianchi	ENTRIX
Rick Hopson	USFS - SNF
Wayne Lifton	ENTRIX, Inc.
Russ Kanz	SWRCB
Larry Lockwood	SAMs
Julie Means	CDFG
Kevin Moody	USBR
Janelle Nolan-Summers	ENTRIX, Inc.
Bill Pistor	Kearns & West
Martin Ostendorf	ENTRIX, Inc
Geoff Rabone	SCE
Steve Rowan	SCE
Julie Tupper	USFS

Telephone Participants

Chuck Bonham	Trout Unlimited
Jen Carville	Friends of the River
Holly Eddinger	USFS-SNF
Roger Robb	Friant Water Users Authority
DanTormey	ENTRIX, Inc.
Paul Wisheropp	ENTRIX, Inc.

Handouts distributed to the group during the meeting:

- Meeting Agenda
- Draft Meeting Minutes March 18, 2001
- Commented Detailed Study Plans, April 18 and 19, 2001

Review March 15, 2001 Meeting Notes

Page 3, 4th Paragraph is changed to read as follows: “ENTRIX was told that the USFWS will not assume the absence of special status amphibians if focused surveys are conducted and no special status amphibians are found.”

Page 4, second paragraph. Add "Condition" at the end of the sentence after Functioning.

Page 4, sixth paragraph, change 1-meter pixels reference to "1-foot pixels".

Page 4, seventh paragraph, change 3-meter pixel resolution to "1 or 3-meter resolution".

Page 4, ninth paragraph Bin List/Action Item . Should read, "Set up comparison on the USFS 1-meter pixel photo to 1-foot pixel infra-red photos at the next meeting in mid-April".

Page 8, Action Items List third bullet. Remove the words "for biota monitoring" from the end of the sentence.

Draft Detailed Study Plan Review

The following is a review of individual detailed study plans. Note: a handout containing copies of the Draft Detailed Study Plan was distributed to the working group participants.

CAWG-13 Water Use

The most significant revision to this plan is the development of a subgroup to review the model on page 13-5 new paragraph of the studyplan. These activities will be completed in 2002 see schedule.

Page 13-1

Stakeholder Management Objective (SHMO) #1, add the word "benefits of" after the word maximize.

Stakeholder Management Objective #4 is amended to read, "Amend Mammoth Pool Agreement if appropriate, in a way that is acceptable to all interests.

Comment was made that the stakeholder management objectives are individual agency or stakeholder interests that should not be changed.

Comment was made that the MPOA was signed in 1956, however not all the water contracts were signed until 1963. The purpose of this SHMO was to evaluate the agreement.

The USFS will need to add new stakerholder management goals and objectives from the Sierra Nevada Framework Forest Plan Record of Decision. **Action Item:** The USFS will provide these in writing. They will be incorporated in the SMG&O 's for the plenary to review and approval.

Page 13-3

General Approach #4, replace the word "constraints" with "protocals".

General Approach #5, change "flow-related" to flow and/or storage related", and change "use" to "uses" at the end of the sentence.

Detailed methodology, first sentence: How will you identify the operational constraints of the MPOA? How will you get this information? By reviewing existing documents, agreements, interviews. Not everyone agrees with this sentence. Change wording to insert after first sentence in Detailed Methodology, "The data will be collected from existing agreements and documents, and the data for consumptive and non-consumptive water uses will be augmented through interviews, as necessary."

Detailed Methodology, last sentence, change "effect" and "use" to plural.

Delete last sentence on page beginning with "Consumptive Project …"

The CAWG approved this plan with revisions.

Study 13 was approved with changes

CAWG –6 Hydrology

Page 6-1

Study Objective – Change the first study objective to read as follows: "Describe the impaired and unimpaired project area hydrology".

The forth study objective should read, "Determine how to classify water year type".

Add a fifth study objective as follows, "Determine the effect of PM&E measures on the hydrologic regime".

Page 6-2

General approach #1, change U.S. Geological Service to "U.S. Geological Survey".

General approach #2, change: 1) Indicator to "Indicators" this is a global change; 2) add "(at least 10 to 20 years)" following the word reasonable in the first sentence; and 3) strikeout the ending text following CAWG in the last sentence.

Page 6-3

Second full paragraph first sentence, strikeout "critical, dry, below normal, above normal, and wet water years", and replace with "water years types".

Second full paragraph third sentence, strike the words "critical and".

Forth full paragraph second sentence, 1) replace the words "be calculated at" with "represent flow above"; 2) delete the duplicate word "diversion"'; and 3) strike out the comment by Hopson.

Page 6-4

Study Area should read, "The hydrology study area will include all project effected streams and impoundment's in the relicensing basin".

Analysis, change to "Analysis/Output"

Analysis/Output second sentence, the following text at the end of the sentence, "determined by the CAWG"

Analysis/Output, add the following sentence at the end of the paragraph, "Fifteen minute data will be provided and analyzed to determine the ramping effects at specific locations as determined by the CAWG".

Page 6-5

First full paragraph, move to Detailed Methodology section as the last paragraph.

Delete the second full paragraph beginning with "The available record….".

Coordination Needs – Add CAWG-17 Fish Passage.

Page 6-6

Schedule Third sentence change to, "IHA will be conducted beginning in 2001….".

References section, comment was made that there are other papers by Richter.

CAWG 6 was approved with changes.

CAWG-2 Sediment Transport and Channel Maintenance

Change the study name to Geomorphology.

Page 2-1

Move Stakeholder Management Goal #8 to Stakeholder Management Objectives

<u>Page 2-2</u>

Study Objective, delete the fist two paragraphs and replace with the following, " The study will determine the effect of flows on the geomorphology of the project effected streams".

Bullet #1 in the Study Objective, replace channel maintenance with "transport"

<u>Page 2-3</u>

Study objective #2, should read, " Evaluate sediment sources (including tributaries) and conditions"

Study objective #5 should read, "Evaluate timing, magnitude, and duration of unimpaired and project effected flows to determine Geomorphological effects".

Study objective #6 should read, "Characterize and quantify sediment in project reservoirs".

Study objective #8 should read, "Determine if the presence and amount of woody debris in project effected reaches is within the range of natural variability".

Add new study objective #10, "Compare unimpaired and project effected sediment regimes".

Add new study objective #11, "Determine the effect of PM&E measures on geomorphology".

Add new study objective #12, "Determine the project effects on geomorphological features".

<u>Page 2-4</u>

Step 2: Change title of Step 2 to: Qualitative Reconnaissance of the Study Area.

Global Change – channel maintenance to geomorphological significant.

<u>General discussion on the study plan.</u>

Review of the plan stopped on Page 2-4. General concern was expressed that the plan needed additional work and that continued review would occur after the plan is revised. The following comments were solicited from the CAWG participants regarding the study plan.

- Points that need to be incorporated into the plan include, measurement of cross-sections, determine the sediment budget, do a Wolman pebble count, determine bankfull indicators, and determine sediment transport curves.
- We need to evaluate at a suite of flows. Study needs to look at bed material and the flows needed to move those materials.
- We need more expertise on this study. This is a very important study.
- Moderately comfortable with the study plan, we should, however, get other expertise to review and provide additional input the study plan.
- Comfortable with plan but does have concern regarding the sluicing of Bear Creek.
- Get another geomorphologist, to review the plan. Then get a third party peer review on this plan.
- The USFS stream conditioning inventory (SCI) handbook provides guidance. We can get a USFS - PSW scientist to look at the plan.

BIN LIST - CAWG-2 steps

Collect comments on plan

ENTRIX to revise study

Schedule conference to review and finalize. Participants, Russ, Rick Julie T, Julie M. Kevin, Ed, and Dan

The sluicing of Bear Creek must be done with separately in another process since another permit will be required. There are other places where sluicing has occurred. Sluicing should be separate, remove Bear Creek from the CAWG –2 study plan. Any discussion on sluicing in this study should be kept at a generic level.

CAWG –16 Volcanic and Seismic

This Study Plan has been moved to Land 11, Handed out copies for everyone to review and provide comments to Brenda Peters on Monday, April 30, 2001.

CAWG-8 Amphibians and Reptiles

New version of the study plan was handed out to the group. The version in the study plan package was not the most recent version.

Page 2

The California Red-legged Frog Draft Recovery Plan should be referred to as the Draft Final Recovery Plan.

Change the California slender salamander (batrachoseps attenuatus) to “slender salamander (batrachoseps)”.

First study objective, change native amphibian to “native and non-native”, and delete all text following the word “habitats”.

Third study objective should read “Determine the year round temperature regime for selected locations known to support Foothill Yellow-legged frog populations. Determine the timing of egg deposition to the extent possible”.

Delete the forth study objective that begins with, “Determine the relationship….”

Fifth study objective should read, “Evaluate the effects of project operations and proposed PM&E measures on habitat and different life stages of special-status amphibians and reptiles and their predators”.

Add new study objective, “Evaluate information collected from other studies to access the effects on amphibians and reptiles”.

Page 3

General approach #2 should read, add “initially” before the word mapped, and replace “ground truthing” with “known information”.

General approach #3, add the words “in more detail’, after “identified”.

General approach #4, change Rosgen Level 1 to “CAWG-1”.

General approach #5, should read, “…..will be used, evaluated, and assessed to determine the project operation….”

General approach #6, should read, “…..identify amphibian areas and sampling protocols to be used. Sampling Areas…..”.

<u>Page 4</u>

General approach #9 should read, "In Project Streams, assess the project flow effects on life stages and habitat for special-status amphibian and reptiles using IFIM/PHASIM or wetted perimeter studies, or some other method".

General approach #10 should read, "……special-status fish, amphibians and reptiles that may…..".

<u>Page 5</u>

Global change "representative sampling sites" changes to "selected sampling sites".

Detailed methodology #5, Delete the fist two sentences, and last sentence should read, "…..effects of project operations in project reaches on habitat and life stages for …..".

<u>Page 6</u>

First partial paragraph, delete the remainder of the paragraph beginning at the sentence starting with, " A "Sample Survey" as defined…..".

Delete the two bulleted paragraphs beginning with "Day surveys" and "Nocturnal surveys".

Detailed methodology #9, insert the word "or other methods" following wetted-perimeter studies.

<u>Page 7</u>

Study Area, keep the first and last sentence of the paragraph and delete the middle sentences.

Analysis section second sentence, delete the word "potential", and add "and lifestages" to the end of the sentence.

Analysis section forth sentence, change "critical amphibian periods" to " critical lifestages".

<u>Page 8</u>

Coordination needs, add CAWG-7 Fish Populations.

<u>General Discussion of Protocol Level Surveys.</u>

If we need to use a habitat based approach why do we need to do special status surveys.

We are really deferring decision on the number of sites we will be visiting for protocol surveys..

We are defining the process that will be implemented to determine the protocol survey and the number sites.

If everything utilizes a habitat based approach and we go out and do focused protocol surveys will this be useful in the decision making process and useful in determining the mitigation measures.

Yes, the surveys are important. The populations and life stage data collected will help determine the type and level of mitigation that will be implemented/required. There was agreement that the protocol surveys will be useful in determining the level of mitigation measures in the decision making process.

CAWG-8 was approved with changes.

<u>CAWG-11 Riparian</u>

<u>Page 11-2</u>

Detailed methodology #4, delete the first sentence, beginning with, "The results of sediment transport….".

Page 11-3

Detailed methodology #5, Combine the first two bullets into a first tier approach, and the third and forth bullet will change to the second and third tier approaches, respectively.

Detailed methodology #6, second sentence insert the words "structural diversity" after the word include. Change the forth sentence to begin, "If sign of riparian encroachment ……". At the end of the paragraph add the following sentence, "At selected sampling and references sites geomorphology data will be collected".

Page 11-4

Detailed Methodology #6 page 4. Will we bore trees to count rings?

Detailed Methodology #7, the PFC reference indicates that relevant data per the PFC protocol will be collected. The PFC methodology relies upon all of the resource specialists conducting their surveys collaboratively and concurrently. Hence the following paragraph will be added to the end of Detailed Methodology #7.

> "The following three steps will be taken in following the PFC process: (1) preliminary assessment based on data collections (CAWG –1, CAWG-2, and CAWG-6); (2) select sites; and (3) use multidisciplinary team to conduct PFC protocol surveys at selected sites."

Analysis section. Replace with the following text, "Identify differences between Project effected reaches and selected reference sites. Evaluate mechanisms that may be responsible for differences including project and non-project causes".

Page 11-5

References – Add PFC reference.

General discussion of study.

Concern was express that the study plan has not adequately addressed groundwater. Specifically, that groundwater dewatering through fractured bedrock into the Ward Tunnel may effect riparian areas located above the tunnel.

Action item/Bin Issue: Jerry DeGraff, Rick Hopson, Dan Tormey, Janelle Nolan-Summers, Julie Means, and Julie Tupper will discuss this issue to determine if there is a potential impact from the Ward Tunnel.

Riparian microhabitat mapping, identifies small areas of riparian habitat in broader scale mapping area. For example a long reach may be mapping as some thing other than riparian due to the river gradient. However a small portion of this reach may have a gradient change that is conducive to riparian habitat.

Will we video riparian from helicopter flights? No, in an earlier meeting we agreed not to do this GIS will be more useful.

CAWG-11 Riparian Plan was approved with changes.

Comparison of Aerial Photography Methods

The following summarize the review and discussion on the aerial photography.

The USFS has 9X9 B&W photos and the forest service will be doing new fly overs this summer that will take 9x9 color photos. We can do the vegetation mapping with these photos.

