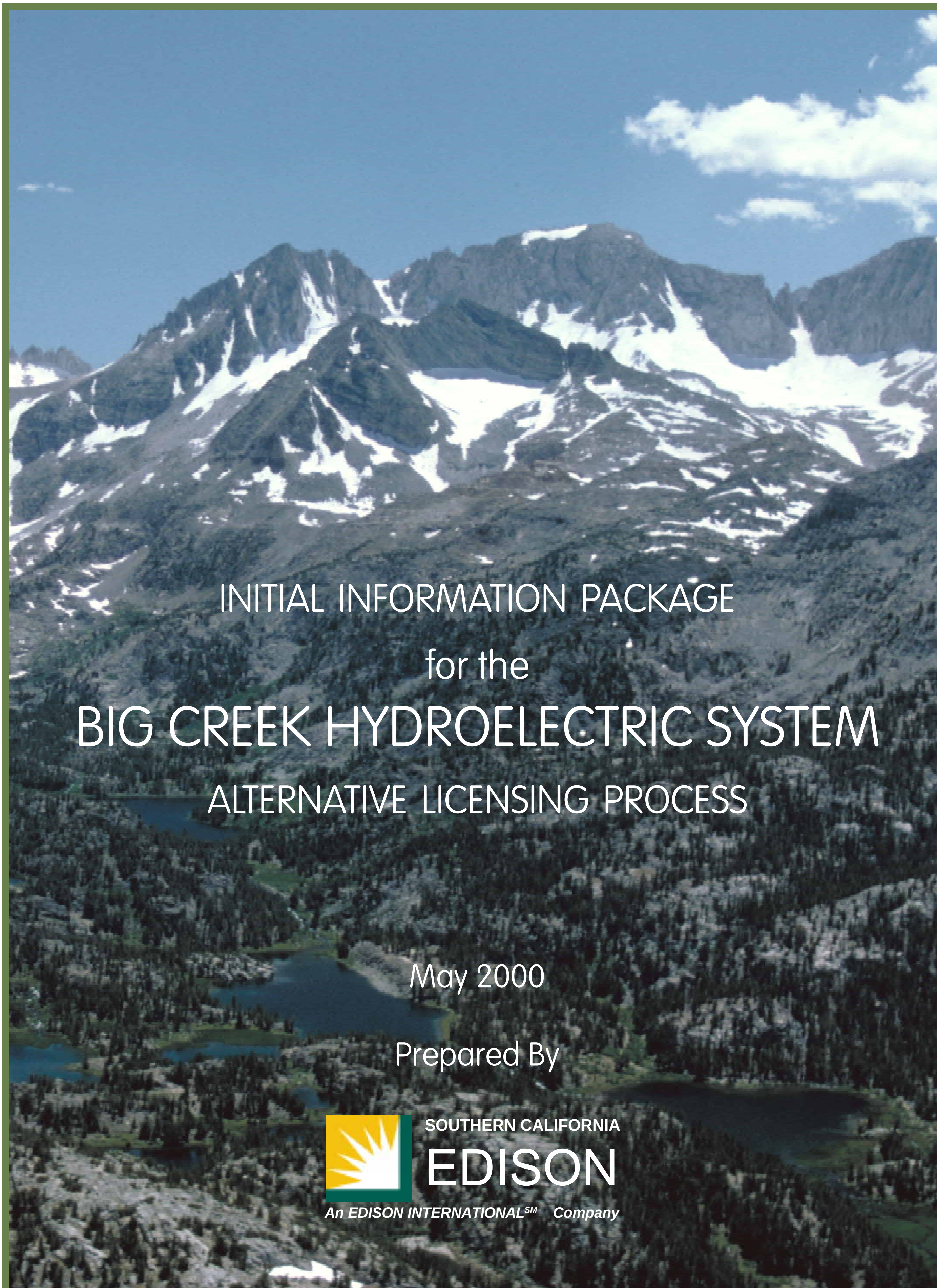

INITIAL INFORMATION PACKAGE

for the

BIG CREEK HYDROELECTRIC SYSTEM

ALTERNATIVE LICENSING PROCESS

May 2000

Prepared By

SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL℠ Company

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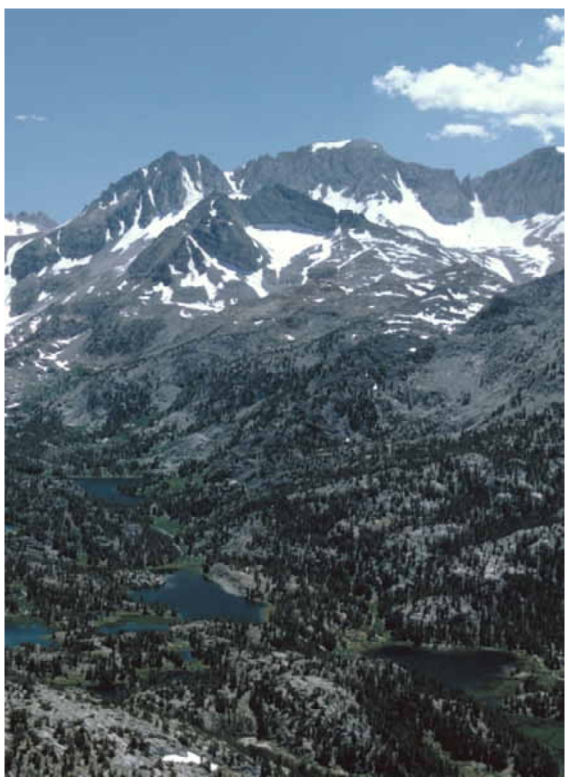
ENTRIX


LAKE THOMAS A. EDISON'S WATERSHED

PAGE

Appendices

Page

Page

ADA	American with Disabilities Act
af	acre-feet
AGR	agricultural supply
AIR	Additional Information Request
ALP	Alternative Licensing Process
APEA	Applicant Prepared Environmental Assessment
BiCEP	Big Creek Expansion Project
CalEPPC	California Exotic Pest Plant Council
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
cfs	cubic feet per second
cm	centimeter
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO	carbon monoxide
COLD	cold freshwater habitat
COMM	commercial and sport fishing
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
DWR	California Department of Water Resources
EA	Environmental Assessment
ECPA	Electrical Consumer Protection Act
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESAP	Endangered Species Alert Program
FAR	floor-area ratio
FERC	Federal Energy Regulatory Commission
FL	fork length
FPA	Federal Power Act
FSCD	First Stage Consultation Document
FWCA	Fish and Wildlife Coordination Act
HAP	Habitat Area Planning
Hp	Horsepower
HSC	Habitat Suitability Curves
IFIM	Instream Flow Incremental Methodology
IIP	Initial Information Package
IND	industrial supply
ISD	Initial Scoping Document
km	kilometer
kW	kilowatt
Ma	million years ago
mg/l	milligrams per liter
m/s	meters per second
msl	above mean sea level

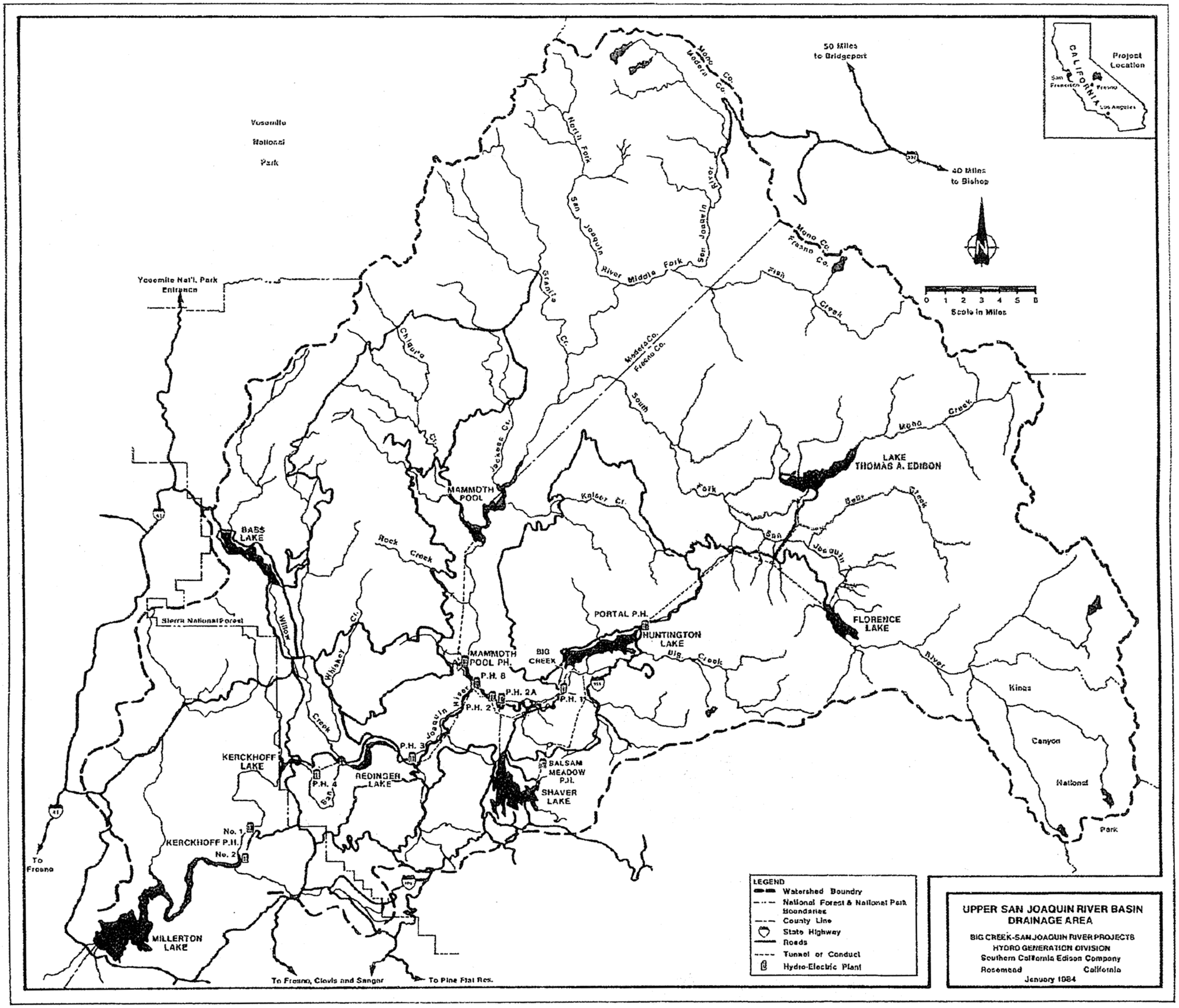
MUN	municipal and domestic supply
MW	megawatt
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NO_x	oxides of nitrogen
O_3	ground-level atmospheric ozone
OHV	off-highway vehicle
PG&E	Pacific Gas and Electric Company
PHABSIM	Physical Habitat Simulation Models
POW	hydropower generation
REC-1	water contact recreation
REC-2	non-contact water recreation
SCE	Southern California Edison Company
SJ&E	San Joaquin and Eastern railroad
SJVAB	San Joaquin Valley Air Basin
SL	standard length
SNTEMP	Stream Network Temperature Model
SO_2	sulfur dioxide
SPCC	Spill Prevention Control and Countermeasure
SWRCB	State Water Resources Control Board
TL	total length
USBR	United States Bureau of Reclamation
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VELB	valley elderberry longhorn beetle
WARM	warm freshwater habitat
WILD	wildlife habitat
WSRA	Wild and Scenic Rivers Act
WUA	Weighted Usable Area
YBP	years before present

HUNTINGTON LAKE AT AN ELEVATION OF APPROXIMATELY 7,000 FT

Southern California Edison (SCE) is initiating a multi-year collaborative process for the relicensing of four of its seven Big Creek hydroelectric projects located in California's upper San Joaquin River watershed, about 25 miles northeast of the City of Fresno and about 250 miles northeast of Los Angeles (Figure ES-1). SCE obtained approval from the Federal Energy Regulatory Commission (FERC) on March 15, 2000 to use an Alternative Licensing Process (ALP) to relicense these four projects. The seven Big Creek hydroelectric projects are referred to as the Big Creek System, and the area encompassing the seven projects is called the Big Creek System Basin (Basin). SCE recognizes that the common ownership and location of the seven hydroelectric projects within one watershed provide an unique opportunity to address complex resource balancing issues within a single process. Therefore, SCE intends to analyze all seven hydroelectric licenses during the Basin planning process for the Big Creek System ALP.

One important goal of the ALP is to facilitate greater participation by, and improve communication among, SCE, state and federal agencies, Native American tribes, local and regional authorities, private interests, and the public. The ALP encourages the development of settlement agreements between relicensing participants. For example, a settlement agreement might detail a preferred project mitigation strategy that has been agreed upon by relicensing participants for future operation of the hydroelectric projects. SCE encourages active participation in the ALP by all parties interested in providing input on the future terms and conditions for the Big Creek hydroelectric project licenses.

This Executive Summary condenses the more detailed information contained in the attached Initial Information Package (IIP). The IIP and this summary present information on the Big Creek hydroelectric projects, the regulations that govern their operation and licensing, the current relicensing activities for these projects, and the natural and other resources surrounding project facilities. The IIP and this summary are provided to interested parties to help inform them of the relicensing of SCE's Big Creek hydroelectric projects.



UPPER SAN JOAQUIN RIVER BASIN DRAINAGE AREA
BIG CREEK-SAN JOAQUIN RIVER PROJECTS
HYDRO GENERATION DIVISION
Southern California Edison Company
Rosemead California
January 1984
LEGEND
Watershed Boundry
National Forest & National Park Boundaries
County Line
State Highway
Roads
Tunnel or Conduct
Hydro-Electric Plant
Scale in Miles
0 1 2 3 4 5 6
Project Location
CALIFORNIA
San Francisco
Fresno
Los Angeles
Yosemite National Park
Yosemite Nat'l. Park Entrance
Sierra National Forest
50 Miles to Bridgeport
40 Miles to Bishop
Mono Co.
Madera Co.
Fresno Co.
North Fork
San Joaquin
River
Middle Fork
Granite Cr.
Chiquito Cr.
Jackass Cr.
South Fork
Fish Creek
Mono Creek
Bear Creek
Kaiser Cr.
Rock Creek
Willow Creek
Whiskey Cr.
Big Creek
LAKE THOMAS A. EDISON
MAMMOTH POOL
BASS LAKE
PORTAL P.H.
HUNTINGTON LAKE
FLORENCE LAKE
MAMMOTH POOL PH.
BIG CREEK
P.H. 8
P.H. 2A
P.H. 2
P.H. 1
P.H. 3
P.H. 4
KERCKHOFF LAKE
REDINGER LAKE
BALSAM MEADOW P.H.
SHAVER LAKE
No. 1
KERCKHOFF P.H.
No. 2
MILLERTON LAKE
Kings Canyon National Park
To Fresno
To Fresno, Clovis and Sanger
To Pine Flat Res.

Figure ES-1

Description of SCE's Big Creek Hydroelectric Projects

The four SCE Big Creek hydroelectric projects using the ALP are:

- Big Creek Nos. 1 & 2 (FERC No. 2175, license expiration 2009);
- Big Creek Nos. 2A, 8, & Eastwood (FERC No. 67, license expiration 2009);
- Big Creek No. 3 (FERC No. 120, license expiration 2009); and
- Mammoth Pool (FERC No. 2085, license expiration 2007).