The USFS investigated these options and identified the following major advantages of digital IR photos: 1) digital infrared imagery is already in a digital format that is easily input into a computer and is georeferenced, and 2) the IR will provide much more info since it enhances riparian vegetation color so it is easier to map.

Does the USFS have any existing IR photos available. Only at a scale of 1:30,000 from NASA taken sometime in the 1980's.

The USFS has estimated the cost of Digital I.R. at $250 to $500 dollars per mile, not the $1,500 that was stated earlier. So instead of $150,000 the costs will be much lower. USFS estimated costs of $50,000 if $600 per mile, $36,000 at $400 per mile, and $22,000 at $250 per mile.

There are limitations using digital IR in areas with canopy. With over 50% canopy you may not be able see under the canopy to identify habitat.

If Digital I.R. is so inexpensive why does the USFS not use this method this summer instead of collecting color 9X9's.

Two issues are identified here, the cost and the value of the information. All the PG&E scientists that have used this method think it's great. If it is so great and it provides the best information then it does save cost in the long run.

Will the field work be significantly less because of the IR? It may be less, however, we don't really know this until we have the data.

Action Items : 1) We need to confirm the true costs of the digital IR. USFS cost and costs from contractors that flew the Pit River (the example provided to us).

Get a quote from Hammod, Jensen and Wallen.

Confirm USFS costs - Julie and Rick.

Develop a list of applications for the digital IR across disciplines.

Have biologists talk to the PG&E biologist (Paul Kopacheck (PG&E)).

Obtain a sample of the one-foot version to see the quality.

ID benefits of IR are over existing photography.

It was recommend that we develop the process that will enable us to make the determination as to whether to do this IR. Lets build the decision process into the study plan so we can approve the study plan.

Everyone agrees that this is a better system, the decision to use it is a business decision. How much does it cost?.

The USFS air photos this summer, are not scheduled to fly over the wilderness. If SCE wants these locations in the wilderness then the USFS will need to know soon. Julie said that the contractor has a map showing the flight locations. Rick will try to get map for us and we will get a decision to the USFS.

The USFS research department is experimenting with CASI imagery, (a new technology). This photography uses many color band wavelengths. This department has funding, they may fly the area for us if we can sell it to them.

Action Item Add language to the riparian study stating that the aerial photography may be determined as part of the study. Then can we approve the riparian study with this language.

Agenda
Big Creek Combined Aquatic Working Group

Meeting at Courtyard by Marriott in Modesto
1720 Sisk Road, Modesto, CA
April 19, 2001, 0900-1700 hrs".

Teleconference Call-in number: 1-800-569-0883
Tell Operator: SCE Aquatic Working Group Call
Moderator: Wayne Lifton

- Review comments on revised draft study plans (we will focus on these plans)

  - Plans not completed from April 18
  - CAWG-7 Fish Populations
  - CAWG-10 Macroinvertebrates
  - CAWG-3 Instream Flow
  - CAWG-1 Habitat

- Lunch Break at Noon

Comments on the following plans will be reviewed during the afternoon following the lunch break.

  - CAWG-17 Passage
  - CAWG-15 Anadromous Fish
  - Aerial photography discussion, if material is available on time

- Future Scheduling

- Other Business/Wrap Up/Review Action Items

Big Creek Collaborative

Combined Aquatic Resources Working Group

April 19, 2001

Draft Meeting Notes

Time:	9:00 AM to 5:00 PM	**Moderator:**	Wayne Lifton
Location:	Courtyard by Marriot Modesto, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Wayne Lifton	ENTRIX, Inc.
Bill Pistor	Kearns & West
Martin Ostendorf	ENTRIX, Inc (Recorder)
Geoff Rabone	SCE
Steve Rowan	SCE
Sharon Stohrer	SWRCB
Julie Means	CDFG
Ed Bianchi	ENTRIX
Larry Lockwood	SAMs
Kevin Moody	USBR
Steve Rowan	USFS-SNF

Telephone Participants

Holly Eddinger	USFS-SNF
Phil Strand	USFS-SNF

Handouts distributed to the group during the meeting (distributed 4/18/01):

- Meeting Agenda
- Draft Meeting Minutes March 18, 2001
- Commented Detailed Study Plans, April 18 and 19, 2001

Draft Detailed Study Plan Review

The following is a review of individual detailed study plans. Note: a handout containing copies of the Draft Detailed Study Plan was distributed to the working group participants, during yesterday's meeting.

CAWG-7 Fish Populations

Page 7-1

Stakeholder Management Goal #2 should read, "Manage both cold water and warm water fisheries, including transitional zones and harvest vs. non-harvest species, where appropriate".

Page 7-7

First partial paragraph question on sub-sample. Each sub-sample will consist of approximately 20 fish randomly drawn.

The units for data will be collected in both metric and English.

Will all fish be sampled for tissue?

Will we save fish for future studies? No we are not planning on killing any fish. We will only collect tissue samples for CDFG. We will do growth and scale analysis on the fish.

Second full paragraph first sentence, change "all non-hatchery" to "representative non-hatchery".

Page 7-8

Whitewater Flow Assessment, first paragraph. The first sentence should be changed to read, "Fish sampling will be conducted on the fry of native trout, cyprinids and catostomids to assess the (negative or positive) effects of high flow releases that may be used to provide whitewater recreation".

How do you evaluate the negative or positive effects? We will look for stranded fish and impacts to the fry population.

Whitewater Flow Assessment, second paragraph. The second sentence should read, "Three sites with substantial nursery habitat will be selected for sampling in a reach that will be subject to whitewater study flow releases".

Whitewater flow assessment section – should we add a section on the consultation with other agencies. Is this referenced in the whitewater study and the amphibian study?

Page 7-10

Analysis section third paragraph, second sentence replace "specific project operations are having and effect on growth" with "differences can be observed".

Page 7-14

References, update Reynolds reference.

CAWG-7 was approved by the group.

CAWG-5 Water Temperature

Page 5-8

Study Area third sentence, Insert the word proposed before the word "locations".

Add the following sentence as the forth sentence, “The final locations to be determined by the CAWG”.

Analysis section third paragraph first sentence should read as follows, “ First we categorize the bypass reaches according to the results of water temperature monitoring into: 1) those reaches where upstream-to-downstream temperature increases appear to not be in compliance with the temperature objective of the basin plan; and 2) those reaches where upstream-to-downstream temperature increases appear to not be in compliance with water quality and temperature objective in the basin plan.

Page 5-9

Table CAWG 5-1, Adit 2, add parenthetical “(At Portal Forebay).

There is another major tributary – Willow Creek. This tributary has already been done in another study for the Big Creek No. 4 Project. We already have a calibrated model for this reach.

Add a footnote to the SJR at Horseshoe Bend reach as follows, “ Horseshoe Bend Reach from Dam 7 to Powerhouse 4 has been modeled using SNTMP and the model is available”.

Page 5-14

First full paragraph, first sentence should read, “For those reaches where temperature is observed to be above the temperature objective in the Basin Plan further analysis will take place”.

Fourth full paragraph, first sentence should read. “The third phase of this analysis involves stream temperature modeling to investigate the potential causes of warm temperature in the bypass reaches, as determined by the CAWG”. Delete the rest of the paragraph after the first sentence.

Page 5-16

Third partial paragraph, the first sentence should read, “In order to analyze the potential for water temperature control by Project reservoirs for downstream releases, the CAWG……”.

Page 5-17

First partial paragraph, add Forward Looking Infra-red (FLIR) to the list of reservoir temperature models.

Page 5-18

Coordination Needs, change from text format to a list of bullets.

Coordination Needs, add CAWG-10 Macroinvertebrates and CAWG-7 Fish Populations

General discussion on the study plan

The SWRCB reserves the right to see a map with all the temperature stations before approving the monitoring locations. The CAWG needs to meet to discuss the locations.

Update Table 5.1 Monitoring locations update.

Action Item – Complete the temperature monitoring location map.

Has last seasons (year 2000) data been complied? This data is still being processed.

Action Item – Temperature location map

Action Item – We will all be meeting on the Vermilion Project on May 8th. Lets take a hour on the 8th while we are together to review the temperature and water quality stations. Set time after the Vermilion meeting, everyone agreed that 4 PM work.

We need to have flexibility in the plan for adding stations based on data from last year.

Do we need to add another temperature monitoring location in Camp 61 Creek to determine the additional contribution of water from Adit #2 just below the confluence. Add this to the tributaries section in the table of water station locations.

CAWG-5 was approved by the group, with changes.

CAWG-10 Macroinvertebrates

A comment was made that Dr. Burke at Fresno State has done work in the Sierra National Forest. He may have some information of interest.

Are we evaluating the effects of high water spring run off or the whitewater boating study "Controlled flow releases"?

Page 10-2

Detailed Methodology second sentence, insert "ethnographic surveys" after SCE studies.

Field Data Collection, Site Selection first sentence, insert the word "help" before the word access.

Field Data Collection, Site Selection, second sentence should read, " To accomplish this objective, comparative macroinvertebrate sampling will be conducted.

Field Data Collection, Site Selection second paragraph, delete the first sentence.

Field Data Collection, Site Selection third paragraph, delete the first sentence.

Field Data Collection, Site Selection delete fourth, fifth, and sixth paragraphs.

Page 10-3

Macroinvertebrate Sample Collection, the second and third sentences should read as follows, "Either non-point source or spot sampling protocol will be used. A D-frame or other net, as approved by the CAWG, with a 0.5 mm net will be used.

Mollusk Sample Collection, first sentence replace macroinvertebrate with fish, and add "as agreed to by the CAWG'" at the end of the sentence.

How many sites will have mollusk sampling? We proposed to do one site at each macroinvertebrate sampling location. It was suggested that the site be determined by the CAWG and literature review (look for ethnography of historical occurrence).

Page 10-4

Whitewater Studies section, the first sentence should begin as follows, " Additional macroinvertebrate sampling may take place …..".

Page 10-5

Reservoirs section, add ", as feasible." to the end of the second sentence.

Laboratory procedure section first paragraph, delete the word "generally" from the first sentence.

Laboratory procedure section first paragraph add ", if possible." to the end of the sentence.

Laboratory procedure section, first paragraph forth sentence, after the word "identified" add the following text, "to the appropriate level of identification in the CSBP taxonomic effort".

Page 10-6

First full paragraph, replace the word macroinvertebrate with "fish".

Page 10-7

Coordination Needs. Change to bullet format, and add CAWG-4 Water Chemistry, and CAWG-11 Riparian.

CAWG 10 was approved with comments

CAWG-3 Instream Flow

Page 3-1

Move Stakeholder Management Goal #7 to Stakeholder Management Objective #7.

Page 3-2

First partial paragraph, third sentence change fish populations to "aquatic populations".

Page 3-5

The SWRCB wants a presentation of the transect selection methodology.

Page 3-7

HSC Selection and Verification

Add as third bullet, " If appropriate macroinvertebrate criteria are available, these will be used with the approval of the CAWG".

Would like to use other existing curves if possible. Concern was expressed about using curves from different regions of the country, we need to be cautious about the interpretation of the data and results when using these generic curves.

Add as the forth bullet, "If appropriate amphibian criteria are available, these will be used with the approval of the CAWG. In the absence of other criteria, fry criteria will be used".

Page 3-8

Third bullet change "Transect locations will" to "Transect locations may".

Adit #2 Seepage add parenthetical (below Portal Forebay).

Page 3-12

Coordination Needs, change to bullet format, add CAWG-10 Macroinvertebrate and CAWG-8 Amphibians and Reptiles.

Do we need the Appendix. It is not part of the plan but should be included. It is subject to change. We need to check the plan for consistency and make sure the appropriate changes are made in the Appendix to assure the consistency.

CAWG-3 was approved with changes.

CAWG-1 Characterize Stream and Reservoir Habitats

The change made to this plan in the stream portion of this study reflects the data collected to date, and the reservoir section contains comments on sediments and bathemetry.

The USFS requested copies of the raw data from the studies already completed.

We need to make sure the Riparian study plan includes a GIS component.

Page 1-3

Add as last bullet of the general approach, "The CAWG will review the information collected to identify the need for any supplemental data collection".

Page 1-9

Table CAWG 1-1, add Cold Creek and Warm Creek above Lake Edison as completed, and a partial on Boggy Meadow.

Page 1-12

Coordination Needs, change to a bullet format.

Page 1-14

Table A-1, Add culvert Additional Unit Designation.

CAWG 1 was approved with changes.

CAWG-9 Entrainment

General comments, this is one of those key studies that if you don't have buy off on. It can be very contentious, you may have to go back and redo the studies, which may cost millions of dollars.

Page 9-1

Stakeholder Management Objective #2 should read, "Manage both cold water and warm water fisheries, including transitional zones and harvest vs. non-harvest species, where appropriate".

Page 9-6

Will Portal Forebay be included in the study area. Entrainment from the forebay will be captured at the powerhouse.

Page 9-8

Coordination Needs, change to bullet format.

We have buy in on this plan from everyone except USFWS. The USFWS has hired a new person that will start on Big Creek immediately. We need buy in from the other personnel in the USFWS also. Is NMFS involved? NMFS is involved in the anadromous fish study.

What is the sampling frequency that you we will be checking nets at the small diversion. We will sample a representative subset of small diversions, set up (see page 9-5) for about three days and nets will be checked on a 12 to 24 hour basis.

CAWG-9 was approved with changes.

CAWG-17   Fish Passage

Page 17-1

Stakeholder Management Objective #1 should read, "Manage both cold water and warm water fisheries, including transitional zones and harvest vs. non-harvest species, where appropriate".

Project Nexus, first sentence should read "In channel structures or conditions may impede the migration of aquatic life".