The three SCE Big Creek hydroelectric projects using the Traditional Relicensing Process are:

- Big Creek No. 4 (FERC No. 2017, operating under an annual license);
- Vermilion Valley (FERC No. 2086, license expiration 2003); and
- Portal (FERC No. 2174, license expiration 2003).

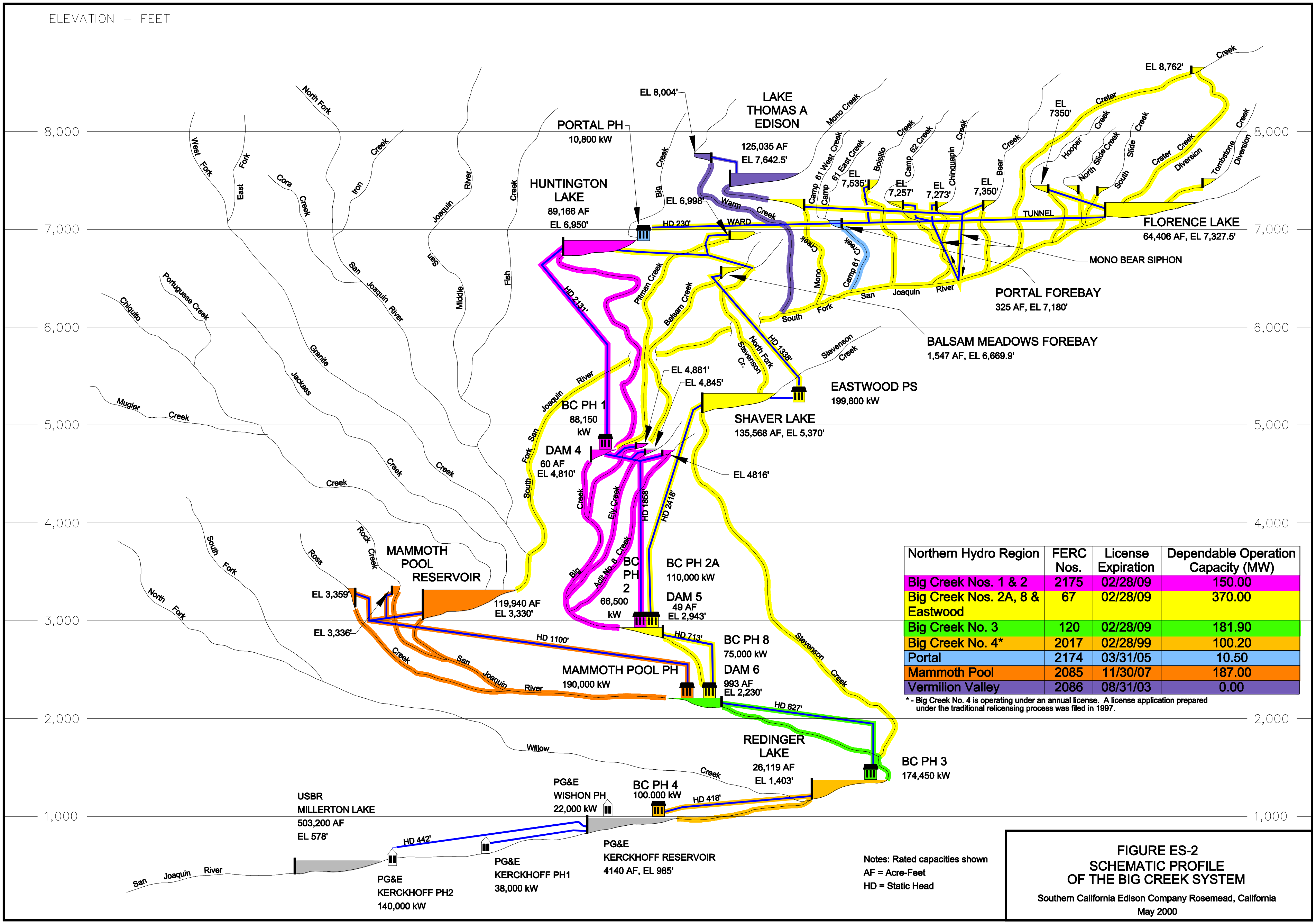
SCE's seven hydroelectric projects within the Basin have a combined dependable operating capacity of about 1,000 megawatts (mW).

The Big Creek System consists of 9 powerhouses containing 23 generating units, 6 major reservoirs, 5 powerhouse forebays, 17 additional diversions, about 54 miles of water conveyance systems and 2 transmission lines (Figure ES-2). The Big Creek System is operated to meet FERC license conditions (such as instream flow requirements), physical constraints, downstream water rights agreements, and power production needs. Minimum instream flow releases are made by SCE from diversions and impoundments to preserve fish habitat and instream beneficial uses in the project bypass reaches.

POWERHOUSE NO. 1 AT NIGHT

Regulatory Framework

Under the authority of the Federal Power Act (FPA), the FERC has the authority and responsibility for regulating non-federally owned hydroelectric power projects. The seven Big Creek hydroelectric projects are operated and maintained by SCE in accordance with terms and conditions specified in individual licenses issued by the FERC for



Northern Hydro Region	FERC Nos.	License Expiration	Dependable Operation Capacity (MW)
Big Creek Nos. 1 & 2	2175	02/28/09	150.00
Big Creek Nos. 2A, 8 & Eastwood	67	02/28/09	370.00
Big Creek No. 3	120	02/28/09	181.90
Big Creek No. 4*	2017	02/28/99	100.20
Portal	2174	03/31/05	10.50
Mammoth Pool	2085	11/30/07	187.00
Vermilion Valley	2086	08/31/03	0.00

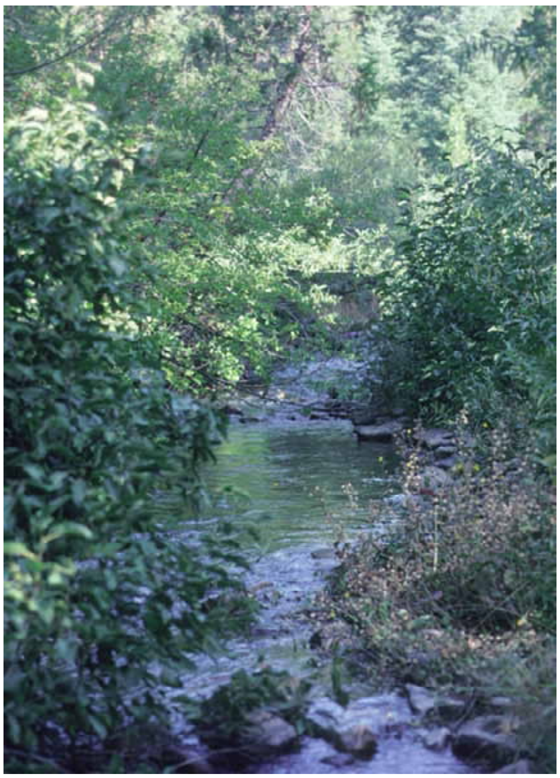
* - Big Creek No. 4 is operating under an annual license. A license application prepared under the traditional relicensing process was filed in 1997.

Notes: Rated capacities shown
AF = Acre-Feet
HD = Static Head

FIGURE ES-2
SCHEMATIC PROFILE
OF THE BIG CREEK SYSTEM

Southern California Edison Company Rosemead, California
May 2000

each of the hydroelectric projects. Each project license issued by the FERC has a specified term, generally 30 to 50 years, during which the licensee (SCE in the case of the Big Creek System) can operate the hydroelectric project. As the term of each license expires, a new license must be obtained to continue operation of the project.



STEVENSON CREEK

A minimum of five years prior to the expiration of a project license, a licensee that wishes to obtain a new license is required to formally initiate a consultation process for the preparation, filing, and processing of a new license application for an existing hydroelectric project. This process, referred to as the relicensing process, has specific regulatory deadlines and requirements which must be met by the licensee, including: filing of notifications at key milestones; submittal of required documents; consultation with state and federal resource agencies and Native American tribes; obtaining comments from the public; and filing a license application with the FERC two years prior to the expiration of the project license. The licensee also is responsible for complying with all laws, statutes and regulations that may apply to the project on a federal or state level.

The FERC staff's role in the relicensing process is to conduct an independent analysis of license applications to determine if a new license should be issued and what terms and conditions will be included as part of any new license. The FERC's staff is responsible for conducting the analyses in accordance with FERC regulations and consistent with the National Environmental Policy Act of 1969 (NEPA). The FPA requires the FERC to develop project conditions based on equal considerations of both power and non-power values associated with a project. Non-power values include environmental, recreation, fish and wildlife values affected by the project. The FPA also requires the FERC to consider whether a project is consistent with federal and state comprehensive plans applicable to the project area. Further, the impact analysis and mitigation must focus on the ongoing impacts of the project as it currently exists.

Description of the FERC Relicensing Process Options

FERC regulations governing the relicensing of an existing hydroelectric project allow the licensee to select either the Traditional Relicensing Process or the Alternative Licensing Process to prepare, file, and process a new license application. However, the licensee must obtain FERC approval to utilize the ALP. Briefly, the primary differences between the traditional and alternative processes are: 1) the extent and timing of collaboration with stakeholders during the relicensing effort; and 2) the timing/sequencing of the FERC's and other regulatory agencies' environmental review processes.

What is the Traditional Relicensing Process?

FERC regulations specify that the Traditional Relicensing Process requires a minimum of a three-year, three-stage consultation process for the preparation and filing of a new license application for an existing hydroelectric project. Under this process, the licensee prepares and submits a license application to the FERC presenting information about the project, the resources in the project area, and the licensee's protection, mitigation and enhancement proposals along with those measures proposed by other parties, but not adopted by the licensee. After submittal of the license application, the FERC embarks upon an independent environmental review of the project. During this time, resource agencies, Native American tribes, the public and the licensee can provide comments. A collaborative process is typically not used throughout the process to discuss the potential license terms and conditions submitted to the FERC. The Traditional Relicensing Process was previously the only process available to a licensee. This licensing approach is still available for use with any project.

POWERHOUSE NO. 8 AT THE CONFLUENCE OF BIG CREEK AND THE SAN JOAQUIN RIVER

What is the Alternative Licensing Process?

The Alternative Licensing Process empowers the licensee and stakeholders to collaboratively design the consultation process for the relicensing effort. The ALP allows the licensee and stakeholders to jointly propose license terms and conditions often based on a negotiated settlement agreement which is submitted to the FERC with the license application. The ALP also combines the pre-filing consultation process with some of the FERC's NEPA requirements. The FERC regulations allow for an integration of pre-filing consultations with the environmental analysis, allowing the licensee to prepare an Applicant Prepared Environmental Assessment (APEA) to meet the requirements of NEPA. The draft APEA is filed with the FERC along with the license application. The ALP may include the development of settlement agreements between relicensing participants. A settlement agreement may detail a preferred project mitigation strategy that has been agreed upon by relicensing participants. Ideally, any settlement agreement would be included in the APEA and would be used by the FERC as a basis for the new license terms and conditions.

The ALP encourages greater public involvement and provides an opportunity for the licensee and stakeholders to tailor the licensing process to address specific issues and streamline procedural compliance with multiple federal laws that are involved in the relicensing process. An atmosphere of cooperation, trust, and support for the alternative approach among relicensing participants is essential to the success of this relicensing effort.

Associated Regulatory Processes

Regardless of the relicensing process used, certain agencies can require the FERC to include additional “mandatory conditions” in the new license. In the Big Creek System, three regulatory agencies have this authority, namely the United States Forest Service (USFS), the United States Fish and Wildlife Service (USFWS), and the State Water Resources Control Board (SWRCB). These agencies typically conduct an independent evaluation of the license application to determine the adequacy of the proposed mitigation measures.

In the Traditional Relicensing Process, the evaluations conducted by the USFS, USFWS and SWRCB are completed after the licensee has submitted the license application to the FERC. In the ALP, these agencies move their environmental review process forward to complete these processes shortly after submittal of the license application and APEA. A collaboratively developed APEA and any settlement agreements serve as the guiding documents for these other regulatory processes. If the collaborative process is successful, the APEA and any settlement agreements should incorporate all terms and conditions deemed appropriate for protection of project resources. Therefore, the USFS, USFWS, SWRCB and the FERC processes should be greatly expedited.

SCE’s Relicensing Approach for the Big Creek System

In the Big Creek System, SCE is utilizing both the traditional and alternative licensing processes. The ALP is being used for the four projects identified above. The Traditional Relicensing Process was selected for the remaining three projects to meet the FERC regulatory deadlines for submission of new license applications.

SCE acknowledges that any settlement agreements and subsequent APEA may recommend protection, mitigation and enhancement measures for the three licenses undergoing the Traditional Relicensing Process (Big Creek No. 4, Vermilion Valley, and Portal) to take advantage of any appropriate mitigation trade-off opportunities within the Basin. SCE will request the FERC to amend these early licenses, if necessary, to modify the protection, mitigation and enhancement terms and conditions consistent with any settlement agreements.

SCE’s Alternative Licensing Process in the Big Creek System

On December 9, 1999, SCE filed a formal request with FERC to use the ALP to relicense four hydroelectric projects in the Basin. The request followed extensive collaboration, input and support from many of the stakeholders regarding the appropriateness and design of the ALP and development of draft communication protocols. On March 15, 2000, the FERC approved SCE's request to follow the ALP.

Goals of the ALP Approach

The specific goals of the Big Creek System ALP are to:

- Combine into a single process the pre-filing consultation, the environmental review under the National Environmental Policy Act, and administrative processes for all four projects;
- Facilitate more effective participation by, and improve communication among, SCE, resource agencies, Native American tribes, local and regional authorities, private interests, the public and FERC staff in a flexible pre-filing consultation process;
- Promote cooperative efforts between SCE and the stakeholders to share information about resource impacts and proposals for protection, mitigation and enhancement measures and to narrow any areas of disagreement and reach a comprehensive settlement;
- Facilitate an orderly and expeditious review of any agreements or offers of settlement for use as a basis for protection, mitigation, and enhancement measures for new hydropower licenses; and
- Allow for the preparation of an APEA by SCE with input from the stakeholders.