Page 17-2

Bullet #4, first sentence should read, " Information resulting from CAWG Study Plans 1 and 7 (Stream and reservoir Habitat Characterization and Fish Populations, respectively) will be used to evaluate if population or communities effects are observed under the current level of passage".

Add general approach #2, "If mussel pops are encountered the effect of fish passage will be evaluated on those populations as well"

Page 17-4

Strike out Adit #2 Seepage. Add footnote to table, "The Adit 8 diversion is not included because it is not an ephermal stream".

Page 17-5

Third full paragraph, the first and second sentences should read, "Data collected during the fish population and habitat mapping surveys (CAWG-7 and 1, respectively) will be considered relative to upstream and downstream potential fish passage barriers. Comparisons of populations and available aquatic habitat could determine if fish passage barriers are likely affecting the viability of fish populations".

Page 17-6

Coordination Need, change to bullet format, and include CAWG-10 Macroinvertebrates.

CAWG-17 was approved with changes.

CAWG-4 Chemical Water Quality

Rick Hopson (USFS-SNF) provided written comments prior to today's meeting.

> Page 4-3, Existing Water Quality Standards 2nd paragraph, last sentence. The lower numeric objective should state: "The most stringent objective….because the lowest standard is not always the most desirable".
>
> Page4-4, 1st partial paragraph. The new statement "reservoir and small impoundment sampling described in the next section will serve as upstream samples water quality samples". I disagree, we should collect the upstream water quality samples separate for the impoundment sample.
>
> Page 4-4, 1st complete paragraph, 2nd sentence beginning with, "For moderate diversion dams….." Same comment as above.
>
> Page 4-6, 1st paragraph under "Characterization of Sediment & Contaminant Sources". The addition, 3rd sentence, "SCE's hazardous material spill record…." If so, please state as such. The sentence has been changed to indicate the hazardous materials spill record.
>
> Page 4-8, under study area, add to the end, "Site specific water quality sampling locations will be identified and approved by the CAWG".
>
> Page 4-9, Table CAWG 4-2. Why do camp 61 Creek and Adit 8 Creek have 0 samples? Because they are not part of the ALP? If so, consider removing from the Table or adding all other water quality monitoring site within study plans for the non-ALP projects.

Comments received and edits made during the meeting.

Page 4-1

Stake Holder Management Objective # 7. Should read, " Understand potential Project impacts of Project maintenance and operations on chemical water quality".

Study Objective #1, DO should be spelled out, "Dissolved Oxygen"

Page 4-4

First partial paragraph, strikeout, delete the following sentences, "~~These samples will be collected immediately upstream and down stream of those structures. Reservoir and small impoundment sampling described in the next section will serve as upstream water quality samples.~~"

Second full paragraph, first sentence insert the word " , impoundment's" following bypassed reaches.

Second full paragraph, delete all text after the first sentence through the sentence beginning with, “Within the reach, …”.and replace the deleted text with the following text.

“Samples will be taken as follows:

- for small diversions samples will be collected upstream of the diversion;
- for moderate diversions samples will be collected in the diversion pool and up stream of it’s influence;
- for reservoirs samples will be collected in the reservoir and the small streams above the influence of the reservoir

Second full paragraph, last sentence, change “samples” to additional samples”.

Third full paragraph, second paragraph, add pH to the list of in-situ measurements.

Third full paragraph, insert the following sentence following the second sentence. “A water depth will be measured at the stations”.

Third full paragraph, second to last sentence, reference to watercraft should be changed to motorize watercraft.

<u>Page 4-5</u>

First full paragraph, second sentence change “polls” to “pools”

First full paragraph, fifth sentence should read, “Mammoth Pool has a drop of approximately 330 feet.

First full paragraph, last sentence delete parenthetical “(federal water quality standard)”.

<u>Page 4-6</u>

First full paragraph should read as follows: “For all reservoir site samples fecal coliform sampling will be conducted as described in the basin plan and shall be collected at near shore areas. The fall sampling shall be conducted in the 30-day period including Labor Day.”

Second full paragraph, there is reference stating that water quality parameters will be measured at 5-meter intervals. This should be changed to 3-meter intervals.

Second full paragraph, insert the following text as the last sentence, “ Sampling of fish tissue for mercury and silver will be conducted in Mammoth Pool using non-hatchery harvest species after consultation with OEHA.

Last partial paragraph, insert “sluicing activities,“ after “storage areas”.

<u>Page 4-7</u>

First paragraph second sentence SCE’s spill record should be “SCE’s hazardous materials spill record”.

First paragraph, delete last sentence which begins with “Monitoring of the Bear Creek….”.

Study Area section, add the following sentence to the end of the paragraph, “Site specific water quality sampling locations and numbers will be identified and approved by the CAWG”.

Analysis section, first sentence delete the word “reservoir”, and add “,where appropriate” to the end of the sentence.

Project Effects on Water Quality section, the first sentence should now read as follows:

> The data collected in the previous tasks will be used to:
> 1) assess sediment and water quality in the project area;
> 2) identify project operations and maintenance activities that may effect water quality; and
> 3) identify how project operations influence the bioaccumulation of mercury and silver.

Project Effects on Water Quality section, delete the two following sentences that begin with “The analysis will identify….” and “The specific Project effect will be determined”.

Comment was made that sediment analysis for mercury and silver should be done before the Bear Creek sluicing event is performed.

<u>Page 4-8 Table 4-1</u>

Include dissolved metals analysis for all metals except for molybdenum

Add pH analysis.

<u>Page 4-9 Table 4-2</u>

Large Dams – Add Mono Creek below Vemilion

Moderately-sized Diversions - Add Balsam Forebay, and Portal Forebay

Small Diversions – Add Warm Creek, Upper Mono Creek, Cold Creek, and Adit 2.

Flow Augmented Streams – Add Boggy Meadow.

Footnote streams that are associated with project that are following the Traditional Licensing Process

Footnote – Stream or creeks that are ephemeral.

Change column heading from “Number of Sample Locations” to “Proposed Sample Locations”

Action Item: There will be a meeting in May 8 at the ENTRIX Sacramento Office at 4 PM to discuss water quality sampling sites and temperature monitoring locations. Before this meeting SCE will post a map of the sample and monitoring locations on the SCE Hydro web page.

CAWG 4 was approved with changes

<u>CAWG-15 Anadromous Fish.</u>

Change title to Salmonids

Page 15-2

The ending of the first partial paragraph should read, The operation of Friant Dam at Millerton Lake affects the availability and quality of water to the San Joaquin River. Federal agencies and their partners are currently studying the feasibility of restoring fall run Chinook, spring run Chinook, and steelhead.

Page 15-4

Coordination Needs change to a bullet format.

General discussion

CDFG is circulating this study plan through their department and compiling comment. They are not ready to approve the study plan

This plan was not approved by the CAWG and is pending additional comments.

Bin Item/Action Item: 1) Get additional comment from CDFG and NMFS. 2) CAWG Approval

General Comment of Process

Approved study plans fall in to the approved category with those plans from the other group. The approved plans will go to the plenary and public for review. However, we need to get everyone's input on approving the Stakeholder Management Goals and Objectives to go into the study package.

There will be a 30 day comment period after the plans are be sent out.. And a public meeting will be held half way through the 30 study plan comment period. We need to issue a 15 day public notice for the public meeting this will dictate when the meeting will be held because this notice will be sent when the plans are sent out.

Bin List Items

CAWG-2
- Obtain comments from everyone.
- ENTRIX will re-write plan with geomorphologist review.
- Set up teleconference call for subgroup review, (Ed, Russ, Julie T., Sharon, Julie M., Kevin, Dan and Wayne)
- Obtain final CAWG approval

CAWG 15
- Obtain review comments from NMFS and CDFG and edit plan accordingly.
- Email back to group for review.
- Obtain final CAWG approval.

Water temperature monitoring locations and water quality sampling location need to be determined by the CAWG. A map will be provided which depicts the locations. The group will reconvene on May 8th in Sacramento to review monitoring and sampling location.

Action Items

New Stakeholder Management Goals and Objectives from USFS must be incorporated into the study plans.

Bear Creek Sluicing Effort should not be part of the study plans and coordinated with the agencies under a separate effort.

Provide raw water temperature monitoring data from 2000 studies to the USFS once it has been reviewed.

Ward tunnel bedrock fractures, groundwater and riparian area relationship. (Subgroup to review Jerry De Graff, Dan, Janelle, Julie M., Rick, and Julie T.)

Review Land Management Volcanic and Seismic Study, and provide comments to Brenda Peters if any.

Temperature Monitoring Stations/Water Quality Sampling Location Map to be completed and sent to the group for review.

Provide reference document mollusk sampling to Kevin.

Big Creek Collaborative

Combined Aquatic Resources Working Group

July 10, 2001

Meeting Notes

Time:	10:00 AM to 4:30 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-569-0883	**Recorder**:	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Wayne Lifton	ENTRIX, Inc.
Bill Pistor	Kearns & West
Martin Ostendorf	ENTRIX, Inc (Recorder)
Geoff Rabone	SCE
Steve Rowan	SCE
Ed Bianchi	ENTRIX
Holly Eddinger	USFS-SNF
Rick Hopson	USFS-SNF
Janelle Nolan Summers (3PM)	ENTRIX, Inc.
Dan Tormey	ENTRIX, Inc.
Phil Strand	USFS-SNF

Telephone Participants

Russ Kanz	SWRCB
Sharon Stohrer	SWRCB
Steve Edmondson	NMFS
Chuck Bonham	Trout Unlimited
Gary Taylor	USFWS
Debbie Giglio	USFWS
Jesse Wilde	USFWS

Handouts distributed to the group during the meeting (distributed 4/18/01):

- Study Plans: CAWG-2 Geomorphology, and CAWG-4 Chemical Water Quality
- USFWS Service Comment Letter
- R2 (USFS consultants) comments table on the CAWG Study Plans

Steve Edmondson asked if the CAWG would get to the Anadramous Fish Study Plan today. Yes. Later today the CAWG will address comments provided by R2 Resources on this study plan. The National Marine Fisheries Service (NMFS) and the U. S. Bureau of Reclamation (USBR) are working on another proceeding to restore of the San Joaquin River and they would like to incorporate these proceedings into the Big Creek ALP.

CAWG-2 Geomorphology

The CAWG reviewed the most recent edits made to this study plan based on comments received from the CAWG during the July 2nd meeting.

CAWG Comments on the Study Plan

Detailed methodology, Step 5. Paragraph beginning "Studies of the sensitive sites…."

This paragraph identifies activities (V*, Wolman pebble counts, etc.), that will be performed at sensitive sites based on observation of excessive deposition or scour. However, we will not know if there is excessive deposition or scour until we complete these activities. The sequence of events is wrong; we need to do these first.

General observation of deposition and scour will be identified during the reconnaissance phase.

V* and the pebble counts need to be done at all the sites, not only the sensitive sites. This section is written for all sites. The first paragraph of the section refers to "all identified sites," hence we should be doing all these analyses at all the sites.

How are we going to select the sites for detailed analysis? Is everyone ok with the CAWG selecting the sites based on the preliminary information? Yes, because we have an opportunity to go back to site, based on the preliminary data.

The CAWG will choose two types of sensitive sites: 1) detailed sites; and 2) other sites based on land use impacts upon the stream. In addition to these two sites, there also will be reference sites.

Action Item: Rewrite the first, second and fourth paragraphs of this section, based on the discussion above.

> First paragraph: Third sentence, add *(study and reference)*. The sentence should be begin Sites (study and reference)..
>
> Fourth paragraph: Delete the first two sentences and half of the third sentence. The remaining text beginning with "*1) measurement of channel dimensions,…"* will be moved and incorporated into the paragraph beginning with "For all identified transects.".

Paragraph (second to last in section 5) beginning *"The Data from Step 2 and 5…."* delete 2nd sentence from this paragraph. This is the sentence beginning with *"Impacted areas…"*

Remove: "Large Woody Debris" from the list of SCI protocol at sensitive sites, since this will already be done at all sites.

> Add to the end of the second paragraph in Geomorphically-Significant Flows:
> "Flood frequency analysis will be used in conjunction with field indicators to determine bankfull flow. Methods in Hill *et al*. (1991) will be used to guide the assessment of the magnitude, timing, frequency, duration, and rate of change of out-of-channel flows. These data will be used in the Riparian Study Plan (CAWG-11)."

R2 Resources Comments

The following discussion is based on a review of comments prepared in response to comments by R2 Resource in the draft study plans.

It was suggested that since many of the R2 comments are asking for definitions, maybe the study plan package should contain a glossary. One standard glossary, for the study plan package (We will have to identify which plans the studies are referring to). The glossary will be a living document, where we can add definitions as needed. **Action Item** – Build a glossary, Include definitions for "alluvial", and "Rosgen Level I and II", (include year version that is being used).

R2 comment table – Page 14, CAWG-2-28. There was disagreement to the response, which referred the reader to CAWG 11 for details on the assessment of out-of-channel flow requirements. **Action item:** Add the following text as the last sentence of this paragraph, "Flood frequency analysis will be used in conjunction with field indicators to determine bankfull flow. Methods in Hill *et al*. (1991) will be used to guide assessment of the magnitude, frequency, timing, duration, and rate-of-change of out-of–channel flows. These data will be used in the Riparian Study Plan (CAWG-11)."

<u>USFWS Comments</u>

Page 2-17 (USFWS letter). This is a comment to the Stakeholder Management Goal and Objective and is not subject to revision.

Page 2-19 (USFWS letter). This comments stated that Items 8, 9 and 10 in the list of study objectives seem out of place and that 6 and 12 are duplicated. The CAWG has extensively discussed these study objectives and have developed the study objectives to have a broad focus.