How the ALP Will Take Place

A schematic overview of the relicensing approach for the Big Creek System under the approved ALP is provided in Figure ES-3. A schedule of key activities during the ALP is presented in Figure ES-4. The Big Creek ALP consists of six major elements including:

1. Formalization by the stakeholders of the collaborative process for the ALP (i.e., ground-rules, communication protocols, and dispute resolution) by July 2000;
2. Initiation and completion of a Basin planning process (i.e., identification of management objectives, key resource issues, existing information, and data gaps) by March 2001;
3. Development, implementation and interpretation of integrated technical studies for project resources (i.e., formulation of study objectives, scopes of work, study schedules, analytical methods, data analyses and presentations) by March 2003;

Figure ES-3

Relicensing Approach for the Big Creek System

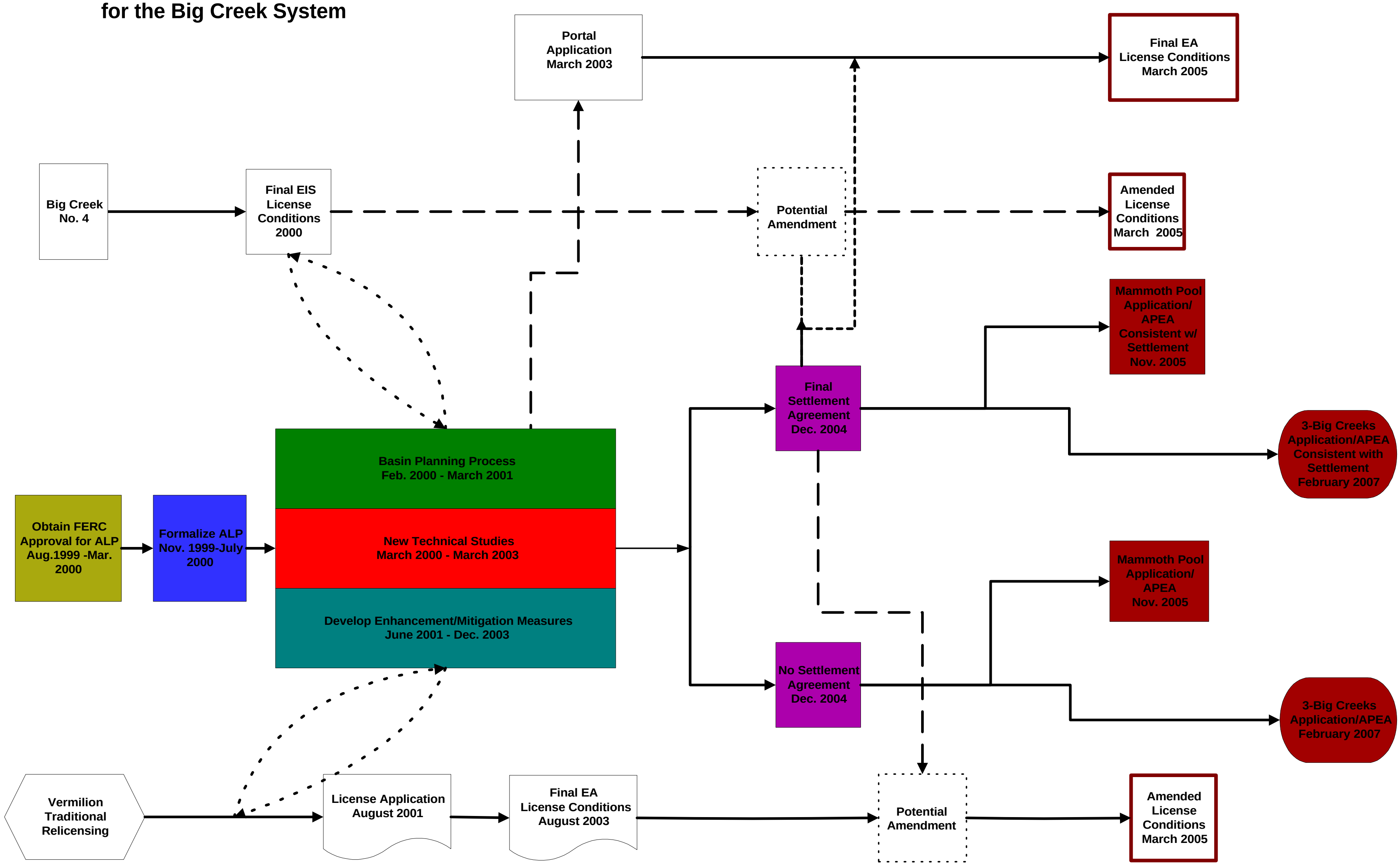
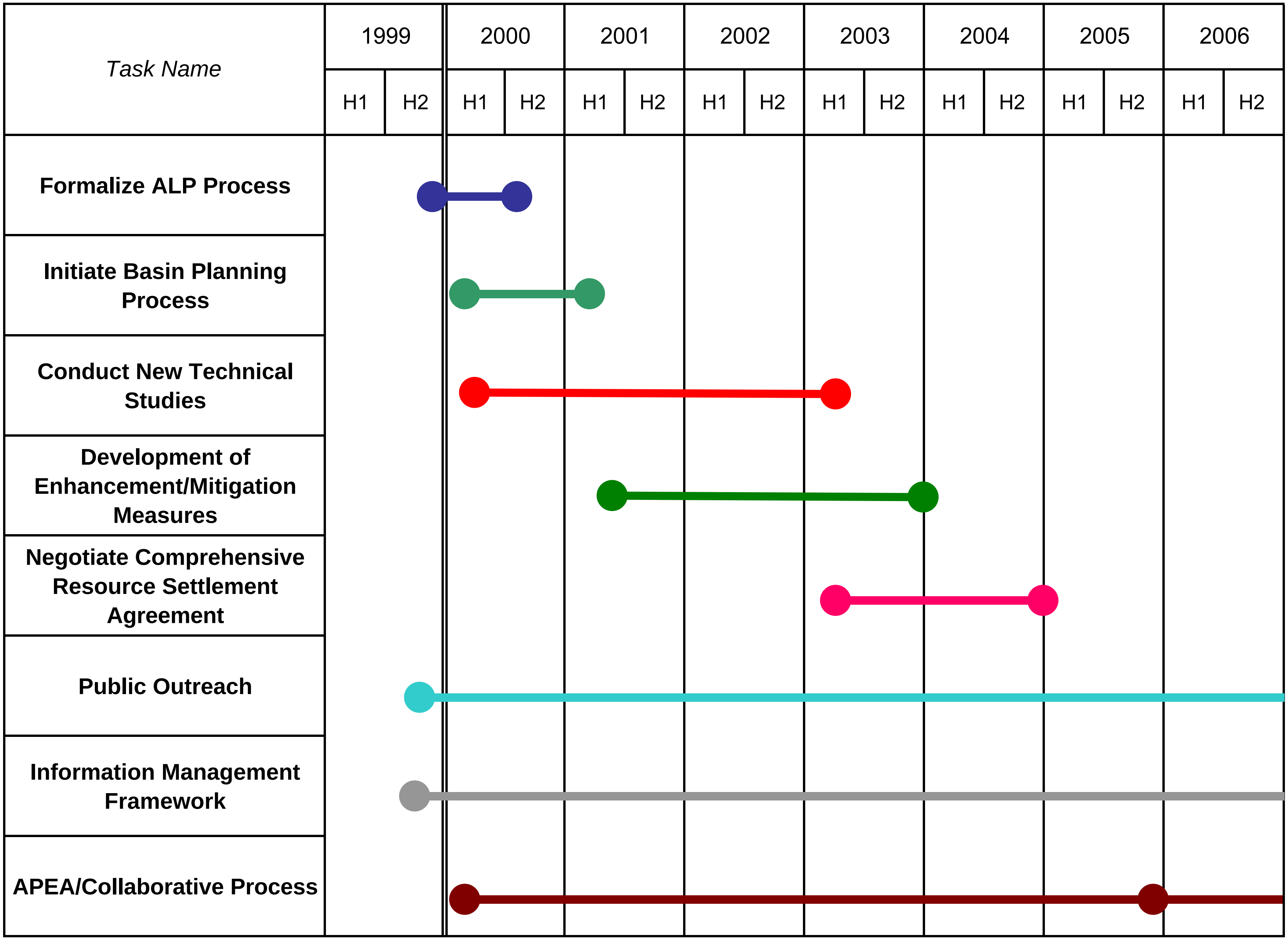


Figure ES-4. Alternative Licensing Process Schedule



4. Development and prioritization of protection, mitigation and enhancement measures (i.e., identification of resource management alternatives and evaluation of tradeoff opportunities) by December 2003;

5. Development and negotiation of a comprehensive resource settlement agreement supported by a consensus of the stakeholders and consistent with other associated regulatory processes (i.e., identification of terms and conditions for new licenses) by December 2004;

6. Submittal of an APEA and license application for each of the licenses formally included in the ALP starting in November 2005, along with any appropriate requests for license amendments for other traditionally relicensed projects within the Basin.

Stakeholder Involvement and Communication in the ALP

Communications and active public involvement are inherent to the ALP approach. By selecting this relicensing process, SCE commits to providing the public with ample opportunity to participate and to communicate their interests. In addition, SCE will offer a variety of mechanisms to inform stakeholders of progress, as the process unfolds. To ensure a basic and consistent level of public involvement and awareness, SCE will implement the following actions.

- Maintain a formal mailing list of interested stakeholders who will receive official relicensing documents and updates.

- Conduct formal, advertised public meetings throughout the process to solicit input.

- Develop and maintain a web site offering a full range of information.

- Maintain a public information library (the Relicensing Room) at Big Creek to complement FERC's Public Reference room in Washington DC.

- Conduct ongoing public education activities related to relicensing at local clubs, recreation group meetings, fairs, school events, etc.

- Provide a report every six months summarizing progress as required by FERC.

In addition to the above, there are other avenues of involvement and communication available to the public. Stakeholders, representing a cross-section of interests, are invited to participate directly on the ALP "collaborative" team. These stakeholders (estimated to total approximately 20 to 40) will provide a consistent and long-term commitment of time and energy to a structured collaborative planning process. The goals of this process will be to: identify issues regarding project impacts; determine and review studies; and work toward a mutually acceptable settlement in regard to protection, mitigation and enhancement measures. This team will engage in its work at both the Plenary level (all participants meeting at least once per month) and at the Working Group level where groups will be assigned by the Plenary to tackle specific technical assignments.

Another segment of Big Creek stakeholders (approximately 100 to 200) are likely to want to engage in relicensing activities at critical points, but not on a consistent basis, and to be regularly informed on progress and decision points. To meet these stakeholders needs, SCE intends to undertake the following actions.

- Hold periodic informational meetings in Fresno and in Big Creek to update stakeholders on ALP progress and to gather ongoing input on relicensing. This will provide a crucial feedback loop to help SCE and the collaborative group keep in touch and address any potential issues in a timely manner.

- Distribute summaries from collaborative meetings four times a year.

NORTH FORK STEVENSON CREEK

Description of Big Creek Basin Resources

Basin Geography

The Big Creek System Basin is located in Central California on the west slope of the Sierra Nevada Range (in Fresno and Madera counties) within the Sierra National Forest about 25 miles northeast of the City of Fresno. Yosemite National Park, a popular tourist destination in central California, is located approximately 20 miles north of the Basin, and Kings Canyon National Park is located approximately 20 miles south. The Basin lies within the upper San Joaquin River watershed. The Big Creek System facilities range in elevation from approximately 1,000 feet msl to 9,000 feet msl. Pacific Gas and Electric's (PG&E's) Kerckhoff Project and the US Bureau of Reclamation's Friant Dam (Millerton Reservoir) are located southwest and downstream of the Basin. PG&E's Crane Valley Project is located northwest of the Basin.

Four Wilderness areas are located within or partially within the Basin. These include: Ansel Adams Wilderness (surrounding Lake Thomas A. Edison and extending to the northern tip of Mammoth Pool Reservoir), John Muir Wilderness (surrounding Florence Lake), Kaiser Wilderness (located immediately north of Huntington Lake), and Dinkey Lakes Wilderness (located between Florence and Shaver lakes, and southeast of Huntington Lake).

Climate

The Basin's Mediterranean climate (comprised of cool, moist winters and warm, dry summers) is variable due to the area's range in topography. Temperature decreases and precipitation increases substantially with increasing elevation. The average annual precipitation in the area (rain and snow) is about 42 inches, with over half falling in January, February and March. Higher elevations may receive over 80 inches of precipitation (mostly snow), while lower elevations receive about 20 inches of rainfall each year (USFS 1991b). The snowmelt period is typically from April through July.

Geology and Soils

The Sierra Nevada is comprised predominantly of granitic rock of the Sierra Nevada batholith. The granitic intrusion metamorphosed older overlying sedimentary and volcanic rocks, which are observed today as roof pendants on the high peaks. Periods of extensive weathering and glaciation formed the current topography and geologic features in the region. Glacial deposits exist only in the eastern half of the Basin above 6,000 feet msl. Excellent examples of terminal moraines from the retreat of the glaciers can be seen at Lake Thomas A. Edison. Limited outcroppings of young volcanics occur near Lake Thomas A. Edison, Mammoth Pool Reservoir, and Huntington Lake. Older metavolcanics are exposed just south and east of Florence Lake. Although portions of the Sierra Nevada are still tectonically active, no known active or po-

THE WATERSHED ABOVE FLORENCE LAKE EXHIBITS THE EFFECTS OF GLACIERS tentially active fault zones are located within the Basin.

Soil development in the Sierra Nevada is generally poor due to the area's cold winter temperatures, steep slopes, dry summers, resistant parent materials, and the short time period since deglaciation. Medium to coarse-grained sands, and large boulders make up most of the substrate in the watercourse drainages in granitic watersheds.

Water Quality and Use

Water quality within the Basin is generally of high quality and conforms with the water quality objectives and standards for beneficial uses. The area's surface waters are low in mineral and nutrient content, which is characteristic of regions composed of granitic bedrock with shallow infertile granitic soils. The existing and potential beneficial uses that apply to surface waters within the Big Creek watershed include: municipal and domestic water supply; agricultural uses (irrigation and stock watering); hydroelectric power generation; recreation; cold and warm freshwater fish habitat; and wildlife habitat.

HORSESHOE BEND REACH OF THE SAN JOAQUIN RIVER

The water-year types in the Basin for the period from 1960 to 1999 display high inter-annual variability with slightly more than half of the years (51 percent) being wet or above normal water-year types. The greatest percentages of water-year types were extreme, either wet (38 percent) or critically dry (28 percent).

The combined storage of the Big Creek System's reservoirs and forebays is only about one-third (560,000 acre-feet) of the average annual runoff in the watershed (about 1,700,000 acre-feet). The small storage capacity relative to average runoff through the Basin often results in spills from System reservoirs, especially in lower parts of the Basin. The streamflow in the Basin responds rapidly to rainfall, snowmelt, and rain on snow events. During the snowmelt season, the peak flow may last one to two months, but runoff returns to controlled flow after that point.

Fisheries Resources

Fish communities in the Basin represent several community types that correspond to the area's range of elevations, gradients and habitat conditions. Generally, Basin waters at higher elevations are cooler and favor various species of trout. At lower elevations, warmer conditions favor native minnows and suckers. Trout species are present in most Basin waters. The only fish species of special status in the Basin is the hardhead (California Department of Fish and Game - Species of Special Concern, Sierra National Forest - Sensitive Species Status).

Fish stocking has resulted in the introduction of a wide variety of species throughout the Basin including non-native rainbow trout, brown trout, brook trout, golden trout, and kokanee, large-mouth bass, and smallmouth bass. The upper reaches of the San Joaquin watershed, above 5,000 feet msl, were originally barren of fish, owing to precipitous upstream access.

Botanical and Wildlife Resources

The diverse botanical resources of the Basin consists of 19 general vegetation community types, of which nine are categorized as forest or woodland, five are shrub and grassland-meadow types, two are wetland types, and three are riparian vegetation types. Eight special-status plant species are known to occur in the vicinity of the projects, including: tree-anemone, Mono Hot Springs evening primrose, subalpine fireweed, Yosemite ivesia, Hall's wyethia, prairie wedge grass, flaming trumpet, and Madera linanthus.


STEVENSON MEADOW NEAR SHAVER LAKE, RESTORED BY SCE

Wildlife resources in the Basin include special status species, resident and migratory populations of general wild-life species, and species considered locally important. Species considered locally important include game species and raptors. Mule deer are the most important big game species in the region. There are also several important game birds in the Basin, including band-tailed pigeon, mountain quail, California quail, and wild turkey. Raptor species present in the Basin include eagles, owls, vultures, hawks, and falcons.