Page 2-21 (USFWS Letter). Bullet 6 (The second to last bullet in Step 3, General Approach). We should add a bullet in Step 1 that states, "review and analyze existing data". **Action item:** Add bullet in Step one Historic and current SCE sediment management practices will be reviewed and described.

Page 2-27. (USFWS letter). The new revised plan includes text in Step 6 that address the USFWS comment. The CAWG may also determine that a more detailed study (for example sediment transport model) is required to make this determination.

Do we have enough time to complete this model? Yes we need a spring and a summer to collect the needed data. All the field data needs to be collected in 2002 so that we can bring the data to the CAWG to select additional sites. Then additional data can be collected in 2003. We need to get a special use permit to use a helicopter in the back country so that we can get to the sites during the snow melt since the road will be closed, otherwise we may miss the waning hydrograph. We would only do this if the road is closed. We have already talked with the USFS on the helicopter over the wilderness issue for the amphibian studies. **Action Item**: Initiate discussion with the USFS regarding the special use permit for a helicopter over the wilderness area. (no height restriction if we will not be landing.)

CAWG-2 was approved by the CAWG with the above changes!

CAWG-4: Chemical Water Quality

The CAWG reviewed the most recent edits made to this study plan based on comments received from the CAWG during the July 2nd meeting.

<u>CAWG Comments</u>

The changes made to this study plan were focused on clarification of water quality measurements in reservoirs, and fecal coliform sampling requirements.

Water quality grab samples will be collected monthly during the period of June through September from the large and moderate size reservoirs, concurrently with the reservoir profiling activities.

Fecal coliform sampling activities will be conducted at a screening level during the spring and fall. Additional sampling (five samples over a 30 day-period) will be conducted at sites that do not pass the screening criteria (200/100-ml) and at sites with significant contact recreation, as identified by the CAWG.

USFWS Comments

Clarification on WQ standards. We refer to the California Toxic Rule and the National Toxic Rule; however, the references are not consistent with that presented in the reference section. Need standard nomenclature that is consistent with the reference section.

We also need to identify the water quality plans with the most stringent standards and add a statement that will SCE comply with those standards. **Action Item**: Add a statement "The most stringent standard will be identified……..." Add this to the second paragraph of the Existing Water Quality Standards section.

Action Item: Add the CA Toxic Plan and National Toxic plan to the glossary. Correct citations in the text that refer to these plans.

Action item: When referring to the Basin plan we need to identify which basin the Sacramento or the San Joaquin River.

Is SCE intends to meet the most stringent standards. Yes it is our intent however, some water quality condition that is out of our control may exist which we can not meet the standard, hence we may have to mitigate if we can not meet the standard.

R2 Resources Comments

Have the R2 comments been added to the study plans. No they have not, they will be added only if the CAWG agrees.

The CAWG-4 study plan was approved by the CAWG.

General Discussion

Process question. When the plans go to the Plenary, do they vote on it? Yes we will explain these changes to the plenary and get their approval. Has the Plenary approved any plans? The Plenary has only approved the draft study plans not the final plans.

The SWRCB indicated that they are all right with the remaining study plans. However, they want to participate in the review of the macroinvertebrate study plan. The CAWG will call the SWRCB when the macroinvertebrate study is discussed.

CAWG-9 Entrainment

No comments from the CAWG or the USFWS on this study plan. Three comments were received from R2 Resources on this study plan; the CAWG did not have any comments to the responses that were prepared.

The CAWG-9 study plan was approved by the CAWG.

CAWG-11 Riparian

R2 Resources Comments

R2 Comment, CAWG-11, page 2-121, top of page items 6 and 8. The response to the R2 comments is an assumption that should be added as a footnote to the study plan. **Action Item**: Add this response as a footnote to the study plan.

The CAWG-11 study plan was approved by the CAWG.

CAWG-12 Water Use

R2 Resources Comment

One R2 comment on Study Objective No. 8. No comments were provided by the CAWG on the response that was prepared for this R2 comment. Everyone agreed that the response text should be incorporated into the study plan.

Action Item: The comment response language will be incorporated into the detailed methodology.

The CAWG-12 study plan was approved by the CAWG.

CAWG-13 Anadromous Salmonids

R2 Resources Comments

Page 2-132, Nexus. Plans to reintroduce anadromous fish above Friant Dam. **Action item**: Insert the following text as the last sentence of the Project Nexus Section “There are no active plans currently being implemented to reintroduce anadromous salmonids above Friant Dam and SCE facilities.”

Page 2-132, Approach, Item 2. Disagreement with the response to comment. The project may not impact salmonids but it does impact habitat. If the Big Creek Project didn’t exist, would there be flow below Friant Dam? **Action Item**: Change response, “One of the goals of the study is to identify limiting factors of anadramous salmonids downstream of Friant Dam that may be affected by operations or maintenance of the Big Creek Projects”

Page 2-134, Analysis. **Action Item**: Change response to comment as follows. “Determine if information is available and the adequacy of limiting factors.”

Action item: Email the text changes to Steve Edmondson for approval. Also get CDFG to review this.

The CAWG-13 study plan was approved by the CAWG, contingent on receiving review comments from Steve Edmondson (NMFS) that would need to be addressed.

CAWG-14 Fish Passage

Page 2-138, Objectives. **Action Item**: change response by editing the second sentence to read as follows: "Anadromous fish do not occur in the Project area."

Page 2-140, Passage in Streams. Discussion on the method used to evaluate fish passage. **Action Item**: Change response to read as follows: "An appropriate method such as Thompson or Bovee will be used to determine fish passage, as determined by the CAWG."

Action item: Provide copies of Bovee and Thompson methodologies.

The CAWG-14 study plan was approved by the CAWG

General Discussion

The USFWS (Debbie Giglio and Gary Taylor) joined the meeting by conference call to review their comments on the CAWG study plans.

The CAWG just received the USFWS comments late last week and has not had sufficient time to review comments and prepare response. We are prepared to discuss USFWS comments to understand where the USFWS is coming from.

CAWG-10 Macroinvertebrates

<u>CAWG Comments</u>

Maybe the first thing we should do is explain that the study is based on the California Rapid Bioassessment protocol and we should give a brief overview of the protocol. Will we add our comments to the study plan so that the reader is aware of the protocol? Earlier in the process we decided to remove the detailed protocol. We need to only reference where the protocol is available.

Action item: Add to the text a statement that the CA Rapid Bioassessment is a common protocol and reference where it is available.

The CAWG did not provided comment on the R2 comments.

<u>USFWS Comments</u>

The USFWS has developed an alternative protocol. The USFWS is not sure that the CA Rapid Bioassessment will not provide the data needed to develop the habitat relationship. It does not represents the entire transect reaches across the stream. Would this protocol be in addition to the CA Rapid Bioassessment?

Can we separate the CA Bioassessment from PHABSIM?

What is the alternative protocol? Gore criteria curves analysis using PHABSIM. The USFWS is not objecting to the CA Rapid Biosassessment, they are only recommending that we also do the PHABSIM.

The USFWS is endorsing PHABSIM. Gore has two sets of curves 1) Rocky Mountain high gradient; and 2) some East Coast curves. The USFWS are comfortable with these curves. A placeholder for PHABSIM is included in the CAWG-3 study plan on Page 2-39. The study plan indicates that this is a CAWG decision point. The CAWG can assess the information and determine its applicability. The CAWG will determine the adequacy and verification of the curves developed.

Action item: Get information on Gore curves (Gary Taylor to send to Wayne).

Site suitability of curves is addressed in CAWG-3; and the CAWG will meet on this.

The CAWG-10 study plan was approved by the CAWG.

CAWG-8 Amphibians

R2 Resources Comments

Page 2-99, Bullet No. 7. Survey protocols. **Action Item**: Change the response to comment to include red-legged frog survey protocol provided by the USFWS.

We should also use the USFS Yosemite Toad Protocol. **Action item**: Add USFS Yosemite Toad Protocol.

USFWS Comments

Action Item: Add the USFWS Stakeholder Management Goal (in their letter) into the synthesized version and into the individual compilation. “Undertake a predator management program for non-native species which affect sensitive native amphibians.”

The USFWS has a revised draft of protocol but have not released them to us. We have concerns about a new protocol coming out when we are in mid-study. We do not want to be in mid-stream when or if the protocol changes and we need to begin studies soon so we don’t miss critical time periods.

It is our understanding that if there is habitat, then the USFWS assumes species presence and must be mitigated for. If this is the case, why do the more detailed work?

The USFS has an interim protocol. The preliminary surveys have not changed (this is what the studies schedule indicates will be done this summer. The detail survey protocols are what have changed and would effect you. However, the final recovery program will be out by the time you have to do the detailed survey, this winter or next spring.

Due to our very large project area, we want to do aerial fly-overs to do the habitat mapping. This would involve high-resolution false color infrared imagery. The USFWS would like to see the aerial photos before commenting on this. What size pond can you identify using this technology? We can see three-ft diameter ponds. People walking map meso-habitat, backwater areas, and seeps and bogs.

Are we aware of the PG&E work ongoing? **Action item**: Contact Ibis Environmental or Craig Seltonridge (PG&E Biologist Staff) and discuss the problems that have encountered with this technology.

Action item: We will provide examples of the aerial photographs to the USFWS. Janelle will drop this off at their office.

The aerial imagery is one tool to identify potential habitat. We are sure that with the additional methods we will use that we will get good data (i.e., aerial Photos, stream typing, etc.).

ENTRIX will get the most current USFS-SNF site assessment that is available.

Survey forms: The CAWG will develop survey forms before studies are implemented.

The CAWG-8 study plan was approved by the CAWG.

CAWG-6 Hydrology

R2 Resources Comments

The CAWG had no comments on the responses prepared to the R2 Resources comments.

USFWS comment

1) Fifteen-minute data. Needed for unimpaired reference reaches.

Additional gages, where is this described in the detail methodology? **Action item**: Add text **"**in addition for areas with limited or no data a recommendation will be made to the CAWG whether additional gages are needed".

Unimpaired gages – we may not be able to do this since they are in the wilderness. We may be able to get this data by adding the diversion measurement and the instream flow release.

Are they any significant lengths of streams that are effected by Project operations where we need gages to provide flow data? We can synthesize data for such reaches.

The fifteen-minute data will be provided at locations where it is necessary.

2) Indices of Hydraulic Alteration methodology. This methodology doesn't identify the significance of the changes. Other studies identify the significance as stated in the last two sentences of the last paragraph of Detailed Methodology. Response last two sentences of first paragraph on page 2-78 which state: "The IHA indices will supplement hydrographs and exceedence tables, and provided basic hydrologic information to be interpreted in other studies (see coordination needs). IHA will also be run for PM&E measures."

The assumption section also addresses the significance of the hydraulic alteration, last sentence of the assumptions section.

3) IHA studies will be implemented in 2001.

The CAWG-6 study plan was approved by the CAWG.

CAWG-7 Characterize Fish Populations

R2 Resources Comments

Page 2-88, 1st full paragraph, comment on minnow traps. The Response to this comment was that we found minnow traps to be ineffective. **Action Item**: Add reference for minnow traps.

USFWS Comments

There are no specific plans to address non-native species that are favored by habitat conditions in the project. What non-native species the being referred to. This is really trying to address the presence of non-fish predators.

The responses to comment is that amphibian predators (bullfrogs) are being addressed in CAWG–8 and macroinvertebrate relationships are addressed in CAWG-3.

The CAWG-7 study plan was approved by the CAWG.

CAWG-1 Characterize Stream and Reservoir Habitats

<u>CAWG Comments</u>

Is Adit 8 affected by the project? No it is an ephemeral stream?

Will SCE explain how the Project is operated? What if you have an outage? We need to explain how the Project would be operated.

<u>USFWS Comments</u>

Page 2-3, Study Objective No. 3. The USFWS comment states that the study should investigate sediment deposition/composition, shoreline erosion, edgewater habitat, woody debris/nutrient cycling, inflow/current routing and seasonal hypolimnion changes. All of these parameters are addressed in many of the various CAWG studies. **Action Item**: Identify the studies that address these parameters in the response to this comment.

It is unclear in the study plan how habitat for given species or guilds will be characterized within different reservoir strata. The reservoir and stream relation type in different water year types – response is to model physical habitat for a range of conditions in CAWG-3 and water temperature is modeled in CAWG-5. Conditions other than those observed can be simulated through historical meteorology and flow records.

We will be doing a flow study of historical flow in CAWG-6 Hydrology.

The CAWG-1 study plan was approved by the CAWG.

Big Creek Collaborative
Combined Aquatic Resources Working Group

July 11, 2001

Meeting Notes

Time:	2:00 AM to 4:00 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University Clovis, CA	**Facilitator:**	Bill Pistor
Teleconference No.:	1-800-569-0883	**Recorder:**	Martin Ostendorf
Teleconference Name:	Aquatic Wkg. Grp.	**Spokesperson:**	

Attended By:

Wayne Lifton	ENTRIX, Inc.
Bill Pistor	Kearns & West
Martin Ostendorf	ENTRIX, Inc (Recorder)
Geoff Rabone	SCE
Ed Bianchi	ENTRIX
Cindi Whelan	USFS-SNF
Steve Rowan	SCE

Telephone Participants

Rick Hopson	USFS-SNF
Julie Means	CDFG
Holly Eddinger	USFS-SNF
Gary Taylor	USFWS
Debbie Giglio	USFWS
Phil Strand	USFS-SNF
Jen Carville	Friends of the River

CAWG-3 Determine Flow-Related Physical Habitat in Bypass Reaches

R2 Comments

Action Item: Insert the following text as the last sentence of the first bullet in the field data collection section on page 2-38, “We will collect sufficient data for utilizing the appropriate stage discharge model including WSP or MANSQ”.