Twenty-two special status wildlife species are known to occur in the vicinity of the projects, including: one invertebrate (valley elderberry longhorn beetle); one reptile (western pond turtle); four amphibians (foothill yellow-legged frog, mountain yellow-legged frog, Mount Lyell salamander, and Yosemite toad); thirteen birds (double-crested cormorant, Cooper's hawk, northern goshawk, golden eagle, Swainson's hawk, bald eagle, osprey, prairie falcon, American peregrine falcon, long-eared owl, great grey owl, willow flycatcher, and California spotted owl); and three mammals (Sierra Nevada red fox, Pine marten, and Pacific Fisher).

Historic and Archaeological Resources

Cultural resources in the Basin include physical resources and intangible cultural values pertaining to archaeology, ethnography (Native Americans), history, and paleontology.

The upland reaches of the Southern Sierra Nevada range (3,000 feet msl and above), including most of the Big Creek System Basin, were sporadically utilized by prehistoric peoples from about 7,000 years before present until relatively late prehistoric times. Traditional and cultural values of importance to contemporary descendants of Native peoples include: archaeological sites; prehistoric trails; natural features such as hot springs and other places of religious or social importance; and native plants and animals used for food-stuffs, building or craft materials, medicines, or that figure prominently in Native American myths or legends.

POWERHOUSE NO. 1 ON FIRST DAY OF OPERATION, DECEMBER 1913

The Anglo period of influence in the Basin coincided with the discovery of gold in the lower San Joaquin Basin (1850) and establishment of foothill homesteads (1860's and 1870's). In the late 19^{th} century to early 20^{th} century, grazing and commercial logging were major activities in the area. The development of the Big Creek Hydroelectric System began in 1911 and continued through 1987.

Several of the Big Creek System facilities are eligible for the National Register of Historic Places including: 1) dams associated with Huntington Lake, Florence Lake, and Shaver Lake, and powerhouse forebays (Dam Nos. 4, 5, and 6); 2) project tunnels (Ward, Mono/Bear, and Nos. 2, 3, 7 and 8); and 3) powerhouses, penstocks, incline railroads and surge chambers associated with Big Creek Nos. 1, 2, 2A, 3 and 8.

Recreational Resources

The Basin provides a wide range of activities for outdoor enthusiasts. Popular activities in the Basin include scenic motor vehicle and bicycle rides, foot and horseback trail activities, camping, winter sports, flatwater sports, whitewater recreation, angling, hunting, off-highway vehicle drives, rock climbing and resort use. Popular recreation activities within the Basin are briefly described below.

CAMP EDISON, PROVIDED BY SCE, OFFERS DEVELOPED RECREATION OPPORTUNITIES AT SHAVER LAKE

There are several scenic drives in the Basin. The Sierra Vista Scenic Byway traverses through the western portion of the Basin. State Highway 168 provides the principal access to Shaver Lake, Huntington Lake, and through Kaiser Pass to the backcountry areas. The Basin offers several off-highway vehicle (OHV) routes for four-wheel drive enthusiasts ranging in length from two to over 30 miles.

The most famous trail in the Basin is the Pacific Crest National Scenic/John Muir Trail. The San Joaquin River Trail System also traverses through the northern portion of Basin. In addition, almost every major lake and reservoir within the Basin has its own system of trails.

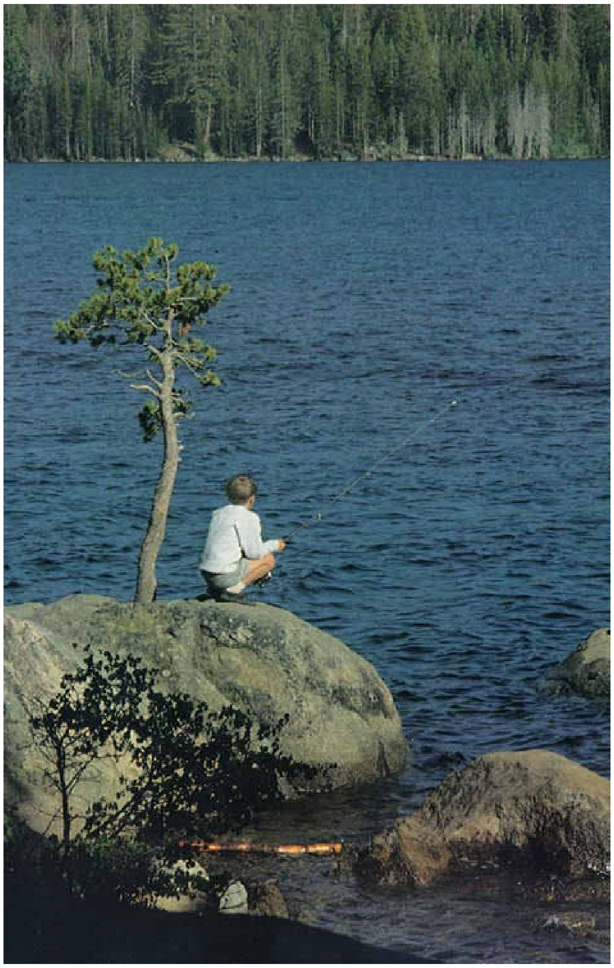
The Basin offers numerous camping and day-use facilities that are usually open from early summer through fall. The Big Creek System reservoirs serve as the base for many of these camping and day-use facilities. A large number of semi-primitive camping areas are scattered throughout the Basin on Forest lands.

The Basin offers a variety of winter sports resources including downhill skiing, snowboarding, cross-country skiing, snowshoeing, snowmobiling and snow camping.

The Basin lakes and reservoirs support a variety of recreational activities (boating, sailing, angling, water skiing, jet skiing, and swimming). Whitewater boating activities take place on various sections of the San Joaquin River flowing into, or between, the Big Creek System reservoirs.

HUNTINGTON LAKE

Almost all waters in the Basin support some type of fishing opportunity. In the upper elevations, the Basin's lakes, streams and rivers provide angling opportunities primarily for trout. In middle to lower elevations, the fisheries provide mixed cold-water and warm-water angling resources (rainbow trout, brown trout, Kokanee salmon, largemouth bass and smallmouth bass). Hunters have many popular species available in the Basin


THE BASIN OFFERS NUMEROUS ANGLING OPPOTUNITIES SUCH AS THOSE ON SHAVER LAKE

including deer, black bear, valley and mountain quail, band-tailed pigeon, wild turkey, Western grey squirrel, bobcat and coyote.

Land Management

Existing uses of the land within the Basin are primarily rural, including: communities and private residences, hydroelectric power generation, range land, timber production, mining, research areas, floodplains, Wilderness areas, recreation and transportation systems. Land holdings in the Basin consist predominantly of federal land in the Sierra National Forest with some private in-holding parcels. Most communities and rural residences are concentrated in the western portion of the Basin near Shaver Lake and adjoining Highway 168, Huntington Lake, Meadow Lakes and North Fork. Planned land uses within the Basin are jurisdictionally intended uses, and therefore they must comply with the USFS's *Sierra National Forest Land and Resource Management Plan* (Forest Plan), the *Fresno County General Plan* and the *Madera County General Plan*.

Southern California Edison Company (SCE) intends to relicense its hydroelectric projects located in California's upper San Joaquin River watershed, about 25 miles northeast of the City of Fresno and about 250 miles northeast of Los Angeles (Figure 1-1). SCE intends to accomplish this through filing new license applications with the Federal Energy Regulatory Commission (FERC), using the Alternative Licensing Process (ALP) for four of these projects. These four hydroelectric projects include the Big Creek Nos. 1 & 2 (FERC No. 2175), Big Creek Nos. 2A, 8 and Eastwood (FERC No. 67), Big Creek No. 3 (FERC No. 120) and Mammoth Pool (FERC No. 2085). Three other SCE hydroelectric projects in the watershed are undergoing the Traditional Relicensing Process. These projects are Big Creek No. 4 (FERC No. 2017), Vermilion Valley (FERC No. 2086), and Portal (FERC No. 2174). Collectively, the seven hydroelectric projects are referred to as the Big Creek System. The area encompassing the seven Big Creek projects is called the Big Creek System Basin (Basin). SCE's seven hydroelectric projects within the Basin have a combined dependable operating capacity of about 1,000 megawatts (mW).

On December 9, 1999, SCE filed a formal request with the FERC, as outlined in 18 CFR Part 4.34(i) Alternative Procedures, to employ the ALP for the four aforementioned hydroelectric projects. SCE received approval from the FERC to utilize the ALP for the Big Creek projects on March 15, 2000. The ALP is allowed under the FERC's Order 596 (final rule issued on October 29, 1997; Docket No. RM95-16-000: Order No. 596). Appendix A presents SCE's ALP request, as filed, and Appendix B presents the FERC's written approval for using the ALP.

SCE prepared this Initial Information Package (IIP) as a reference document for the entire Big Creek System, even though only four projects are being relicensed under the ALP. The IIP is intended to help those interested in the relicensing of the Big Creek projects gain a better understanding of the ALP, the Big Creek System's facilities and operations, and the related environmental resources found in the Basin.

As described in more detail in Section 2, the ALP is designed to combine into a single process, the consultation with resource agencies required prior to a licensee filing an application with the FERC for a new hydroelectric project license and the environmental review process required by federal and state laws. Additionally, the ALP is intended to facilitate greater participation, improve communication, and promote cooperative efforts among individuals and organizations interested in the relicensing of the hydroelectric projects. A goal of the ALP is to develop a settlement agreement among the ALP participants for presentation to FERC as a part of the license application.

SCE invites comments on this IIP. Written comments should be clearly identified as "**Comments on the Initial Information Package for the Big Creek Hydroelectric System**" and include the commenter's name, affiliation or organization represented (if applicable), address, phone number and e-mail address.

Please submit comments to:

Licensing Coordinator
Southern California Edison Company
Northern Hydro Region Office
P.O. Box 100
Big Creek, CA 93605

Placeholder for Figure 1-1
Big Creek Hydroelectric
Relicensing Basin and Watershed

<u>Non-Internet Public Information</u>

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1.1 ORGANIZATION OF THE IIP

This IIP is organized into the following sections:

Executive Summary

This section provides an overview of the information presented in the IIP.

Section 1.0 Introduction

This section briefly introduces the relicensing project, and describes the overall organization of the document.

Section 2.0 Regulatory Framework

This section describes the traditional and alternative FERC licensing processes, including a discussion of associated regulatory processes. SCE's specific relicensing approach for the Big Creek System is also discussed.

Section 3.0 Description of the Big Creek System

This section describes the Big Creek System, its development history, as well as each of the individual projects, the associated facilities, and the project operations and constraints. The existing environmental programs, measures and facilities maintained by SCE also are presented.

Section 4.0 Description of Big Creek System Basin Resources

This section describes the general environmental resources of the Big Creek System Basin, including: geography, topography, climate and air; geology and soils; water use and quality; fisheries; botany and wildlife; historic and archeological resources; recreational resources; and land management.

Appendices

The appendices present supplementary information, including: SCE's ALP request and draft communication protocol; the FERC's approval of the proposed ALP; detailed descriptions of project components; water quality information; water use tables and exceedance graphs for Basin gaging stations; fisheries resource tables; and botanical and wildlife special status species lists.

2.1 GENERAL OVERVIEW

Under the Federal Power Act (FPA), the FERC has the authority and responsibility for regulating non-federally owned hydroelectric power projects. The majority of FERC regulations governing the process of relicensing major constructed hydroelectric projects are contained in Title 18 of the Code of Federal Regulations, Part 16 (18 CFR Part 16). Other applicable FERC regulations can be found in other parts of Title 18 of the Code of Federal Regulations.

The seven Big Creek hydroelectric projects owned by SCE in the upper San Joaquin River watershed are operated and maintained in accordance with terms and conditions specified in individual licenses issued by the FERC for each of the hydroelectric projects. Each project license specifies the project description and boundaries, the constraints and limits of project operations, and describes the engineering, safety and environmental protection requirements specific to the project. The licensee (SCE, in the case of the Big Creek System) must comply with each term and condition in the license to generate hydroelectric power. Each project license issued by the FERC has a specified term, generally 30 to 50 years, during which the licensee can operate the hydroelectric project.

A minimum of five years prior to the expiration of a project license, a licensee that wishes to obtain a new license is required to formally initiate a consultation process for the preparation, filing, and processing of a new license application for an existing hydroelectric project. This process, referred to as the relicensing process, has specific regulatory deadlines and requirements, which must be met by the licensee. These requirements include: filing of notifications at key milestones; submittal of required documents; consultation with state and federal resource agencies and Native American tribes; obtaining comments from the public; and filing a license application with the FERC two years prior to the expiration of the project license. The licensee also is responsible for complying with all laws, statutes and regulations that may apply to the project on a federal or state level. Among the laws that must be complied with during the relicensing process are the Endangered Species Act (ESA), National Historic Preservation Act (NHPA), Wild and Scenic Rivers Act (WSRA), Clean Water Act (CWA), Fish and Wildlife Coordination Act (FWCA), and Americans with Disabilities Act (ADA). In addition, special rules come into play when a project includes lands that are part of a federal reservation. Federal reservations can include National Forests, Defense Department bases, and Native American reservations, among others. These rules allow the federal agency responsible for managing the reservation to set conditions for the FERC license for the protection and utilization of the federal reservation.

The FERC staff's role in the relicensing process is to conduct an independent analysis of license applications to determine if a new license should be issued and what terms and conditions will be included as part of any new license. The FERC staff is responsible for conducting the analyses in accordance with FERC regulations and consistent with the National Environmental Policy Act of 1969 (NEPA). The new license issued by the FERC describes the terms and conditions that the licensee must adhere to over the life of the new license.

The FPA requires the FERC to evaluate license applications based on an equal consideration of both power and non-power values associated with a project. Non-power values include environmental, cultural, recreation, fish, and wildlife values affected by the project. The FPA also requires the FERC to consider whether a project is consistent with federal and state comprehensive plans applicable to the project area. Further, the impact analysis and mitigation must focus on the ongoing impacts of the project as it currently exists.

2.2 DESCRIPTION OF THE FERC RELICENSING PROCESS OPTIONS

FERC regulations governing the relicensing of an existing hydroelectric project allow the licensee to select either the Traditional Relicensing Process or the Alternative Licensing Process to prepare, file, and process a new license application. Briefly, the primary differences between the traditional and alternative processes are: 1) the extent and timing of participation and collaboration among stakeholders during the relicensing effort; and 2) the timing/sequencing of the FERC's and other regulatory agencies' environmental review processes.

Under the Traditional Relicensing Process, the licensee prepares and submits a license application to the FERC presenting information about the project, the resources in the project area, and the licensee's protection, mitigation and enhancement proposals along with those measures proposed by other parties, but not adopted by the licensee. After submittal of the license application, the FERC embarks upon an independent environmental review of the project. During this time, resource agencies, Native American tribes, the public and the licensee can provide comments to the FERC and other parties to the relicensing. However, a collaborative process is typically not used throughout the process to discuss the potential license terms and conditions submitted to the FERC. The Traditional Relicensing Process was previously the only process available to a licensee. This licensing approach is still available for use with any project.

The ALP empowers the licensee and stakeholders to: collaboratively design the consultation process for the relicensing effort; jointly propose license terms and conditions, possibly in a negotiated settlement agreement submitted to the FERC with the license application; and combine the pre-filing consultation process with many of the FERC's NEPA requirements. The ALP encourages greater public involvement and provides an opportunity for the licensee and stakeholders to tailor the process to address and resolve specific issues and streamline procedural compliance with multiple federal laws that are involved in the relicensing process. The ALP is intended to expedite the licensing process through combining pre-filing consultation and environmental review processes.