Action Item: Page 2-35, move footnote with clarification to glossary.

Action Item: Copy Table CAWG 1-3 and insert it next to Table CAWG 3-1.

Action Item: Define in the glossary “small Diversions” and “Small Streams”.

Action Item: Page 20 of R2 Resources comment table (handout to the CAWG). Within the response to comment replace the words “it may be possible to do so”, with “they will”. This is in reference to the need for additional transects.

Page 21, CAWG-3, 2-36, 7. Appropriate Suitability Curve, we should get other experts to review the suitability curves. Can we have successfully transfer curves to the Big Creek System? We need an option to have people in the CAWG review curves, and not solely rely on accepted practices in the past.

If transferability testing does not work, will there be enough information to test another method? Yes there will be.

Action Item: Page 21, CAWG-3, 2-36, 7. Appropriate Suitability Curve. Edit the response by deleting the first three sentences. The response should begin with “a preliminary investigation….”. Add the following as the last sentence, “The CAWG has the option of 3rd party review as per the protocol”.

Action Item: Page 22 CAWG-3, 2-36, time series analysis. Change response to: “We intend to be flexible, please refer to page 2-41, Analysis Section”

Action Item: Page 22 CAWG-3, 2-36, Flow-related habitat for Small Streams. Change the response to the following: CAWG will decide on the protocol for macroinvertebrate suitability curves to PHABSIM and the use of wetted perimeter to describe macroinvertebrate habitat.

Page 24, R2 Resources comment table. We need to clarify the methodologies that we will use at the study transects. Our responses to the 2nd, 3rd and 4th comments on this page are confusing. The following language will be used:

“The study plan addresses habitat variability within project streams by placing transects in each geomorphic channel type present in a given reach (Rosgen 1996). Additionally, two transects are placed within each mesohabitat type within each of the aforementioned channel types. Unique habitats and hydraulic controls may be represented by additional transects. Site and transect selections will be made in collaboration with the CAWG.”

“Our field data collection approach is to place additional transects across controls and collect all data to allow us to use the WSP or MANSQ models should the empirically derived stage-discharge relationship not meet the modeling requirements.”

Page 25, CAWG-3, 2-40, Wetted perimeter, paragraph 1. Change response to read, “An appropriate method such as Thompson or Bovee will be used to determine fish passage, as determined by the CAWG.”

<u>USFWS Comments</u>

Page 2-36, second paragraph, PHABSIM may also be need in the smaller streams. The study plan would use wetted perimeter to evaluate the small streams. The USFWS was asked what information they would like to see, since flows related to the source of a habitat bottleneck in the small streams would generally occur during the period when the small diversions were turned out. In general, the diversion has no direct effect on this bottleneck.

The USFWS has recently lost a battle using the wetted perimeter approach when trying to make an argument on flow versus habitat. The USFWS is uncertain that this method will be adequate. They view the smaller streams as an opportunity for a lot of fauna flora improvement. They are just as important as the larger streams.

In these smaller streams there is a base flow that affects habitat. And geomorphology is affected by the higher flows. Need to determine habitat area and how the geomorphology is affected at the higher flows.

We are talking about very low flow streams. We are talking about base flow from and 1 cfs to 0.1 cfs, however the peak flows are much higher for a short duration. There is a period between the base and peak flows when diversions are turned out. And during these periods will PHABSIM or wetted perimeter be the method to use. The use of PHABSIM for this purpose may not be appropriate.

If we begin data collection next year and then struggle with the data, does this preclude doing something else the following year? Another way to get at this is to go through some pilot exercise. Is there an example of how we have done this in the past, for example from Vermilion? We are currently working up the data. Will the Vermilion example data be useful to the USFWS? Yes it will.

The August site tour will be a good opportunity to get everyone to the small streams. We can discuss the applicability of PHABSIM and wetted perimeter analysis on the small streams during the tour.

Wetted perimeter is not the only tool to complete this analysis of the small streams. The geomorphological information also will be very important.

Action item: Develop a bulleted list to USFWS of the different studies on the small streams PHABSIM and Wetted Perimeter.

Page 2-37, Occurrence of mesohabitat. This was addressed with the R2 comments

Page 2-38, Survey protocols. We don’t tie benchmarks together in individual reaches. The USFWS was OK with this. Also it was unclear, which criteria would be used to determine the high flows that will be modeled. This will be determined by the CAWG based on the bankfull determination from the Geomorphology study, etc.

Page 2-39, Adjacent cell velocities – we are not proposing to use adjacent cell velocities in the PHABSIM modeling.

The USFWS thinks it is a valid method that should be used. We are not comfortable using the curves developed for adjacent cell velocities in other location of the country, would rather used the common curves developed here in the west.

The USFWS we will reserve our right to use your data to run the model.

Do you collect the same data and then run the different models in the office? There is no difference in the data collection. There are very large differences in the assumptions that are plugged into the model.

If they go do the HSI curves and they are found to be transferable, will you have sufficient data and curves to run your analysis?

The USFWS indicated that we should not be fearful that they would change the methodology requirement for the study later in the process.

SCE expressed concern, that they are fearful of this, that new methodologies imposed later in the process will result in redoing the studies entirely to obtain data for the new methodologies. We are somewhat fearful that later in the process we may to do the study differently.

The USFWS was asked if they could supply those curves set to us? Yes they can provided these. That would be good, then we would have a common point of discussion.

Page 2-39, Macroinvertebrate criteria. This criteria is addressed in the macroinvetebrate study plan.

The CAWG-3 study plan was approved by the CAWG.

CAWG-5 Water Temperature

CAWG Comments

The CAWG agreed with the R2 comments and responses, and agrees with the USFWS comments.

Modeling is a CAWG decision point. The USFWS is fine with that.

Page 28 of the R2 comments 2-65 to 2-69. There is a dense array of temperature monitoring location and sparse flow data. The temperature data must be much denser than flow data in-order to accurately calibrate the model. While flow data we are mostly interested in the inflow data. We have lots of gage data. We have sufficient flow data and gages on small diversions and medium streams. The South Fork San Joaquin River is the only area where there are only a few gages.

Action Item: Edit the response to this comment to include a statement that we will have sufficient flow data to do the needed temperature modeling.

Is the SWRCB ok with CAWG-5? Pending confirmation from the SWRCB, everyone agrees to approve CAWG-5

Action Item: Follow up with the SWRCB to verify that they will approve the CAWG-5 study plan.

The CAWG-5 study plan was approved by the CAWG.

The CAWG approved all 14 study plans during the July 10th and July 11th meetings.

Big Creek Collaborative
Combined Aquatic Working Group

May 19, 2003

Final Meeting Notes

Time:	10AM to 2:30 PM	**Moderator:**	Wayne Lifton
Location:	Piccadilly Inn University Fresno, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatic Working Group		

Attended By	Bill Pistor	Kearns & West
	Bryan Harland	Kearns & West
	Lonnie Schardt	Huntington Lake Association
	Geoff Rabone	SCE
	Phil Strand	USFS
	Julie Means	CDFG
	Wayne Lifton	ENTRIX
Phone Participants:	Britt Fecko	SWRCB

Introductions

Stakeholders introduced themselves and the organization they represent, then reviewed and approved the day's meeting agenda.

Review of Previous Meetings' Action Items

Outstanding action items below:

Ongoing

- Action Item #2: Geoff Rabone to send out CEII information as related to the Big Creek ALP.
- Action Item #4: Larry to ID alternative approaches for the food transport study on Bolsillo Creek for the CAWG review.

April 17, 2003 Meeting

- Action Item #8: Geomorphology meeting originally scheduled for May 7th has been postponed.
- Action Item #9: Water Quality meeting on hold.

May 6, 2003 Meeting

- Action Item #3: Geoff to check SCE operatio0ns on how they handle LWD that collects in the diversions.
- Action Item #6: Geoff to check with Wayne Allen on the Hydrology data and report back to the CAWG at the next meeting. (Wayne Allen has been in the field, Geoff will check back with him)

Review and Approve Meeting Notes

Meeting notes have not been sent out at this time.

Presentation of CAWG-9 Entrainment Sampling Recommendations: Large and Medium Size Reservoirs

Wayne Lifton (ENTRIX) gave a presentation on CAWG-9: Entrainment Draft Technical Study Report. For the full details, please see the PowerPoint presentation attached to this summary. Stakeholders requested that Wayne L. distribute a copy of the CAWG-9: Entrainment PowertPoint presentation to the group.

Action Item #1: Wayne Lifton will burn CD copies of the Fish Entrainment PowerPoint presentation and send to Phil, Britt, and Julie.

CAW-9 General Approach:

1. Review Scientific Literature
2. Evaluate Potential for entrainment mortality
3. Evaluate entrainment rates

Wayne L. explained that according to the CAWG-9 Study Plan, the study will prioritize the large reservoirs with no source of turbine mortality upstream which may entrain fish. Wayne L. proposed sampling Huntington and Shaver Lakes for the Big Creek Chain since the other reservoirs intake water from other reservoirs and would not be the primary source of turbine mortality.

For the small diversions, Wayne L. explained that a representative subset would be selected by the CAWG.

Wayne next reviewed the evaluation of vulnerability to entrainment with the group. Entrainment vulnerability was determined by evaluating the following information:

- Available information on turbine mortality
- Data on the design of the intake
    - Review of design drawings
    - Intake capacity
    - Location of the intake
    - Records of operations and flows
    - Approach velocities calculated
- Data on fish vulnerability and their use of the area near the intake face

Wayne reviewed the potential turbine mortality for each of the types of turbines used in the Big Creek system. The Vertical Francis turbine, which is used in most Big Creek powerhouses, has low potential turbine mortality. The medium head (250-500 ft) Francis Reaction turbine has low to medium potential mortality. The high head (>500 ft) Francis Reaction turbine has low to high potential turbine mortality; and the Impulse Pelton turbine has high potential turbine mortality.

A stakeholder asked if there's a difference between small and large fish survival on the Pelton. Wayne L. said not really.

Two stakeholders asked if the differences in intake and output depths can harm fish. Wayne L. said that if there's an intake at a greater depth and a fish is taken in and then spit out at less depth, they can experience pressure-related injuries (such as the Bends in humans).

Wayne L. reviewed the intake design and fish vulnerability for the large reservoirs (Florence Lake, Huntington Lake, Mammoth Pool, and Shaver Lake), medium size reservoirs (Bear Creek Forebay, Mono Creek Diversion Forebay, Balsam Meadow Forebay, Dam 4 Big Creek Powerhouse 2 Forebay, Dam 5 Big Creek Powerhouse 8 Forebay, and Dam 6 Big Creek Powerhouse 3 Forebay). The factors for potential fish entrainment mortality examined for each of the listed reservoirs include:

- Potential turbine mortality, if entrained.

- Relative numbers of fish in source waterbody.
- Fish presence near intake face.
- Intake velocities.
- Fish swimming capabilities.

Based on these factors, Wayne L. proposed sampling recommendations to the group. For the large reservoirs, the proposal is to sample at Big Creek Powerhouses 1 and 2A due to the large numbers of fish upstream and the high mortality of entrained fish likely due to impulse turbines, as well as sample the Mammoth Pool Powerhouse due to the large numbers of fish upstream, the relatively high head Francis Turbine, the variability if potential mortality, and the intermediate /high head among other high head Francis Turbines (1,100 ft).

The sampling approach would be to place a Kodiak trawl with a live car to hold fish in the tailrace. Sampling would take place bi-monthly during the summer months and quarterly for the remainder of the year, depending on project operations. Each sample would entail a 48 hour period where the trawls would be checked once or twice a day.

A stakeholder asked if there's evidence that some fish are attracted to the tailrace areas due to flows. Wayne L. said not that he knows of, but they try to get the netting as close to tailrace to avoid that possibility. He said it is certainly something to field crews to watch out for.

A stakeholder asked if decisions were made on recommended sampling sites because there's a lot of fish in reservoirs. Wayne L. said that they are trying to get at the original source of mortality, before fish pass through several diversions. Since there is no powerhouse upstream from Mammoth, would be getting information on the powerhouse itself.

Two stakeholders asked for more time to review the proposed fish entrainment sampling. The group agreed.

A stakeholder asked how well covered the winter months will be. Wayne L. said that usually less operations in the winter. The samples will be focusing on the time when operations are high, which is during the warmer months (June thru October).

A stakeholder asked if the information provided in the fish entrainment study for the Portal application is sufficient to make conclusions about entrainment on that project. Wayne L. answered yes, and they found low mortality on that project. He doesn't recall how many times they sampled, but the field crew was out there 5 times. They tried to get out there this winter, but powerhouse was not in operation. They got the expected results at Portal: fish came through in pretty good shape. Wayne L. stated that there are plenty of fish up in the upper basin around the diversions and fish aren't highly vulnerable for entrainment at Portal.

BREAK FOR LUNCH

<u>Presentation of CAWG-9 Entrainment Sampling Recommendations: Small Diversions</u>

Wayne L. continued on the topic of the CAWG-9: Fish Entrainment study by presenting information regarding the small diversions in the Big Creek system to the group.

In the Upper Basin, three small diversions are out of service and therefore will not be considered for entrainment sampling. These diversions are Tombstone Creek, South Slide Creek and North Slide Creek.