The following provides a more detailed description of the ALP.

2.2.1 Alternative Licensing Process

In October 1997, the FERC issued new rules that permit alternative approaches to the Traditional Relicensing Process. The primary distinction between the traditional approach and the alternative approach results from how the two processes accommodate compliance with NEPA. The ALP allows licensees to customize their relicensing process by combining the FERC's "traditional" consultation process that takes place prior to the licensee filing of a license application with the environmental review of the NEPA process. Consultation, review and studies required by laws other than NEPA also are conducted during the pre-filing period (Pacific Power 1999).

The FERC allows the licensee to prepare an Applicant Prepared Environmental Assessment (APEA) document to meet the requirements of NEPA. The draft APEA is filed with the FERC along with the license application. Thus, scoping activities associated with NEPA are performed early in the alternative process, whereas in the traditional process they occur at the end, after the final application has been filed. NEPA compliance involves collaborative decisions and agreement by the participants regarding the scope and extent of the APEA and its supporting studies and analyses. An atmosphere of cooperation, trust, and support for the alternative approach among relicensing participants is essential to the success of this relicensing effort.

Formal approval for the use of the ALP must be obtained from the FERC. To use the ALP, the licensee must lay the framework for developing a consensus-based license application. As with traditional relicensing, the licensee must file a Notice of Intent (NOI) to apply for a new license. However, under an alternative process, the licensee must also discuss the project with stakeholders to determine if there is a consensus to proceed using an ALP. If a consensus to proceed is reached between stakeholders, the group develops a formal communications protocol. This protocol governs how the stakeholders will communicate with all relicensing participants, including FERC staff and other interested parties, throughout the multi-year process. Once the FERC approves the use of an ALP, the licensee, at a minimum must conduct the following steps:

- prepare and distribute an IIP containing information on the project works, operations, and environmental resources;
- conduct an initial information meeting open to the public;
- conduct cooperative scoping of environmental issues with all participants, including the selection and design of required scientific studies;
- prepare and file with the FERC a status report every six months; and

- prepare and submit an APEA (preliminary draft NEPA analysis) with the final license application.

NEPA scoping can be initiated following approval by the FERC of the ALP. The objective of NEPA scoping is to define the resource issues of concern and assess what scientific information will be needed to develop a strategy for resource use. Scoping is one of the most important aspects of the process and involves working cooperatively to identify project issues and alternatives and develop the best method for resolving issues. An Initial Scoping Document (ISD) is prepared based on information from the scoping meetings.

Implementation of the study plans described in the ISD usually requires one to two years. As the studies are completed, the licensee provides the study results to relicensing participants and to the FERC. Based on the results of the studies, the licensee, in collaboration with the stakeholders, prepares a preliminary license application and a draft APEA. In the draft APEA, the licensee includes an analysis of proposed license terms and conditions. The draft APEA must also include an analysis of alternative projects and an identification of a preferred alternative as well as an analysis of the resource impacts of a "no-action" alternative.

The licensee then presents the draft license application and draft APEA to all relicensing participants for additional review and comment. This comment period is typically 60 days. To facilitate comments, the licensee may hold meetings to discuss disagreements, if needed. The licensee incorporates any comments into the license application and APEA.

The ALP may include the development of settlement agreements between relicensing participants. A settlement agreement may include a preferred set of proposed license terms and conditions that have been agreed upon by relicensing participants. Ideally, any settlement agreements would be included in the license application and APEA and be used by the FERC as a basis for the new license terms and conditions.

Once the licensee formally submits the Application for New License and APEA, the FERC staff reviews the submission for adequacy in terms of content and analysis. Once deemed adequate, the FERC issues a Notice of Acceptance and, simultaneously, formally requests any final proposals for license terms and conditions from interested entities and relicensing participants.

The FERC staff may modify the APEA, and include additional analyses of project alternatives and resource mitigation measures, if needed. The FERC thenissues the draft Environmental Assessment (EA) as a FERC document that contains preliminary license terms and conditions. Unless challenged, the terms and conditions in the draft APEA typically are incorporated into the new license.

2.3 Associated Regulatory Processes

Regardless of the relicensing process utilized by the licensee, certain state and federal agencies have the regulatory authority to require the FERC to include additional “mandatory conditions” in the new license. Three regulatory agencies have mandatory conditioning authority in the relicensing of projects within the Big Creek System, namely the United States Forest Service (USFS), the United States Fish and Wildlife Service (USFWS), and the State Water Resources Control Board (SWRCB). These mandatory conditioning agencies typically conduct an independent evaluation of the license application to determine the adequacy of the proposed mitigation measures. The USFS under Section 4(e) of the FPA is charged with establishing license conditions deemed necessary for the adequate protection and utilization of the Sierra National Forest (Forest). The USFWS has authority under FPA Section 18 to prescribe fishways (fish passage) for a project. The SWRCB under Section 401 of the Clean Water Act is required to certify whether a project meets the state’s water quality standards.

In the Traditional Relicensing Process, these evaluations conducted by the mandatory conditioning agencies (USFS, USFWS and SWRCB) are completed after the licensee has submitted the license application to the FERC. The SWRCB is required to complete a review process and provide 401 Certification, outlining any mandatory conditions, or waive Certification within one year after requested by the licensee. Under NEPA, the USFS can act as a cooperating agency with the FERC, but often the USFS prepares a separate NEPA document. The USFS is required to submit their proposed conditions within 60 days after the FERC deems that the license application is ready for environmental review. The FERC typically requires a minimum of one year to make this determination, and the determination often takes substantially longer if Additional Information Requests (AIRs) are required of the licensee (i.e. detailed analyses or new field studies).

The FERC incorporates mandatory conditions provided by the SWRCB, USFWS and USFS into the new license. In the ALP, participating mandatory conditioning agencies may move forward their environmental review process with the intent of completing these processes shortly after submittal of the license application and APEA. The collaboratively developed APEA and any settlement agreements are intended to serve as the guiding documents for these other regulatory processes. If the collaborative process is successful, the APEA and any settlement agreements should incorporate all terms and conditions deemed appropriate for protection of project resources. Therefore, the USFS, SWRCB and the FERC processes should be greatly expedited.

2.4 SCE’s Relicensing Approach for the Big Creek System

In the Big Creek System, SCE is utilizing both the Traditional and Alternative Licensing Processes. Figure 2.4-1 presents the Big Creek System with FERC project boundaries, major project facilities and associated waterways. Expiration

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Placeholder for Figure 2.4-1
Big Creek Basin Proposed FERC Re-licensing Boundaries

<u>Non-Internet Public Information</u>

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dates of the FERC licenses for these projects range from 1999 to 2009, as listed in Table 2.4-1 The following describes SCE's relicensing approach for the projects comprising the Big Creek System.

Table 2.4-1 Southern California Edison Company Hydroelectric Projects in the Upper San Joaquin Basin

Project Name	FERC Project Number	License Expiration Date	Exhibit M Generator Capacity (MW)	Dependable Capacity (MW)
Big Creek No. 4	2017	February 28, 1999[1]	100.00	100.20
Vermilion Valley	2086	August 31, 2003[2]	--	--
Portal	2174	March 31, 2005[3]	10.80	10.50
Mammoth Pool	2085	November 30, 2007	190.00	187.00
Big Creek Nos. 1 & 2	2175	February 28, 2009	154.85	150.00
Big Creek Nos. 2A, 8 and Eastwood	67	February 28, 2009	384.80	370.00
Big Creek No. 3	120	February 28, 2009	174.45	181.90

[1] Big Creek No. 4 is operating under an annual license. A license application prepared under the Traditional Relicensing Process was filed in 1997.

[2] Vermilion Valley is in 2nd Stage Consultation of the Traditional Relicensing Process.

[3] The NOI for Portal was filed with the FERC in March 2000.

2.4.1 Traditional Relicensing Process in the Big Creek System

The Traditional Relicensing Process has been initiated by SCE for three Big Creek hydroelectric projects including Big Creek No. 4, Vermilion Valley and Portal. SCE submitted the Application for New License for Big Creek No. 4 (FERC Project No. 2017) to the FERC in February 1997. The FERC has conducted scoping meetings and a site visit, issued AIRs, and has noticed that it will prepare an Environmental Impact Statement (EIS) for Big Creek No. 4. The Big Creek No. 4 Project has been operating on annual licenses issued by the FERC since February 1999 (original license expiration date), pending completion of the FERC's NEPA process.

The Traditional Relicensing Process was initiated for the Vermilion Valley Project (FERC No. 2086) in August 1998 with the submission of a NOI by SCE. First Stage Consultation for the Vermilion Valley Project was completed in December 1999. Currently, the project is in the Second Stage Consultation phase with field studies scheduled for summer and fall 2000 and the license application scheduled for submittal to the FERC in August 2001.

SCE initiated First Stage Consultation on the Portal Project (FERC Project No. 2174) in March 2000 with the submittal of a NOI to the FERC. SCE intends to use the Traditional Relicensing Process for the Portal Project. The First Stage Consultation document for the Portal Project will be distributed to interested parties in summer 2000 followed by the joint agency/public scoping meetings and site visit. The new license application for the Portal Project must be submitted to the FERC by March 2003.

The selection of the Traditional Relicensing Process for the Vermilion Valley and Portal hydroelectric projects was necessary to ensure that SCE could meet the FERC's regulatory deadlines for consultation, project scoping and submission of applications for new licenses by August 2001 and March 2003, respectively. These licenses, along with Big Creek No. 4, were not selected for "formal" inclusion in SCE's ALP for the Big Creek System. The reason is that the anticipated timing for completing the negotiation phase (the target date for any settlement agreement is December 2004) and license application phase (the target date for an APEA ready for use with Mammoth Pool application filing is November 2005) of the Big Creek ALP is several years after the deadline for submittal of these earlier license applications. SCE is required by FERC regulations to meet the filing deadlines for submission of new license applications or risk losing the right to operate these hydroelectric projects in the future.

Despite the regulatory constraints, SCE recognizes that the common ownership and the location of the seven projects within one watershed basin provide an unique opportunity to address complex resource balancing issues within a single process. Therefore, SCE intends to analyze all seven hydroelectric licenses during the Basin planning process for the Big Creek ALP. Further, SCE acknowledges that any settlement agreement and the APEA developed in the Big Creek ALP may recommend protection, mitigation and enhancement measures for the three licenses undergoing the Traditional Relicensing Process (Big Creek No. 4, Vermilion Valley, and Portal) to take advantage of any appropriate mitigation trade-off opportunities within the Basin. SCE will request the FERC amend these early licenses, if necessary, to modify the terms and conditions of protection, mitigation and enhancement measures consistent with any settlement agreement.

2.4.2 Alternative Licensing Process in the Big Creek System

On December 9, 1999, SCE submitted a formal request to the FERC to use an ALP for four hydroelectric projects within the Big Creek System. The four hydroelectric projects owned and operated by SCE and included in the ALP request are Big Creek Nos. 1 & 2 (FERC Project No. 2175); Big Creek Nos. 2A, 8 and Eastwood (FERC Project No. 67); Big Creek No. 3 (FERC Project No. 120); and Mammoth Pool (FERC Project No. 2085). The request followed extensive collaboration, input and support from many of the stakeholders regarding the appropriateness and design of the ALP and development of communication protocols. On March 15, 2000, the FERC approved SCE's request to follow the alternative licensing procedures for the four Big Creek hydroelectric projects. A complete copy of SCE's ALP request submittal to the FERC is provided in Appendix A and the subsequent approval letter from the FERC is provided in Appendix B, respectively.

The specific goals of the Big Creek System ALP are to:

- Combine into a single process the pre-filing consultation, the environmental review under NEPA, and administrative processes for all four projects;

- Facilitate more effective participation by, and improve communication among, SCE, resource agencies, Native American tribes, local and regional authorities, private interests, the public and FERC staff in a flexible pre-filing consultation process;

- Promote cooperative efforts between SCE and the stakeholders to share information about resource impacts and proposals for protection, mitigation and enhancement measures to narrow any areas of disagreement and reach a comprehensive settlement;

- Facilitate an orderly and expeditious review of any agreements or offers of settlement for use as a basis for protection, mitigation, and enhancement measures for new hydropower licenses; and

- Allow for the preparation of an APEA by SCE with input from the stakeholders.

A schematic overview of the relicensing approach for the Big Creek System under the approved ALP is provided in Figure 2.4-2. A schedule of key activities during the ALP is presented in Figure 2.4-3. The Big Creek ALP consists of six major elements including:

1) Formalization by the stakeholders of the collaborative process for the ALP (i.e. ground-rules, communication protocols, and dispute resolution) by July 2000;

2) Initiation and completion of a Basin planning process (i.e. identification of management objectives, key resource issues, existing information, and data gaps) by March 2001;

Figure 2.4-2

Relicensing Approach for the Big Creek System

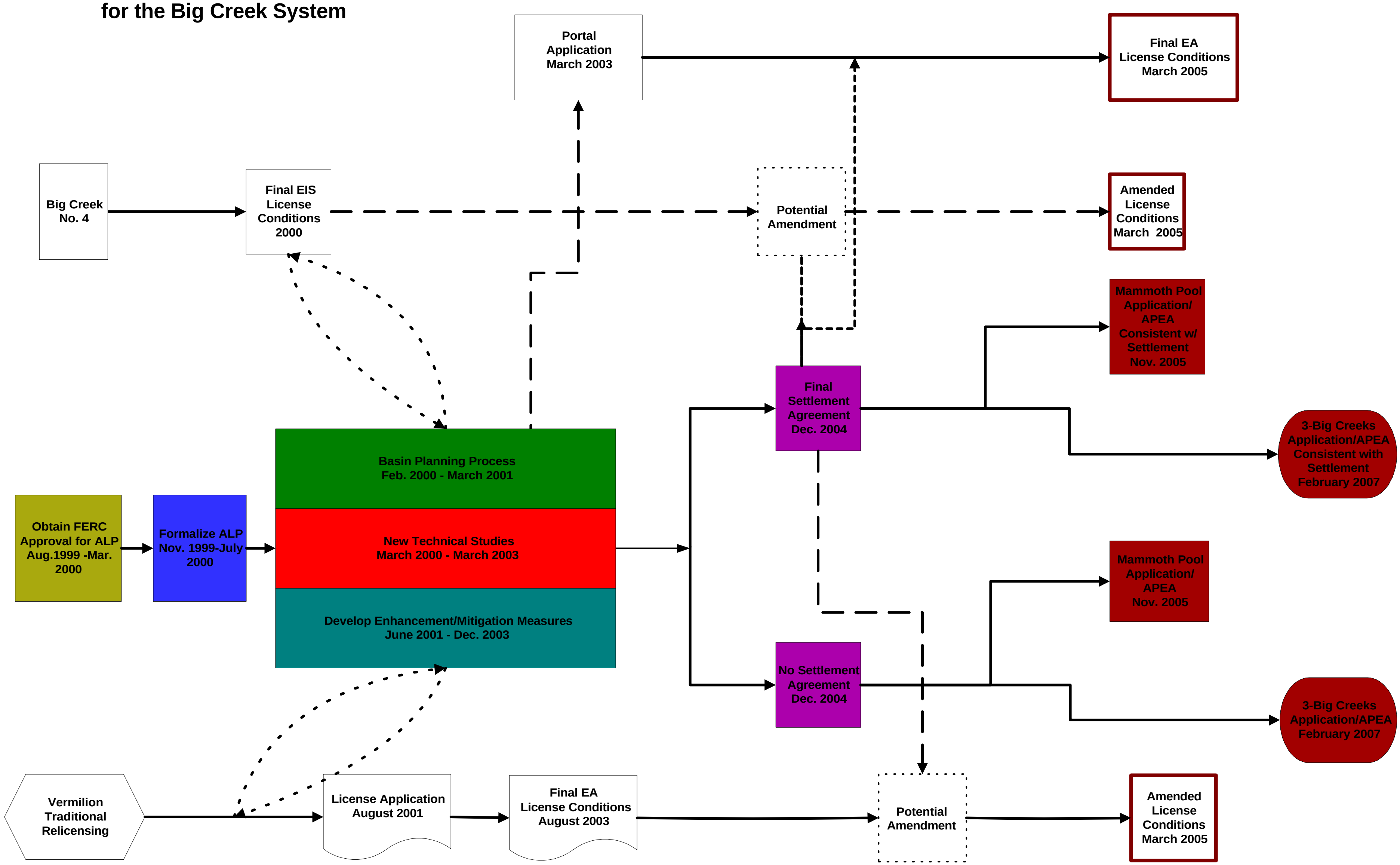
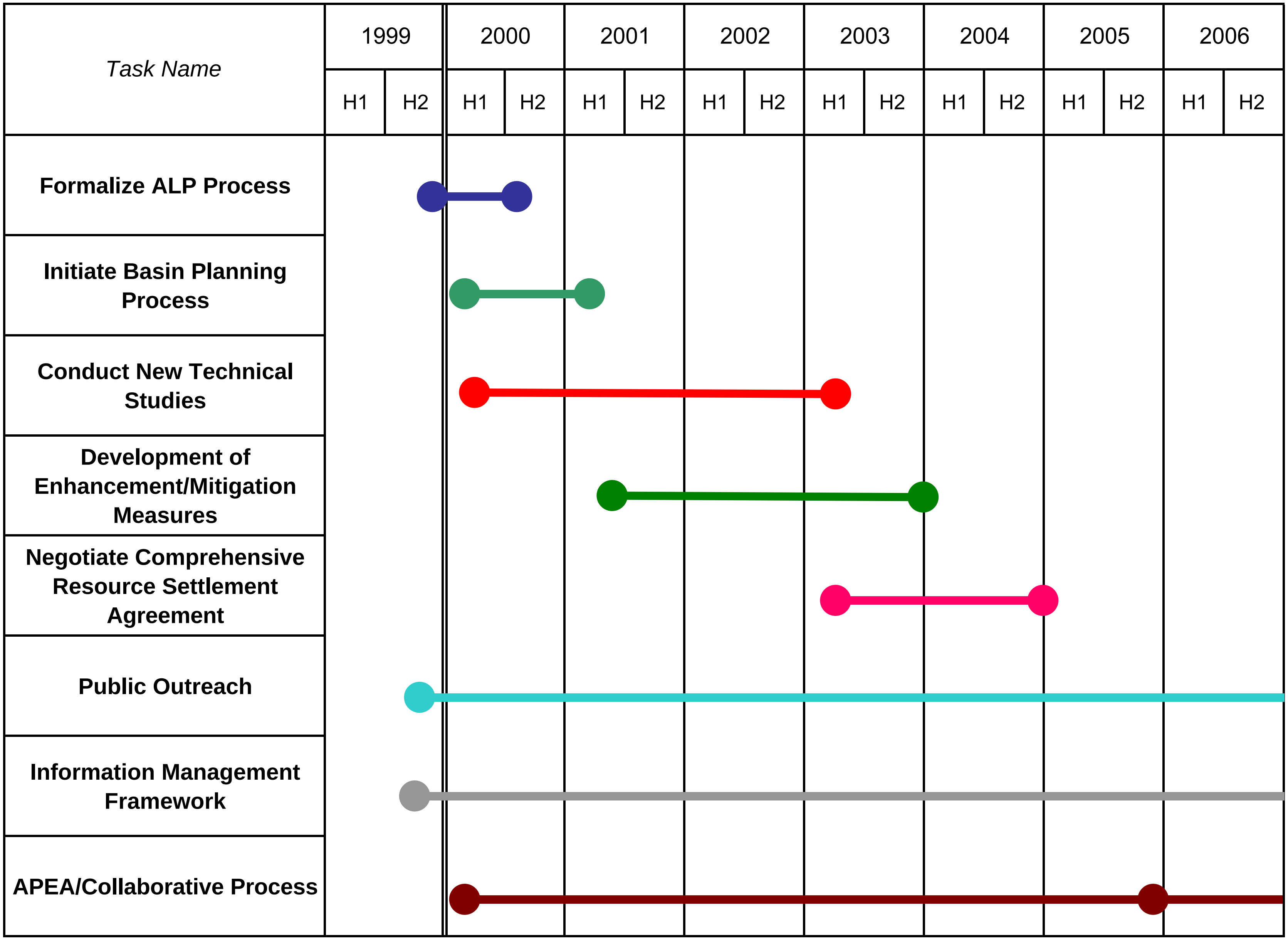


Figure 2.4-3. Alternative Licensing Process Schedule



3) Initiation and completion of a Basin planning process (i.e. identification of management objectives, key resource issues, existing information, and data gaps) by March 2001;

4) Development, implementation and interpretation of integrated technical studies for project resources (i.e. formulation of study objectives, scopes of work, study schedules, analytical methods, data analyses and presentations) by March 2003;

5) Development and prioritization of enhancement and mitigation measures (i.e. identification of resource management alternatives and evaluation of tradeoff opportunities) by December 2003;

6) Development and negotiation of settlement agreements supported by a consensus of the stakeholders and consistent with other associated regulatory processes (i.e. identification of terms and conditions for new licenses) by December 2004; and

7) Submittal of an APEA and license application for each of the licenses formally included in the ALP starting in November 2005, along with any appropriate requests for license amendments for SCE's other licensed projects within the Basin.

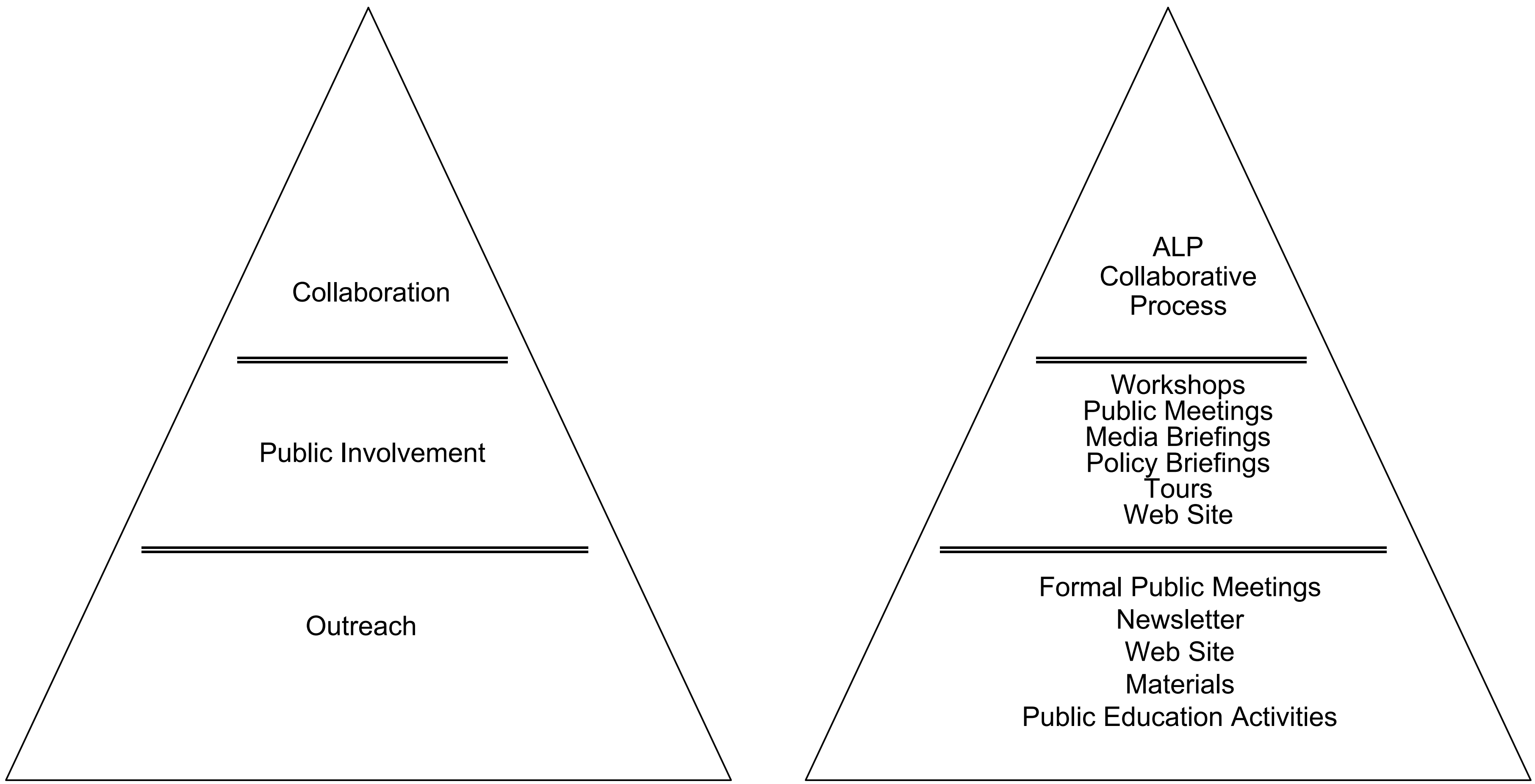
2.5 BIG CREEK ALP: STAKEHOLDER INVOLVEMENT AND COMMUNICATION

2.5.1 GENERAL OVERVIEW

Communication and active public involvement are intrinsic to an ALP approach. By using the ALP, SCE plans to provide the public with many opportunities to participate and to communicate their interests in the relicensing process. In addition, SCE will offer a variety of mechanisms to inform stakeholders of progress and performance as the process unfolds.

Approximately 600 stakeholders or groups, ranging from members of the local community to federal officials in Washington D.C., are anticipated to have some degree of interest in the Big Creek ALP. Formal public meetings, an active web site and broad availability of relicensing documents will ensure an opportunity for a base level of involvement and awareness. Three general levels of public involvement and communication are anticipated to provide stakeholders with opportunities to participate or be informed at a level which meets their respective needs. Figure 2.5-1 depicts the different levels of involvement expected for stakeholders involved in the Big Creek ALP.

Figure 2.5-1. Different Levels of Involvement for Different Needs



2.5.2 General Public Involvement and Communications Activities

Stakeholder Mailing List

SCE will maintain a mailing list of interested parties to the Big Creek relicensing proceedings. The list will incorporate names of individuals or groups already listed on Big Creek relicensing mailing lists or local resource agency lists. Names will be added to the list if a request is made in writing with FERC, SCE, or from sign-in sheets at ALP public meetings. The list will be updated on an ongoing basis.

Public Meetings

Formal public meetings (initial information/scoping meetings and APEA public comment meetings) will be held and formally noticed by SCE in appropriate local and other forums. These notices also will be provided to stakeholders on the mailing list. Meetings will likely be held in Fresno, California as a central nearby location with reasonable access. Those unable to attend these public meetings will be able to provide written comments.

Web site

SCE will develop and maintain a web site designed to support and facilitate the Big Creek ALP. This web site will have several integrated functions, including:

- Educate stakeholders (descriptions of: Big Creek System Basin, SCE project operations, ALP, collaborative process, resource agency management goals, and principles of mutual-gains negotiation);

- Inform stakeholders of licensing proceedings and collaborative activity (meeting notices, status reports, meeting summaries, regulatory milestones, collaborative milestones and schedule);

- Provide an accessible, downloadable repository for technical reports, public correspondence, legal documents, meeting notes, records of formal verbal communication and stakeholder lists; and

- Provide a central location for documents where the public can review progress and for use by collaborative participants engaged in working group assignments and any settlement agreement discussions.

Media

The media will be provided with initial information on relicensing and periodic progress reports on the Big Creek ALP. In addition, meeting notices will be placed in key local newspapers.

Availability of Materials

Materials related to relicensing and access to additional pertinent communications between stakeholders will be available to the public via:

- FERC's Public Reference Room, Washington, D.C.; and,

- a Public Information Library (Relicensing Room) established and maintained by SCE at its Northern Hydro Region Administrative Offices in Big Creek, California (this library will also house a collection of relevant reference materials).

2.5.3 ALP Collaborative Team

While all stakeholders are invited, it is expected that approximately 20-40 stakeholders, representing a cross-section of interests (e.g. government agency representatives, community leaders, public-interest groups, etc.), will directly participate on the ALP "collaborative" team. These stakeholders are expected to provide a consistent and long-term commitment of time and energy in a structured collaborative planning process to identify project resource issues, assist in development of study plans, and work toward a mutually acceptable settlement that addresses potential mitigation and enhancement measures. The collaborative planning process structure is proposed as follows:

- All participants on the collaborative team (Plenary) will convene for one to two days each month. During the process planning and scoping phase, meetings will be held monthly. During the study/technical phase of the process, the plenary meetings will be held quarterly. During the first phase, the plenary meeting's purpose and focus will be on assigning, reviewing and finalizing outputs from participant work groups (see below). During settlement agreement negotiations, plenary meetings will return to once per month status, and most of the collaborative work will take place in the Plenary context.

- Work groups will be formed by the Plenary participants and assigned to address particular issues or accomplish discrete tasks. Much of the technical activity in the process will occur at this Work Group level.

A framework Communications Protocol (Appendix A) has been developed to define initial communications practices for the collaborative team. This Communications Protocol emphasizes open but documented communications, use of electronic means (e-mail and web site) for work and information sharing, and mutual respect in participant interaction (verbally and in writing). One of the initial goals, once plenary meetings have begun with open public participation, will be the finalizing of Communications Protocols.

2.5.4 PUBLIC INVOLVEMENT

Another segment of Big Creek stakeholders (approximately 100 – 200) is likely to want to engage in relicensing activities at critical points, but not on a constant basis, and to be regularly informed on progress and decision points. SCE intends to provide the following to address these stakeholders' needs:

- SCE will organize opportunities for local and Fresno area stakeholders to tour the area and SCE's facilities and talk about the project and its environmental setting.

- During the ALP, plenary meetings will be noticed and will be open to the public. SCE will also hold periodic informational meetings in Fresno and in Big Creek to update stakeholders on ALP progress and to gather ongoing input on relicensing. This will provide a crucial feedback loop to help SCE and the collaborative group to keep in touch and address any potential issues in a timely manner.

- Summaries from collaborative meetings and other relevant information will be posted on the web site and distributed four times a year to interested stakeholders.

2.5.5 PUBLIC OUTREACH

For stakeholders who are unable to participate in ALP activities, but are interested in being kept generally informed, SCE will conduct the following information and outreach activities:

- SCE will work with collaborative participants to tailor public education activities to include presentations on Big Creek relicensing. SCE can inform a large number of involved citizens by giving presentations to local clubs (Lions, etc.) and recreation groups and participating in fairs, school events, etc. This will be an opportunity to let the public know what relicensing is, and how SCE is involving stakeholders to address and resolve environmental issues.