Wayne L. reviewed the schematics and fish present in the stream for the upper basin small diversions that are in service (Hooper Creek, Crater Creek, Camp 62 Creek, Chinquapin Creek, and Bolsillo Creek); Pitman Creek and Big Creek small diversions (Pitman Creek, Balsam Creek, Ely Creek and Adit 8 Creek); and the Mammoth reach small diversions (Rock Creek and Ross Creek).

Wayne L. recommended sampling two small diversions by netting incoming flow to diversion pool. The two diversions he recommended are Balsam Creek and Rock Creek. Sampling would take place twice during runoff, once near the peak and then later in the season.

A stakeholder asked for the rationale for choosing Balsam and Rock creek. Wayne L. said that because they divert water to the powerhouses and the potential for turbine mortality. Ross dries out and showed no fish present, whereas Rock Creek has fish present. Balsam and Ely diversions are twins and operate more frequently. Balsam will be used as a model for Ely Creek diversion.

Another stakeholder asked how collecting all the fish upstream of the diversion will indicate how many fish are being diverted. Wayne L. answered that the assumption is that all fish are diverted.

<u>Fish Entrainment Study at Portal Powerhouse</u>
After reviewing the Portal entrainment study, the State Water Board advises that the study be conducted again. The reason for this is that six complete samples were taken during the study and the Water Board does not believe that to be representative enough to base management decisions on. Their concern is that there is more entrainment taking place than the study results indicate. Based on the results, they see entrainment taking place at Portal, but not enough evidence to suggest that entrainment is insignificant. Wayne L. said they wanted to take two more samples, but due to the net being shredded and operational restrictions, they couldn't. The Water Board asked if the group could reevaluate the Portal study after reviewing other information on entrainment studies from other licensings.

Action Item #2: Britt Fecko to review information regarding entrainment studies on the Stanislaus and Pit relicensings and forward to Bryan, who will forward to the CAWG.

The Water Board proposed that the group should also sample the medium size reservoirs in the Big Creek chain. Their concern is that excluding all the medium-sized diversions will not give the information they need to make management recommendations.

Wayne suggested that examining the medium size reservoirs would not give the group the information it needs, since medium size reservoirs are downstream from other sources of potential entrainment.

A stakeholder requested a different schematic than the one referenced in the presentation.

Action Item #3: Geoff Rabone to locate a different schematic of the Big Creek system and forward to Bryan Harland, who will distribute to the CAWG.

A stakeholder asked if there is a verification process to where a fish was killed in the system. Wayne L. answered that there are challenges to determining the location of fish mortality. The variability can be reduced by sampling at sites with no upstream probability of fish entrainment.

Action Item #4: The CAWG to hold a conference call on May 29th (time to be determined) for approving the proposed fish entrainment sampling. Bryan will finalize the time with CAWG members and send out an agenda ASAP.

Another stakeholder stated that the group should put the fish entrainment sampling information into perspective before concluding that there are project effects on fish populations. Wayne L. agreed and explained that the group will be looking at a couple of methods for determining fish populations and mortality rates.

Big Creek Collaborative
Combined Aquatic Working Group

June 12, 2003

Final Meeting Notes

Time:	9AM to 3 PM	**Moderator:**	Wayne Lifton
Location:	USFS Clovis Office 1600 Tollhouse Rd. Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatic Working Group		

Attended By	Bill Pistor	Kearns & West
	Bryan Harland	Kearns & West
	Wayne Allen	SCE
	Geoff Rabone	SCE
	Phil Strand	USFS
	Wayne Thompson	Federation of Fly Fisherman
	Wayne Lifton	ENTRIX
	Cathy Little	ENTRIX
	Janelle Nolan-Summers	ENTRIX
	Katy	ENTRIX
	Rick Hopson	USFS
	Julie Means	CDFG
	Debbie Giglio	USF&WS
Phone Participants:	Britt Fecko	SWRCB
	Mitchel Katzel	ENTRIX
	Kelly Catlett	Friends of the River

Introductions
Bill Pistor (Kearns & West) began the meeting by having stakeholders introduce themselves and the organization they represent, then reviewed and approved the day's agenda. The agenda was approved with no edits.

Action Item #1: Kearns & West will distribute the April 17, May 6, and May 19th CAWG meeting summaries to the group for review.

Action Item #2: Wayne Lifton will edit the CAWG-1 DTSR to include SCE large woody debris operations protocols.

Fieldwork Update
Wayne Lifton (ENTRIX) gave the group and update on the recent fieldwork that has taken place in the field. Please see the PowerPoint presentation for the full details.

Action Item #3: The fieldwork update PowerPoint presentation to be sent to the group.

Single Flow Whitewater Stranding Studies

A stakeholder asked if the field crew walked to the sites. Wayne said they helicoptered in, but the storms prevented them from completing the depth and velocity measurements.

A stakeholder asked if there were any tributaries entering upstream of the upper and lower sites. Wayne Allen answered no for the upper and yes for the lower. Hooper was turned out north and south slide and tombstone. The estimated CFS of those combined would be about 20—25 cfs accretion coming in.

For the South Fork San Joaquin River near Jackass Meadow - five very small fry (20 mm or less) found in residual pools. Two fish were isolated; three in a pool that was still connected to the river at base flows. For the South Fork San Joaquin River above the gage, five brown trout about 95 to 180 mm long. Four deceased, one rescued. One brown trout observed in side channel, flow still present but fish likely could not move back. One dead 150 mm long rainbow.

Remaining work: topographic data collection for SFSJR sites. Reduce data and prepare overlays of topography, depths and velocities. Select depth and velocity thresholds with CAWG concurrence, and then complete evaluation.

A stakeholder asked what the ramping down rate was. Wayne Allen did not know, will pull the card and get the data.

Action Item #4: Wayne Allen to find out the ramp-down rate for the spill flows on the South Fork San Joaquin River

A stakeholder asked if there will be another spill event. Wayne A answered that the temperature has cooled off, so it has slowed the flow. He says there probably won't be one.

Small Diversion Entrainment Sampling

A stakeholder asked how close the velocities were measured to the intake. Wayne Lifton answered that they took several readings at different distances and the measurement reported is the maximum velocity measured.

Another stakeholder asked where the net was set up. Wayne said fairly close to the stream inlet to the diversion impoundment.

A stakeholder asked why they chose Balsam over other diversions. Wayne answered that the two tributaries are Ely and Balsam. Balsam is bigger and has more fish, so it seemed like a better location to take a representative sample. The stakeholder asked about Pitman diversion. Wayne said that it is far upstream and is diverted into Balsam Meadow Fore bay and not into a turbine.

The stakeholder asked if there is any mortality information on fish being entrained to forebays. Wayne said he wasn't aware of any, there was no likely source of direct mortality associated with such a diversion and the focus of this study is to measure turbine mortality.

A stakeholder asked if there was any progress on the food study. Wayne said that he and Larry have talked about it and Larry is coming up with an alternative approach to addressing flow analysis for Bolsillo Creek. (Continuing Action Item).

A stakeholder asked if they will sample Balsam again. Wayne said they will go out again and do an additional 48-hour sample. Balsam Creek contains primarily rainbow trout. The stakeholder asked if they would do a study in the fall also. Wayne said the CAWG can discuss that option, but none was planned.

A stakeholder asked for a picture of a trawl with a live car. Wayne showed a picture of the trawl used in the Pit 4 study. He said that they used a larger trawl for the Pit project than would be used for the small diversions. Wayne explained the trawl device and how the live car reduces the potential for further fish injury by blocking the high velocity flow.

Entrainment Monitoring Discussion
Wayne explained that at the last meeting, the group did not get to a decision on the medium and large reservoirs.

Proposal: Powerhouse 1, 2A (high-head, impulse turbines, which are known for high mortality), Mammoth Pool Powerhouse (good representative of high head Francis). Bimonthly during summer and quarterly during other months.
The group discussed the proposal and several options for obtaining the information needed for entrainment on medium and large reservoirs. The group reached an agreement on sampling:

Agreement: ENTRIX will conduct entrainment sampling at the tailraces of Big Creek Powerhouses 1 and 2A, Mammoth Powerhouse, and Eastwood Powerhouse. Samples will be taken bi-monthly during the warm months and quarterly during the winter months. Eastwood will not be sampled during the winter months.

A stakeholder asked if the pumpback of water is a factor. Wayne said that pumpback occurs separately and that in general, fish mortality can be high during pump back cycle, due to pressure and turbulence. This has been studied.

A stakeholder asked what the percentage of survival would be at the higher mortality turbines. Wayne said no more than about 20% based on literature values.

The State Water Board expressed a concern that the entrainment information collected for the Portal Project is not sufficient to base a management decision on and that the group cannot conclude that entrainment isn't taking place at Portal. Wayne said that they can extrapolate the information gathered at Portal for the time of year and type of operation at Portal.

Geoff stated that the FERC position is that we don't have to prove that there isn't a problem, only that there is a problem. Geoff went on to say that if there is no fish population deficiency, then it would be difficult to conclude that there was an entrainment problem.
Wayne suggested looking at the Portal operations in terms of the entrainment samples and general operations.

Action Item #5: Wayne Allen will collect Portal Powerhouse operations data and entrainment sampling dates and times; distribute to the CAWG before the next meeting; the CAWG will compare sampling with operational modes to determine if sampling is representative for normal operations.

A stakeholder said that since she hasn't seen the diversions directly she has trouble conceptualizing how the fish might be entrained. She would like to see one at low flow for clarification. Geoff suggested Bolsillo and small diversions with vertical drops. She stated that she would like velocity measurements.

Action Item #6: Wayne Allen to research if there is any velocity information for diversions with vertical drops, specifically Bolsillo Creek Diversion.

Wayne L. said the study they conducted on Mokelumne is indicative of what might be expected of trout entrainment in the relation to the pattern of the Sierra Nevada hydrograph.

Action Item #7: Wayne Lifton to provide citations for Mokelumne entrainment study and for relevant literature on trout movement and provide to the CAWG for review.

A stakeholder asked if SCE has a fishing license or something similar that allows them to take fish. Geoff said that if you look at the CDFG code, it's the operator's responsibility to keep fish pops in good condition downstream from the project, but this begs the question: What constitutes good population? And: What is a significant impact?

A stakeholder asked what the protocol would be for determining the level of entrainment during the winter time. Wayne Lifton answered that they are going to do bimonthly sampling in the summer and quarterly in the winter.

Meeting Adjourned

Summary of Action Items

Action Item #1: Kearns & West will distribute the April 17, May 6, and May 19th CAWG meeting summaries to the group for review.
Action Item #2: Wayne Lifton will edit the CAWG-1 DTSR to include SCE large woody debris operations protocols.
Action Item #3: The fieldwork update PowerPoint presentation to be sent to the group.
Action Item #4: Wayne Allen to find out the ramp-down rate for the spill flows on the South Fork San Joaquin River
Action Item #5: Wayne Allen will collect Portal Powerhouse operations data and entrainment sampling dates and times; distribute to the CAWG before the next meeting; the CAWG will compare sampling with operational modes to determine if sampling is representative for normal operations.
Action Item #6: Wayne Allen to research if there is any velocity information for diversions with vertical drops, specifically Bolsillo Creek Diversion.
Action Item #7: Wayne Lifton to provide citations for Mokelumne entrainment study and for relevant literature on trout movement and provide to the CAWG for review.

Big Creek Collaborative
Combined Aquatics Working Group

July 9, 2003

Final Meeting Notes

Time:	10:00 AM to 4:00 PM	**Moderator:**	Wayne Lifton
Location:	USFS Forest Supervisors Office, Clovis, CA	**Facilitator**:	Bill Pistor
Teleconference No.:	1-800-556-4976	**Recorder**:	Bryan Harland
Name:	Combined Aquatics Working Group		

Attended By:	Bill Pistor (Facilitator)	Kearns & West
	Bryan Harland (Notetaker)	Kearns & West
	Wayne Lifton	ENTRIX
	Wayne Allen	SCE
	Phil Strand	USFS
	Geoff Rabone	SCE
	Cindy Whelan	USFS
	Rick Hopson	USFS
	Wayne Thompson	Federation of Fly Fishermen
	Martin Ostendorf	ENTRIX
	Julie Means	CDFG
	Julie Tupper	USFS - RHAT
	Ed Bianchi	ENTRIX
Phone Participants:	Britt Fecko	SWRCB
	Kelly Catlett	Friends of the River
	Larry Wise	ENTRIX

Introductions

Stakeholders introduced themselves and the organization they represent. Bill Pistor (Facilitator, Kearns & West) proposed approving the REVISED meeting agenda distributed to the group this morning. The group agreed to the revised agenda.

Kearns & West distributed the summaries from the April 17th, May 6th, and May 19th CAWG meetings. The summaries were approved with slight revisions.

Review Previous Meeting Action Items

Outstanding action items listed below:

- **Action Item:** Geoff Rabone to send out FERC's Critical Energy Infrastructure Information (CEII) guidelines as they relate to the Big Creek ALP.
- **Action Item:** Bryan to send PowerPoint presentation on fieldwork to the CAWG.
- **Action Item:** Wayne Lifton to provide citations for Mokelumne entrainment study and for relevant literature on trout movement and provide to the CAWG for review.
- **Action Item:** Geomorphology subgroup will schedule a fieldtrip at the July 10 Geomorphology subgroup meeting.

Action Item #1: Timeline for outstanding study elements in the DTSRs will be developed on a group by group basis. ENTRIX will provide an initial draft of the timeline, then discussed in the groups. The CAWG will need to make decisions before the outstanding study elements timeline can be fully developed. Two weeks from today.

South Fork San Joaquin Single Flow Study
Action Item #2: Bryan to send the South Fork San Joaquin Single Flow Study ramping down rate PowerPoint slide to the CAWG.