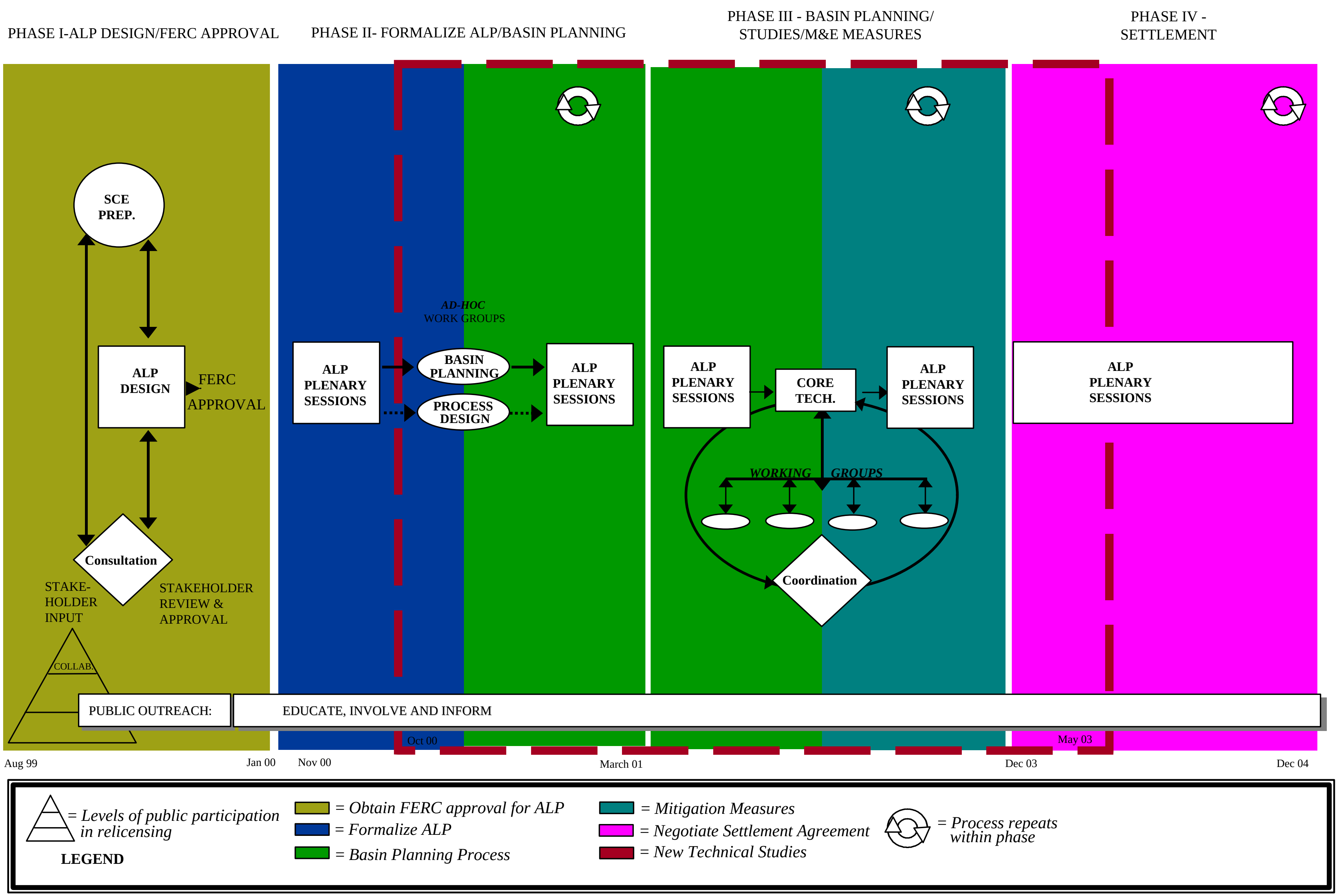
- A report summarizing progress in the ALP will be distributed to all stakeholders on the mailing list. This will take the form of a newsletter with updates on relicensing to be distributed to the full mailing list about every six months.

2.5.6 STAGES OF THE ALP

Involvement and communications activities will vary as the ALP goes through its different stages. During the first year, 2000, the ALP and communications protocols will be formalized and basin planning activities designed. During this stage, communications efforts will need to be particularly intense to establish an effective collaborative process, learn stakeholder issues, explain SCE constraints and interests, and bring stakeholders up to speed. During the years 2001 to 2003, studies will be conducted and potential mitigation and enhancement measures assessed. During this phase, much of the communications will be of a technical nature.

Finally, the stakeholders will attempt to negotiate a comprehensive settlement between 2001 and 2004, which will then serve as the model for resource agencies' recommendations and for FERC's license conditions. At this phase, stakeholder involvement and communications efforts will be ramped up to ensure a successful conclusion to the ALP. Figure 2.5-2 graphically depicts the collaborative process for the relicensing of the Big Creek System.

Figure 2.5-2. Collaborative Process For Relicensing the Big Creek System



3.1 PROJECT HISTORY

3.1.1 GENERAL OVERVIEW

Construction of the Big Creek System was begun by Pacific Light and Power Company in 1911 and carried forward by its successor, Pacific Light and Power Corporation. In 1917, the latter corporation conveyed all rights and properties to Southern California Edison Company, who completed construction and continues to operate the project.

Construction of the Big Creek System occurred over four distinct construction phases. During the initial phase, from 1911 to 1914, Powerhouse Nos. 1 & 2 were built with two generating units each, and Huntington Lake was built with half the current capacity. The second construction phase occurred from 1917 to 1929. During this phase, Huntington Lake's storage was increased, and additional generating units were added to Powerhouse Nos. 1 & 2. Additionally, Florence Lake, Shaver Lake, Mono-Bear Diversions and Siphon, various back country diversions, Powerhouse No. 2A, Powerhouse No. 8, and Powerhouse No. 3 were built. The third construction phase occurred from 1948 to 1960. During this period, Redinger Lake, Lake Thomas A. Edison, Mammoth Pool Reservoir, Powerhouse No. 4, Mammoth Pool Powerhouse, Portal Powerhouse, and several small diversions were built. The last construction phase occurred from 1984 to 1987. At this time, Balsam Meadows Forebay and Eastwood Power Station were built.

The history of the development of the Big Creek System is summarized in further detail below.

3.1.2 INITIAL DEVELOPMENT

1911

- The Pacific Light & Power Corporation, almost entirely owned by Henry Huntington, purchased from the San Joaquin Light & Power Corporation all rights necessary to proceed with the development of the Big Creek System.

1912

- Construction began with the Stone and Webster Engineering Corporation as the primary contractor.

- February-July: The 56-mile San Joaquin and Eastern (SJ&E) railroad from El Prado (near present-day Friant) to Big Creek was built. This railroad was used to transport construction material, equipment, and people to the construction site.

- Summer: Work was started on three dams in the Basin that, when completed, created Huntington Lake.

1913

- Spring: The concrete foundations for Powerhouse No. 1 and Powerhouse No. 2 were poured.

- October 14: Powerhouse No. 1 began generating electricity. By the end of the year, Powerhouse No. 1 contained two generating units with a combined capacity of 20,800 kW.

- Fall: Dams 1, 2 and 3 forming Huntington Lake were completed, however they were not yet at their present height.

- December 18: Powerhouse No. 2 began generating electricity. By the end of the year, Powerhouse No. 2 contained one generating unit with a capacity of 14,000 kW.

- Dam 4, at the tailrace of Powerhouse No. 1 was completed forming the Forebay for Powerhouse No. 2.

1914

- The second operating unit at Powerhouse No. 2, Unit 4 with a capacity of 14,000 kW was installed.

- July: Tunnel work began on a tunnel from Powerhouse No. 2 to the future site of Powerhouse No. 3.

Interesting Fact (1914):
At the completion of the Initial Development phase, Big Creek Powerhouse No. 1 had the highest head (vertical distance between the top of the penstock and power turbine) of any hydroelectric generator in the country. The penstock serving Big Creek No. 1 was the longest and steepest penstock in the world. The water wheels and generators were also the largest of their type at the time.

3.1.3 SECOND PHASE

1917

- A consolidation occurred between the Pacific Light & Power Corporation, Mt. Whitney Power & Electric Company (Kaweah 1-3, and Tule), and the Southern California Edison Corporation with the consolidated company retaining the Southern California Edison name.

- Dams 1, 2, and 3 at Huntington Lake were extended by 35-feet in height and Dam 3A was added, doubling the storage capacity of the Lake.

1919

- Southern California Edison acquired the Shaver Lake lands and water rights from the Fresno Flume and Lumber Company.

- Design work began for the Huntington-Pitman-Shaver Conduit, Shaver Lake Dam, Powerhouse No. 2A, and Tunnel No. 5 (Shaver Lake to Powerhouse No. 2A).

1920

- February: Only 2,050 feet of the approximately 6 mile long tunnel between Powerhouse No. 2 and the future site of Powerhouse No. 3 had been completed.

- June: Due to the pressing demand for power and improvements in reaction-turbine type water wheels (which could produce efficient power at lower head pressure) the decision was made to build Powerhouse No. 8 at the confluence of Big Creek with the San Joaquin River. The length of the tunnel being constructed was reduced from 6 miles to 5,933 feet.

- To provide additional waterpower for the Big Creek System, SCE decided to utilize the water resources of the South Fork San Joaquin River, at the time called the "East Side Development".

- Camp 61 was established near the present site of Portal Forebay and Camp 62 was established near the present fork in the road for Florence Lake and Lake Thomas A. Edison to accommodate construction workers.

- November: Construction of the 13.5 mile long Ward Tunnel from Florence Lake to Huntington Lake began.

> Interesting Fact (1920):
>
> The rapid increase in population and industry in Southern California Edison's service territory after the end of World War I made swift additional development of the Company's power resources necessary. Over 2,000 workers were employed during this period of construction. The work camps were isolated from the outside world most of the winter months except for radio communications and a dog sled, which carried the first class mail.

1921

- January 8: Excavation for Powerhouse No. 8 was started.

- May 6: Years prior to the completion of the Shaver Lake Dam and 7 years prior to the completion of Powerhouse No. 2A, the power capacity of the Big Creek System was increased by 17,500 kW when water from Stevenson Creek was diverted through the newly constructed Tunnel No. 5 to Powerhouse No. 2.

- August 15: Southern California Edison filed an application for license of the Big Creek No. 3 Hydro Project with the Federal Energy Commission.

- August 16: Unit No. 1 at Powerhouse No. 8 was placed in service with a rating of 22,500 kW.

- Early Fall: Construction of Tunnel No. 3, between Dam 6 and Powerhouse No. 3, began.

1922

- June 5: Excavation for Powerhouse No. 3 began.

- Early Fall: Excavation for the footings of Dam 6 began.

- November 20: Placing of concrete for Dam 6 began. The flume discussed in the interesting fact below was abandoned on December 6 with the water flowing through the sluice gates that had been poured.

Interesting Fact (1922):

According to David Redinger, construction of Dam 6 was about the most difficult job encountered in the development of the entire Big Creek Project. While the footings for the dam were being excavated, the flow of the river had to be carried around the site through a flume hanging on the slick canyon side.

1923

- March 18: Dam 6 was completed just a few days before the first spring flood came down the river.

- In May, the Big Creek System voltage was increased from 150 kV to 220 kV. This was the highest voltage transmission system in the world at the time.

- August: The last section of Tunnel No. 3 (Powerhouse No. 3 Water Conveyance System) was “holed through” on August 1 and the tunnel was officially completed on August 26.

- September 30: The first generating unit of Powerhouse No. 3 began generating power.

Interesting Fact (1923):

After completion in 1923, the trade press hailed Powerhouse No. 3 as “the Electrical Giant of the West,” for its then 99,000 kW of rated capacity made it the largest hydroelectric plant in the West.

1925

- April: The Ward Tunnel (from Florence Lake to Huntington Lake) was completed. Water first flowed from Jackass Meadows (Florence Lake area) through Ward Tunnel to Huntington Lake on April 13.
- Spring: Construction of the Florence Lake Dam was started.
- November: Construction of the Huntington-Pitman-Shaver Conduit was started.

Interesting Fact (1925):

The 13.5-mile long Ward Tunnel through the massive Kaiser Mountain was at the time the longest water tunnel in the world. George C. Ward was vice president of engineering and construction during the busiest phase of the Big Creek Project construction.

1926

- Spring: Excavation work for the Shaver Lake Dam began.
- July: Work was started on Mono Diversion, Bear Diversion, and the Mono-Bear Siphon, which would augment water into the Ward Tunnel with water from the Mono Creek drainage and the Bear Creek drainage.
- August 15: Florence Lake Dam was completed. The previous year, water had been stored in the lake at half capacity while work continued on the dam.
- Fall: Construction of Powerhouse No. 2A began.

1927

- October 23: Shaver Lake Dam was completed.
- November 15: The Mono and Bear diversions and siphon were completed.

1928

- April 21: The Huntington-Pitman-Shaver Conduit was completed allowing water to be diverted into Shaver Lake.

- August 6: The first generating unit of Powerhouse No. 2A was placed in service.
- Diversion of water from Tunnel No. 5 to Tunnel No. 2 was discontinued after Powerhouse No. 2A went into service, as it was more efficient to run the water directly into the Powerhouse No. 2A penstocks and waterwheels.
- Upon completion, Powerhouse No. 2A consisted of two units rated at 40,500 kW each.
- Due to construction winding down as the various projects were completed, most of the construction camps were dismantled by the end of this year.

1929

- Unit 2 of Powerhouse No. 8 was installed with an initial rating of 31,500 kW.
- June: The second construction phase of the project was complete.

Interesting Fact (1929):

Increases in water supply, made available from the South Fork San Joaquin River watershed by construction of the Florence Lake Reservoir, Mono Creek Diversion, and Bear Creek Diversion, and from the Pitman Creek and Stevenson Creek watersheds by construction of the Shaver Lake Reservoir and their respective water conduits, increased the generating capacity of the Big Creek System from the original 70,000 kw to a total of 424,500 kw. The Big Creek System consisted of 533,000 Hp capacity of operating turbines, 398,000 kW of generation capacity, and 36 miles of tunnels. At the time this was the largest hydroelectric project in the world, providing 90% of the electric power needs of SCE into the 1940's. The construction of the project was at the time considered to be an engineering and construction challenge of the same magnitude as the Panama Canal.

3.1.4 Depression/War Years

1929 to 1945

There was no construction activity on the Big Creek project during this period due to the Great Depression and World War II. SCE satisfied its needs for increased generation during this period by investing in the large public works project known today as the Hoover Dam.

3.1.5 Third Phase

1948

- The fourth generating unit was added to Powerhouse No. 3. Space had been provided in the original design of the powerhouse.
- April 28: Powerhouse No. 3, Unit 4 began commercial operation.

1949

- June 29: Approval was granted for SCE licenses and permits to construct the Big Creek 4 project.
- July: Construction began on Redinger Lake Dam and on the Powerhouse No. 4 Water Conveyance System consisting of two tunnels and associated penstocks.

1951

- Dam 7 and Redinger Lake were completed.
- June 12: The first generating unit of Powerhouse No. 4 began commercial operation.
- July 2: The second generating unit of Powerhouse No. 4 began commercial operation.
- SCE filed applications for licenses and permits to construct the Mammoth Pool Project and Vermilion Valley Dam.

1953

- The approval to construct the Vermilion Valley Dam was received.
- April 18: Construction of the Dam began. Forty percent of the earthfill material for the dam was placed during this first construction season.

1954

- October: Vermilion Valley Dam was completed.
- SCE filed with the Federal Power Commission for the necessary licenses and permits to build the Portal project, a power turbine/generator to the outlet of the Ward Tunnel. The development of efficient Francis-type reaction turbines operating at low head meant that a small power plant at this location was now feasible.