Bolsillo Diversion Downward Flow
Wayne Lifton (ENTRIX) gave a presentation on the Bolsillo Diversion down ramping flows per an action item from the June 12 CAWG meeting. He explained that information provided by Wayne Allen was used to prepare velocity calculations. At lower flows, water passes through the grating at the side of the intake or overflows the upper lip. Velocity is proportional to the height of the flow and when the water surface elevation is higher, the surface area for intake is larger. Velocity increases are related to the flow passing through the area formed by the depth of flow and the circumference of the intake. At larger flows, water passes through the entire upper surface of the intake, as well as the side resulting in lower velocities. Velocities were presented for average, maximum, and minimum monthly flows for 2001 and 2002. Velocities ranged from 0.19 to 1.06 ft/s for the flows evaluated.

Geoff Rabone (SCE) said that there is surface flow and an orienting flow going downstream when the diversion is diverting water. He thinks that smaller fish will be towards the shallower areas.

A stakeholder asked what time period has the highest downward velocities. Wayne L. answered that May is consistently the highest daily average velocities. The stakeholder asked if the other diversions are similar structures. Wayne Allen said yes. Geoff said the only difference in other diversions is that the bore hole is at more of an angle.

Fieldwork Schedule
Wayne explained the process for the study timeline and fieldwork schedule. ENTRIX does not have a master schedule yet because the CAWG needs to make decisions in other meetings before the schedule can be set. Martin gave a brief overview of the scheduled events as of today.

Entrainment
Last week did small diversions. Next week will do BC1, 2A, Mammoth and Eastwood. Wayne explained that the work is contingent on operations constraints and that the ISO may issue a “no touch day” especially with the hot weather. During September, we will do a second round of entrainment sampling.

Instream Flow
PHABSIM for SFSJR and Bear Creek being done this week.
Wetted perimeter and PHABSIM on Big Creek Stevenson Creek and NF Stevenson in August.
Supplementary Habitat mapping in August.
Habitat Suitability Criteria in August.

Native American Mollusk Sampling will be conducted at the end of September near Big Creek 4.

No further scheduled activities at this time, but shifts in the schedule are possible. There will be entrainment sampling in November.

Action Item #3: Wayne Allen will notify members of the CAWG when he receives fieldwork notifications. Kearns & West and Wayne Allen will coordinate on the CAWG distribution list. CAWG members interested in attending fieldwork can contact Wayne Allen to coordinate logistics.

A stakeholder asked about the Supplemental Habitat Mapping work. Wayne Lifton said that there is an area that needs to be mapped and the Big Creek QC work as well. Woody debris work also may take place, depending upon CAWG decisions regarding need and geomorphology studies. Mitchell will discuss where there will be additional mapping with the Geomorphology group.

Overview of CAWG-4: Chemical Water Quality Draft Technical Study Report
Martin reviewed the CAWG-4 with the group. The CAWG-4 DTSR is not up for approval at this meeting. Martin will be presenting the report and the comments simultaneously. After Martin reconciles the stakeholder comments into the report it will be up for approval at a future meeting. References to stakeholder comments are included in this summary along with the group's decision on addressing those comments.

DTSR Comment: Page 1-2: SWRCB
Samples not taken in 2002 should be taken in 2003. Martin explained that they are tracking to see if they can get them. Flows too high, inaccessible areas stand in the way. ENTRIX will try to take those samples.

DSTR Comment: Page 2: SWRCB
Martin explained that the intent was not to try to interpret, but compare to the CA Toxic rule, the national rule and Basin Plan. Needs further discussion with the SWRCB and SCE. Britt explained that for compliance with the CWA, they need to use the strictest standards available.
DSTR Edit: ENTRIX will change language to be less interpretive.

DTSR Comment: Page 2: SWRCB
DTSR Edit: ENTRIX will add a discussion of those samples.

DTSR Comment: Page 3: SWRCB
DTSR Edit: ENTRIX will provide edits to the text. The justification of eliminating reservoirs will be included.

DTSR Comment: Page 3: SWRCB
DTSR Edit: The reservoirs and impoundments need to be listed. ENTRIX will provide the justification for not sampling all reservoirs.

DTSR Comment: Page 4: SWRCB
DTSR Edit: ENTRIX will make changes to address the beneficial uses. Martin said that the study element can be kept and the SWRCB comment on beneficial uses will be provided in the text. State that it may meet standards and include more detailed discussion below.

DTSR Comment: Page 5: SWRCB
DTSR Edit: ENTRIX will incorporate references to proper tables, figures, etc.

Action Item #4: Martin to send the preliminary results of In-situ gas saturation at mammoth pool during a spill event.

DTSR Comment: Pg 5: SWRCB
Arsenic will be evaluated.

DTSR Comment: Pg 6: SWRCB
DTSR Edit: Comments on the most controlling values and beneficial uses. Will be made a footnote to the report. Another paragraph will be added regarding a water quality subgroup being formed to decide which standards will be used.

DTSR Comment: Pg 7: SWRCB
DTSR Edit: ENTRIX will add an explanation on justifications.

DTSR Comment: Pg 8: SWRCB

DTSR Edit: Martin will address the explanation developed by subgroup.

DTSR Comment: Pg 8: SWRCB
Fecal sampling will be completed.

DTSR Comment: Pg 8: SWRCB
DTSR Edit: Tombstone diversion mention will be fixed.

DTSR Comment: Pg 8: SWRCB
DTSR Edit: ENTRIX will add language on why some samples cannot be taken due to safety issues.

DTSR Comment: Pg 8 (bottom paragraph): SWRCB
DTSR Edit: ENTRIX will add the dates when diversions were turned out. ENTRIX will explain the Hooper Creek diversion.
North Slide, South Slide and Tombstone samples will be explained.

DTSR Comment: Pg 9: SWRCB
DTSR Edit: 4.3.3 ENTRIX will add paragraph on fish tissue sampling.

DTSR Comment: Pg 11: SWRCB
DTSR Edit: Appendix A will add discussion on methyl mercury.

DTSR Comment: Pg 11: SWRCB
DTSR Edit: ENTRIX will include a paragraph that will address the J-values limit.

DTSR Comment: Pg 13: SWRCB
DTSR Edit: ENTRIX will strike the reference to USFS.

DTSR Comment: Pg 14: USFS
DTSR Edit: ENTRIX will correct statement Re: Shaver Lake Tributaries.

DTSR Comment: Pg 15: SWRCB
DTSR Edit: ENTRIX fix

DTSR Comment: Pg 17: SWRCB
DTSR Edit: ENTRIX will define water quality goals

DTSR Comment: Pg 17: USFS
DTSR Edit: ENTRIX will add % of pH

DTSR Comment: Pg 19: SWRCB
DTSR Edit: ENTRIX will incorporate turbidity standard.

DTSR Comment: Pg 29: SWRCB
DTSR Edit: Will be addressed in Appendix J

DTSR Comment: Pg 29: SWRCB
DTSR Edit: Referred to in Appendix A comments

DTSR Comment: Pg 31: USFS
DTSR Edit: Edit will be incorporated. Partial sentence will be fixed

DTSR Comment: Pg A3: SWRCB
DTSR Edit: Will be incorporated.

DTSR Comment: Pg A4: SWRCB
DTSR Edit: Edit will be incorporated. Geoff suggested "when the hardness is high…" be added to the sentence before the comment.

DTSR Comment: Pg A8: SWRCB
DTSR Edit: Edit will be incorporated

DTSR Comment: Pg A9: SWRCB
DTSR Edit: Edit will be incorporated

DTSR Comment: Pg A10: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A10: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A11: SWRCB
DTSR Edit: Will be addressed in Appendix J

DTSR Comment: Pg A12: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A14: SWRCB
DTSR Edit: Will be incorporated

DTSR Comment: Pg A21: SWRCB
DTSR Edit: Edit will be incorporated

A stakeholder asked why the study was analyzing Silver. Ed Bianchi explained that the Cloud seeding study is a cross reference to this and will be referenced in the DTSR. (Silver Iodide) CAWG-12: Water Use addresses cloud seeding.

Action Item #5: ENTRIX will make the edits necessary and Kearns & West will redistribute the CAWG-4 to the group. The group will review and then approve at future meeting.

CAWG-7: Characterize Fish Populations
Wayne reviewed the CAWG-7 DTSR with the group. Comments from stakeholders on CAWG-7 will be due on August 3, 2003. The group will discuss comments at the next CAWG meeting.

Hydroacoustics
Wayne explained that when sampling with hydroacoustics, the beam of the device starts narrow and widens as it gets farther from the boat. This results in a smaller sampled volume for shallower water, when compared to deeper water.

A stakeholder asked if ENTRIX lumped hatchery and wild rainbow trout. Wayne L. said they did not. They did not age hatchery rainbow trout because their scales do not allow adequate aging.

Action Item #6: Wayne Lifton will check the condition factors reported in the CAWG-7 DTSR to confirm that hatchery trout were not included with wild rainbow trout.

Portal Entrainment Monitoring Discussion
Wayne L. showed the group a chart of information provided by Wayne Allen and USGS with the generation, total flow, ISO no touch days and ISO emergency days and the entrainment sampling for 2001-2002. When

the HB valve is open, sampling cannot take place. When the ISO issues no touch or emergency days, there can be no outages to set up a net or retrieve a sample. The net was damaged in August 2002 due to HB valve operation, so no samples could be taken at that time.

Wayne L. showed the group the exceedance flows for Portal. Most water is moved between the months of May to August. Wayne pointed out that there appeared to be adequate numbers of samples in the winter months when operations are generally decreased due to decreased flow availability, but the summer months were represented by few samples.

The State Water Board said that the problems of having inadequate sampling are due to sampling during the wrong part of the year. The Board referenced the Portal Application which states that for the December 12th period sampling started at 12 o'clock, and went for 24 hours. The Water Board stated that this is not enough info. The second sample was in January, there was no information on the volume of water when a Kokannee carcass was caught. The application says you did not catch any fish in the summer months, but that there were portions of fish that were caught in the net.

Agreement: The CAWG agreed that additional entrainment sampling will be taken at Portal to represent the higher flow period. Sampling will focus on flows of over 400 cfs. ENTRIX will coordinate with SCE operations to find the window of opportunity and go take the samples.

Review of Habitat Suitability Data Collection

Wayne L. reviewed the HSC Verification Update with the group. Focus will be on testing the altered flows preference criteria for trout and the Pit River criteria developed by Peter Moyle and Don Baltz for Sacramento sucker, Sacramento pikeminnow, and hardhead.

Wayne explained that there are two components in using PHABSIM to analyze habitat at different flows. A hydraulic model such as IFG4a is used to simulate velocities and depths for a range of flows at each transect. The other is to evaluate these results in terms of fish microhabitat. The PHABSIM HABTAT, HABTAV, and HABTAE models interpret hydraulic model results using habitat suitability criteria to interpret the suitability of habitat for different species and lifestages.

Suitability goes from 0 to 1. Zero is unsuitable habitat and 1 is completely suitable habitat. Wayne drew some sample curves and explained what they meant. Suitability of velocity multiplied by suitability of depth for an area of stream equals the weighted usable area for that location in the example shown.

A stakeholder asked how we know that a fish is "happy" in a habitat. Wayne said that "happy" fish is determined by how many fish are observed in certain microhabitat conditions. We observe where the fish are in relation to the availability of habitat choices. Geoff added that there's a different set of suitability for different fish and different lifestages.

The habitat suitability curves that we will be using are based on large data sets of habitat availability and fish habitat use observations. The first step in this study is to see if the existing curves can be used for our purposes. The specific approach will be to use the Groshens and Orth testing approach to compare HSC to observations of habitat availability and use by fish in the study streams. If HSC pass the test then they will be adequate for use in PHABSIM.

A stakeholder asked what the timeframe for developing site specific curves is. Wayne said that the first order of business is to determine whether existing curves are adequate, then we will assess what information we have and don't have, then see where we stand.

A stakeholder asked if they are using any of the snorkeling results to develop suitability curves. Wayne said they need about 50 snorkeling observations of fish habitat use to test a HSC. However, these are not the same observations collected for CAWG-7.

A stakeholder explained that on the Pit River, recent observations of juvenile suckers were different from the curves they had developed there. Wayne said that the HSC would be tested prior to use. In addition, there are ways to adjust curves to reflect actual habitat use, otherwise site-specific curves would need to be developed.

Wayne gave a summary of the sampling locations and years and numbers of observations collected, so far. He then outlined the data gaps for each fish species. Wayne said they tried not to take observations where they stock fish to avoid having hatchery fish from influencing the HSC decisions.

A stakeholder asked if the adequate sample numbers have been verified. Larry Wise (ENTRIX) said they are ready to do the QC work, and then will run through the various tests for information available. Larry said they will come back to the August CAWG meeting with the tests where there are sufficient numbers of observations.

Ed Bianchi asked about the latest time they can continue to make observations this year. Larry said until October. The CAWG will need to decide soon whether to do site-specific models or to use existing data. Ed said that they need to put together a schedule for collecting the data and bring back to the group with the decision whether to go site specific.

Action Item #7: ENTRIX will develop a schedule for making a decision on whether existing habitat suitability criteria (HSC) for fish, to be used in PHABSIM, can be verified and used or whether they will need to be adjusted or site specific HSC will need to be developed. Schedule will be incorporated into field work schedule to be distributed to the CAWG by July 23.

Schedule
CAWG is behind on approving study reports. Bill proposed having multiple CAWG meetings next month. The CAWG will meet on August 19, 20, 21. No Plenary in August.

The USFS said the hydrology information will affect every study we have right now. Ed recognized that and said that SCE and ENTRIX are working on a solution to get the information to the group as soon as possible. The USFS that they are concerned that if the hydrology data comes out and makes the group have to revisit the DTSRs.

Action Item #8: Per the USFS's request, SCE and ENTRIX will get the Hydrology Information out to the group, soon.

<u>Meeting Adjourned</u>

<u>Summary of Action Items</u>
Action Item #1: Timeline for outstanding study elements in the DTSRs will be developed on a group by group basis. ENTRIX will provide an initial draft of the timeline, then discussed in the groups. The CAWG will need to make decisions before the outstanding study elements timeline can be fully developed. Two weeks from today.
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Big Creek Collaborative
Combined Aquatics Working Group

February 23, 2005

Meeting Notes

Time:	10:00 AM to 4:00 PM	**Facilitator**:	Bill Pistor
Teleconference No.: **Access Code:**	1-800-556-4976 271911	**Recorder**:	Emily Armstrong

Participants:	Wayne Allen	SCE
	Emily Armstrong	Kearns & West
	Ed Bianchi	ENTRIX
	Deborah Giglio	U.S. Fish and Wildlife Service
	Rick Hopson	USFS
	Wayne Lifton	ENTRIX
	Martin Ostendorf	ENTRIX
	Bill Pistor	Kearns & West
	Geoff Rabone	SCE
	Roger Robb	Friant Water Authority
	Lonnie Schardt	Huntington Lake Association
	Phil Strand	USFS
	Wayne Thompson	Fly Fishers for Conservation, Inc
	Julie Tupper	U.S. Forest Service
	Cindy Whelan	U.S. Forest Service
	Larry Wise	ENTRIX
Phone Participants:	Woody Trihey	ENTRIX
	Julie Means	CDFG
	Matt Myers	SWRCB

Introductions and Agenda
Bill Pistor asked the group to introduce themselves and reviewed the agenda.

Discussion of Populated Hydrology PRIM, RIM and Criteria
Wood Trihey reviewed the IHA Summary Table that was distributed to the group. The table provides a compilation of information presented in the CAWG 6 report.

Woody reviewed Parameter Group 1 and said that it summarizes monthly flow statistics for unimpaired and existing flow regimes and provides an indication of how stable the flow condition is between the two scenarios. The values are in cfs.

The group asked questions about Parameter Group 1. Phil asked if this information is based on synthetic information. Woody said yes, the unimpaired values are the unaltered hydrograph or the hydrograph above the point of the diversion. For the most part, the data are primarily derived from synthesized records. Woody thinks this should be taken up on a case by case basis. If the diversion is turned out and there is a difference from what is shown below the diversion, it could be an artifact of the process used to simulate the data.

Woody reviewed Parameter Group 2. This shows minimum and maximum stream flows that occurred in the period of record for daily increments for the unimpaired and existing flows. This shows a comparison of extreme values that exist in the period of record.

Woody continued with the summary of flood frequency analysis on page 3. This table is a comparison of the unimpaired and existing flood frequency results. Woody explained how he tried to identify the number of years where existing flows met or exceeded the unimpaired flow indicated for the 1.5 year return interval. Cells with dots indicate no data was available. Rick asked if the same column could be added for the other return periods. Woody responded that other magnitudes of flow could be tallied. Rick said it might be interesting to have that information.

Woody reviewed the unpopulated Hydrology PRIM. The table is broken out seasonally and by portions of the year that have biological significance. The summer/fall period stands out as a low flow, high temperature period. Winter is another period, where in higher elevations there might occur low flow and cold water temperatures. During winter, the high elevation and low elevation streams behave differently and that is why there are maximum and minimum values for winter. All values in this table would be median values. He explained how the median values were calculated and that the information exists in the table for unimpaired and existing flows. The seven-day value is an indicator and is the seven-day stream flow that yields the maximum or minimum seven-day flow volume in the period of record.

Woody asked the group to review the seasonal table for additional indicators that would be helpful in making assessments on biological effects. He asked that group members please provide a brief explanation of why the indicator would be valuable.

Rick raised concern about July not being included. Woody said July is a transition month with a lot of variability, but it can be evaluated independently for the boating and recreation folks.

Rick asked if it might be useful to have the Julian day or day that flow occurred in the seasonal table. Woody said it could be useful if there is not a lot of variability in the data record. Woody said that information probably won't be necessary on every stream, but it might be useful for high flow events on some streams. He suggested the group address this on a case by case basis.

Julie Tupper thinks it is important to include April in the table because historically, the high flows occur into April and May and less in June. Woody suggested breaking the streams into higher elevation and lower elevation segments to address the monthly timeframe concern.

Lonnie Schardt asked if there are project safety concerns with not showing the 50 and 100 year events in terms of potential recreation Project enhancements. Woody responded that the Project had little effect on these flows and that they occur too infrequently for this context. The Forest Service said recreation is something that needs to be considered in the Hydrology PRIM for some sites like Jackass and Mono Hot springs. They want to understand the potential of a new recreation site washing out and this might be achieved through understanding stage changes.

Julie asked that the seasonal streamflow table not be populated until she provides comments. The group agreed to provide comments on the Hydrology IHA Summary Table and PRIM by March 9th (see AI #1 below).

Continue Discussion from February 22 Fisheries Criteria, RIM and Populated PRIM

Larry Wise reviewed that the group's prior discussion on WUA to fish ratios and how they are used in this process yesterday. He wants to continue this discussion and look at how PHABSIM results will be used in this process. Larry reviewed the proposed process, which was to look at streams and see where the amount of available physical habitat is most restrictive for fish populations. One way to look at that is to use WUA to fish ratios. In the criteria, we've taken the ratio values (20 WUA : Adult Trout) reported to us by the Instream Flow Group (IFG) (these WUA ratios are similar to those reported for some of the project streams) and doubled them to be conservative. Areas where the WUA to fish ratio is less than double the IFG value were identified as potentially having a resource issue. Phil mentioned that spawning habitat may be an issue. Larry explained how they looked at spawning area for species spawning at different times of the year based on literature values for spawning area requirements and existing minimum flows. Because most of the spawning habitat is in pocket gravels, Larry believes the literature areas are very conservative. The criteria also presume that every female will spawn in every year. Based on this, the overall criteria are conservative, and how that impacted how a certain species would spawn at a given time of year. He thinks the criteria is very conservative and if we see an indication of a problem it may or may not be there and if we don't see an indication, there is probably not a problem.

Phil said habitat time series may be a focus for the Forest Service. Exceedance information can have some value in evaluation of brown trout spawning. He asked if there is a way to sort through percentiles to sort out extreme events or not. He also asked about characterizing habitat and if there are a lot of habitats with low suitability cells or if cells of good suitability are dominating the WUA functions. He asked if there is a way to demonstrate how responsive meso-habitats are to changes in flows. Larry replied that the information is available, but we would need to discuss the value of generating habitat specific WUA functions, given the stream reach must be managed as a whole, and that mesohabitat type was taken into account in generating spawning WUA, which is most mesohabitat sensitive. Phil suggested adding columns to the RIM for Rosgen channel type and meso-habitat type. Phil reiterated that these comments are preliminary and he and Larry should talk in more detail.

Rick asked about embeddedness in spawning gravel. Larry said that embeddedness was visually estimated and we have the embeddedness for each patch of spawning gravel along a transect. Wayne Lifton said we will need to look at where heavy embeddedness is being reported in the Geomorphology PRIM and track that in terms of fish production.

Larry distributed the populated Aquatics PRIM. He wants to go through the examples of Bear Creek and Mono Creek because they are opposite extremes. He reiterated that we are not looking at this PRIM in isolation; all other resources areas have to be considered as well. Larry reviewed each fish species and other attributes across the top of the table, contrasting Bear Creek and Mono Creek.

Phil said he has major reservations with criteria based on Gerstung's data. Lonnie asked what the high density of Sacramento Sucker in Huntington Lake means as a resource issue. Wayne Lifton said it can be identified as a community composition issue for purposes of discussion. Martin added that he'll have to look at the Recreation criteria and see if we have a mechanism for integrating that. Lonnie has the same question/concern with the smallmouth bass in Shaver Lake. Julie Means requested a copy of the Recreation PRIM materials and that she is added to the Recreation distribution list (see AI#2 below).

The group agreed to provide written comment on the Aquatics PRIM by March 9th (see AI #3 below)

<u>Discussion of Populated Water Quality PRIM and Criteria</u>
Martin distributed the Water Quality criteria and PRIM and copy of the comments that are integrated into the PRIM. The PRIM is broken up into three major areas. The dark blue band across the top is the main portion of the PRIM. Gray cells indicated where samples were not taken. The fish tissue analysis is another part of the PRIM and focuses on Mammoth Pool Reservoir. The third section has to do with gas saturation (super saturation below Mammoth Pool). There is a key on the back page and source references and footnotes.

The group reviewed the criteria. Criteria in group 1 are tied to Table 4-3 in the study report where the most stringent criteria were identified. Criteria in group 2 will be addressed as we get into the next phase of the PRIM. Martin noted that the stringent criteria aren't always used; the aquatic life criteria are sometimes used. The third criteria were written for the fish tissue. Martin discussed the different kinds of mercury that are captured. There were no questions from the group.

Martin reviewed each analyte to show how the PRIM was populated. Alkalinity values were included in the PRIM. He reviewed the metals that were analyzed and how the threshold criteria were different because of the different alkalinity values. Julie Tupper was concerned that things would be missed with the range currently identified. The group discussed if the ranges meet the criteria or not. The concern is that if it doesn't meet the criteria, it still needs to be included so that the group can decide if it's an issue or not in the future. Julie Tupper suggested marking it with a symbol now so that potential issues aren't lost. Martin will put a 'p' or 's' in the cells that didn't meet the criteria so that they don't fall off the radar screen. He will add a column for alkalinity for the narrative criteria and the numerical criteria.

Julie Tupper asked if there are records of herbicide use. Ed said we work with the Forest Service to do and approve that process. The group agreed to deal with this in the next round of PRIM discussions in determining a Project nexus. SCE will talk to the people who apply the herbicides to get the application schedule.

Phil said he doesn't see information on water temperature warming. Martin said that is handled through the CAWG 5 report and not part of the chemical water quality study. Julie said the Forest Service thinks macroinvertebrates and temperature need to be included in the Water Quality PRIM. Martin will have to think about how to include that information. He asked if this is more of a cross-resource issue. Julie said the State Water Board was interested in looking at macroinvertebrates because it is a water quality issue not only a fish issue. Wayne Lifton said macroinvertebrate information was collected using water quality survey methods. CAWG 10 shows a lot of conflict for indices between streams, so we have to think how to present something that makes sense without a lot of columns (see AI #4 below).

The group discussed the potential cross resource issue between geomorphology sediment contribution and water quality. They agreed that it was something that needed to be addressed by this group and the Land group in the future. Ed said different players from different groups are going to have to meet to talk about these cross resource issues. Prescriptions will be made from both groups.

Rick asked about temperature water quality standards related to the Basin Plan. Ed asked Matt Myers (SWRCB) to follow-up on how the State Water Board would interpret those standards. Rick's preference is to show that information on the Water Quality PRIM. Ed asked Martin to take a first cut at that and then the Water Board can look at it and make adjustments. Martin said another column for temperature could be added (see AI #5 below).

Rick asked Martin about Dissolved Oxygen (DO) and pH. Martin said values are based on in situ measurements taken. In pH stream sampling events, 38% were outside of the criteria range. pH in this kind of system is traditionally low and that connects with the alkalinity. Ed said we still need to look at the samples that are above the range. Rick agreed.

Cindy Whelan asked that all PRIM materials be dated (see AI #6 below).

The group agreed to provide comments on the Water Quality PRIM to K&W by March 15 (see AI #7 below). In the meantime, Entrix will work with the comments received during the meeting. A revised version will not be sent out until the March 15 comments are addressed.

<u>Brief Overview of CAWG 9 Entrainment Report</u>
Wayne Lifton reviewed the table of contents of the Entrainment Report. There will be a 30 day review period after this report is distributed. It will be mailed out on CD. This report is a follow-up

to the initial review of intakes and the 2003 agreement to sample the tailraces. The literature review includes information presented in 2003. This is a stand-alone document and includes 2003 information.

Debbie Giglio asked for a master list of study reports. Entrix will provide the group with a master list (see AI #8 below).

Bill ran through the action items.

The meeting was adjourned.

February 23, 2005 Action Items

AI #1: CAWG members will review Hydrology IHA Summary Table and PRIM and identify any additional indicators of Project related change and provide a brief rational on how it would be used by March 9. All comments are to be provided to K&W before March 9 or brought to the March 9 CAWG meeting.
AI #2: Entrix and K&W will add Julie Means to the Recreation work group distribution list and send her current Recreation PRIM materials.
AI #3: CAWG members will provide comments on the Aquatics and Fisheries PRIM materials to K&W by March 9 or bring comments to the March 9 CAWG meeting.
AI #4: Martin Ostendorf will identify potential issues in the alkalinity column of the Water Quality PRIM and bring temperature and macroinvertebrate information into the Water Quality PRIM.
AI #5: Martin Ostendorf will include Basin Plan water temperature criteria in the Water Quality PRIM. Matt Myers will provide consultation in regards to SWRCB requirements with water quality standards.
AI #6: Entrix will provide dates on all future PRIM materials.
AI #7: CAWG members will provide comments on the Water Quality PRIM materials to K&W by March 15.
AI #8: Entrix will produce a master list of all final study reports for distribution to the CAWG.