> Interesting Fact (1954):
>
> On the 75th anniversary of the invention of the electric light bulb, October 19th, the Vermilion Valley Dam was dedicated and the lake was named Lake Thomas A. Edison in honor of the great inventor's contribution to the electric power industry.

1955

- Construction of the Portal Powerhouse and Portal Forebay began.

1956

- December: Portal Powerhouse was completed.

> Interesting Fact (1954):
>
> Portal Powerhouse, a small 10,000 kW facility, was different from any built previously at Big Creek, in that it was an outdoor design, built open to the weather. The plant was entirely automatic in operation, at the time controlled by Powerhouse No. 1. Portal Powerhouse was later upgraded to the current installed capacity of 10,800 kW.

1957

- December 30: After many delays, the approval to build the Mammoth Pool project was given.

1958

- Spring: Work on the Mammoth Pool Dam site, Water Conveyance System, and Powerhouse began.

1959

- October 17: Mammoth Pool Dam was completed.

1960

- March 28: Mammoth Pool Powerhouse became operational Fourth Phase

1983

- November 1983: Construction of the Balsam Meadows Project began.

1987

- December 1: Balsam Meadows Project was complete.

3.2 DESCRIPTION OF SCE HYDROELECTRIC PROJECTS IN THE BASIN

3.2.1 GENERAL OVERVIEW

The Big Creek System includes seven hydroelectric projects licensed under separate FERC licenses (Figure 3.2-1). The Big Creek hydroelectric projects within the Basin range in elevation from approximately 1,000 feet msl to about 9,000 feet msl and include: Big Creek Nos. 1 & 2 (FERC No. 2175), Big Creek Nos. 2A, 8, & Eastwood (FERC No. 67), Big Creek No. 3 (FERC No. 120), Big Creek No. 4 (FERC No. 2017), Vermilion Valley (FERC No. 2086), Portal Powerhouse (FERC No. 2174), and Mammoth Pool (FERC No. 2085).

Major components of the hydroelectric project infrastructure are the dams and diversions, reservoirs and forebays, water conveyance systems, and powerhouses. These components for the seven individual projects are summarized in Table 3.2-1. Detailed descriptions of the project facilities/components are provided in Appendix C.

Table 3.2-1 Summary of Big Creek System Components by License

BIG CREEK NOS. 1&2 **FERC No. 2175**

License Issue Date:	1959	Dependable Operation Capacity (MW):	150.00
License Expiration Date:	02/28/2009	Exhibit M Generator Capacity (MW):	154.85

Huntington Lake
- Dams 1, 2, 3, and 3A

Powerhouse No. 1
- Tunnel No. 1 and penstocks (from Huntington Lake)

Powerhouse No. 2 Forebay
- Dam 4

Powerhouse No. 2
- Tunnel No. 2 and penstocks (from Dam 4)
- Diversion dam and conduit on Balsam Creek to Tunnel 2
- Diversion dam and conduit on Ely Creek to Tunnel 2
- Diversion dam and conduit on Adit 8 Creek to Tunnel 2

BIG CREEK 2A, 8 AND EASTWOOD **FERC NO. 67**

License Issue Date:	1977	Dependable Operation Capacity (MW):	370.00
License Expiration Date:	2/28/2009*	Exhibit M Generator Capacity (MW):	384.80

Florence Lake
- Florence Lake Dam

Diversion to Florence Lake
- Tombstone Creek Diversion Dam and Conduit (steel pipe natural channel)
- Crater Creek Diversion Dam and Conduit (ditch and natural channel)
- Hooper Creek Diversion Dam and Conduit
- North Slide Creek and South Slide Creek Diversion Dams and Conduits (steel pipe)

Table 3.2-1 Summary of Big Creek System Components by License (continued)

BIG CREEK 2A, 8 AND EASTWOOD (continued)

Diversion to the Ward Tunnel
- Florence Lake
- The Mono-Bear Conduit (steel pipe)
- Bear Creek Diversion Dam
- Mono Creek Diversion Dam
- Chinquapin Creek Diversion Dam
- Camp 62 Creek Diversion Dam
- Bolsillo Creek Diversion Dam

Shaver Lake
- Shaver Lake Dam
- Huntington-Pitman-Shaver Conduit /Tunnel No. 7
- Pitman Creek Diversion Dam and Conduit

Big Creek 2A Powerhouse
- Tunnel No. 5 (from Shaver Lake)

Powerhouse No. 8 Forebay
- Dam 5

Big Creek 8 Powerhouse
- Tunnel No. 8 (from Dam 5)

Eastwood Development
- Balsam Meadow Forebay /Diversion structure/Tunnels
- Eastwood Power Station

Transmission Line

Big Creek 1 – Eastwood Power Station Transmission Line

BIG CREEK NO. 3 **FERC No. 120**

License Issue Date:	1977	Dependable Operation Capacity (MW):	181.90
License Expiration Date:	02/28/2009	Exhibit M Generator Capacity (MW):	174.45

Powerhouse No. 3 Forebay
- Dam 6

Powerhouse No. 3

Tunnel No. 3 and penstocks (from Dam 6)

BIG CREEK NO. 4 **FERC No. 2017**

License Issue Date:	1949	Dependable Operation Capacity (MW):	100.20
License Expiration Date:	02/28/1999**	Exhibit M Generator Capacity (MW):	100.00

Redinger Lake
- Dam 7

Powerhouse No. 4
- Tunnel / pipe and penstock (from Dam 7)

Table 3.2-1 Summary of Big Creek System Components by License (continued)

PORTAL **FERC No. 2174**

License Issue Date:	1955	Dependable Operation Capacity (MW):	10.50
License Expiration Date:	03/31/2005	Exhibit M Generator Capacity (MW):	10.80

Portal Forebay (Camp 61 Creek Forebay)
- Diversion dam
- Adit 2 Conduit and surge chamber (to the Ward Tunnel)

Portal Powerhouse

- Steel pipe (from Ward tunnel)
- Powerhouse bypass to Rancheria Creek

MAMMOTH POOL **FERC No. 2085**

License Issue Date:	1957	Dependable Operation Capacity (MW):	187.00
License Expiration Date:	11/30/2007	Exhibit M Generator Capacity (MW):	190.00

Mammoth Reservoir

- Mammoth Pool Dam
- Fishwater Generator

Mammoth Pool Powerhouse

- Mammoth Pool tunnel and penstock (from Mammoth Pool Reservoir)
- Ross Creek diversion and conduit
- Rock Creek diversion and conduit

Transmission Lines

- Big Creek 3 – Mammoth Pool Powerhouse Transmission Line

VERMILION VALLEY **FERC No. 2086**

License Issue Date:	1953	Dependable Operation Capacity (MW):	0.00***
License Expiration Date:	08/31/2003	Exhibit M Generator Capacity (MW):	0.00***

Lake Thomas A. Edison (Storage only)

- Vermilion Valley Dam across upper Mono Creek

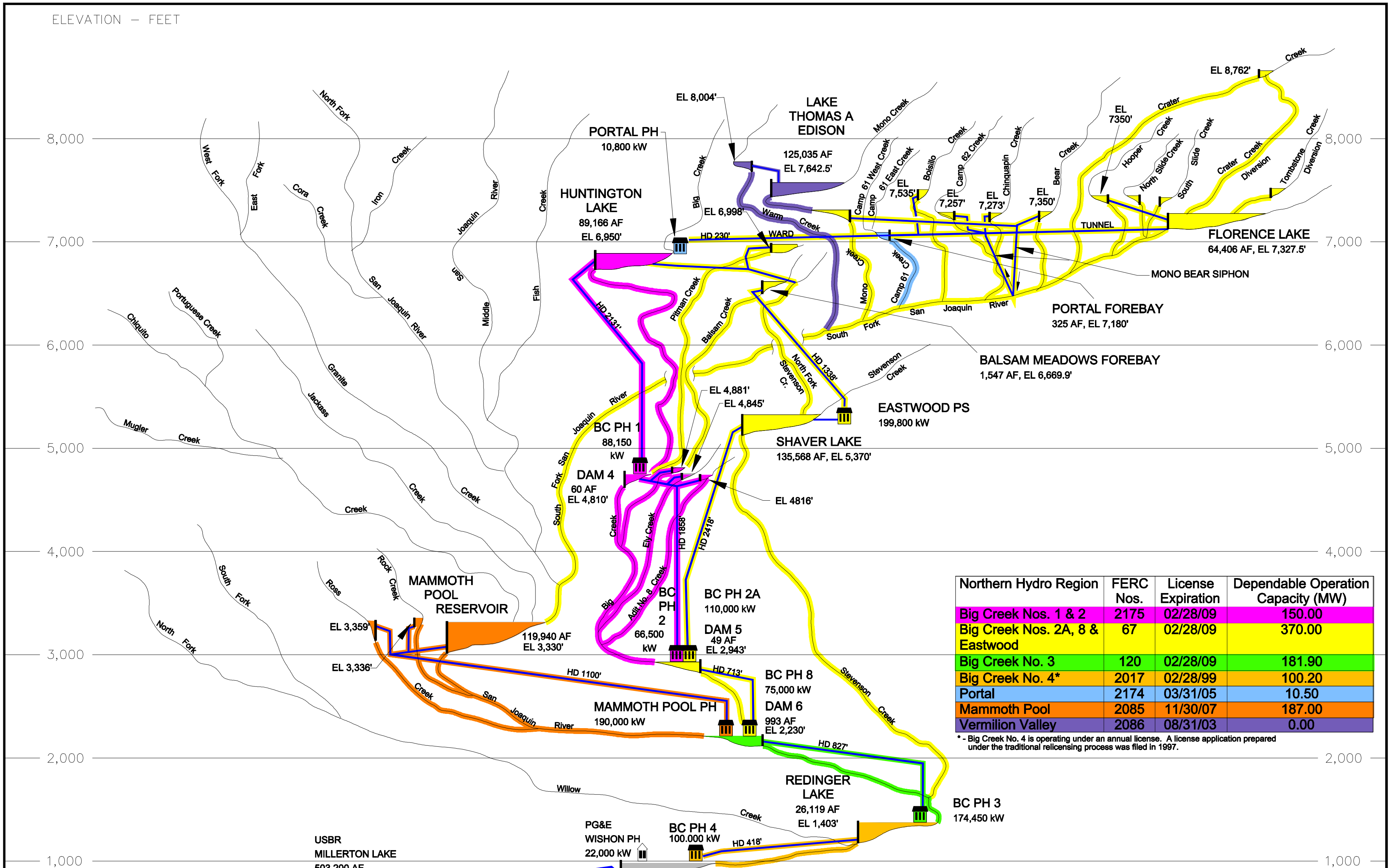
Warm Creek diversion and canal

Footnotes

* Amended in 1983 to include Balsam Meadow Development.

** Application for new license filed with FERC for Big Creek No. 4 in 1997.

*** Project does not include generating facilities.



Northern Hydro Region	FERC Nos.	License Expiration	Dependable Operation Capacity (MW)
Big Creek Nos. 1 & 2	2175	02/28/09	150.00
Big Creek Nos. 2A, 8 & Eastwood	67	02/28/09	370.00
Big Creek No. 3	120	02/28/09	181.90
Big Creek No. 4*	2017	02/28/99	100.20
Portal	2174	03/31/05	10.50
Mammoth Pool	2085	11/30/07	187.00
Vermilion Valley	2086	08/31/03	0.00

* - Big Creek No. 4 is operating under an annual license. A license application prepared under the traditional relicensing process was filed in 1997.

FIGURE 3.2-1
SCHEMATIC PROFILE OF THE BIG CREEK SYSTEM

Southern California Edison Company Rosemead, California
May 2000

3.3 PROJECT OPERATIONS

3.3.1 GENERAL OVERVIEW

The Big Creek System, located within the upper San Joaquin River watershed, covers over 1,000 square miles. The watershed spans a range from 560 feet msl at Millerton Lake to about 14,000 feet msl at the crest of the Sierra Nevada mountain range. Snowmelt runoff is highly variable, so that water supply is unlikely to be at the annual average runoff of approximately 1,700,000 acre-feet (af). Annually, the snowmelt begins in the lower western side of the watershed and proceeds upward in elevation to the eastern side of the watershed. Shaver Lake receives most of its runoff in May. Mammoth Pool Reservoir and Huntington Lake receive most of their runoff in May and June, and Florence Lake and Lake Thomas A. Edison receive the bulk of their runoff in June and July. Spill and diversion of water from lakes higher in the project continue to supply water to lower elevation lakes even after runoff into the higher lakes has diminished. Figure 3.2-1 depicts the Big Creek System facilities and their physical relationships.

3.3.2 OPERATING CONSTRAINTS

WATER RIGHTS

SCE's water rights licenses and permits fall under the jurisdiction of the SWRCB, Division of Water Rights. Failure to make beneficial use of the licensed water rights could be considered an abandonment of those water rights. Additionally, a stipulation between SCE and Pacific Gas and Electric Company (PG&E) in a water rights proceeding requires that SCE provide a minimum flow to PG&E when Mammoth Pool Reservoir storage is increasing.

PERMIT AND LICENSE CONDITIONS

Licenses issued by the FERC require SCE to hold levels of water high, if possible, in its reservoirs during the summer recreation season. SCE also is required by its FERC licenses to provide minimum flows in most river reaches from which water is diverted. SCE measures and records reservoir volumes and streamflows through an extensive system of gages and recorders. Streamflow gages and instream flow release requirements are listed in Tables 3.3-1 a, b and c.

CONTRACTUAL OBLIGATIONS

The Mammoth Pool Operating Agreement between SCE and the U.S. Bureau of Reclamation (USBR), essentially representing the downstream water users, includes constraints on the annual and seasonal timing and volume of releases

Table 3.3-1a. FERC License Normal Water Year Minimum Instream Flow Release Requirements[1]

USGS STA. NO.	STREAM REACH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		Minimum Instream Flow Release Requirements (cfs)[1]											
FERC # 67, Big Creek 2A, 8 & Eastwood													
			(Nov1-15) / (Nov 16-30)										
11230215	South Fork San Joaquin River below Hooper Creek	17	15	15	15	15	15	15	27	27	27	27	27
11230530	Bear Creek below Diversion	2	2	2	2	2	2	2	3	3	3	3	3
11231600	Mono Creek below Diversion	9	7.5	7.5	7.5	7.5	7.5	7.5	13	13	13	13	13
11237700	Pitman Creek near Tamarack Mountain	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
11241500	Stevenson Creek below Shaver Lake	3	3 / 2	2	2	2	2	3	3	3	3	3	3
11238500	Big Creek near Mouth (below Dam 5)	3	3 / 2	2	2	2	2	3	3	3	3	3	3
11230600	Camp 62 Creek below Diversion	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
11230560	Chinquapin Creek below Diversion	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1
11230670	Bolsillo Creek below Diversion	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
11230200	Hooper Creek below Diversion[2]	2	2	2	2	2	2	2	2	2	2	2	2
11230120	No. Slide Cr. Below Diversion	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11230100	So. Slide Cr. Below Diversion	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
11239300	No. Fk. Stevenson Creek above Shaver Lake[3]	4	4	4	3.5	3.5	3.5	5	5	5	4.5	4.5	4.5
11238270	Balsam Creek below Balsam Meadow Forebay[4]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1
--	Tombstone Creek from Diversion to So. Fk. San Joaquin	Diversion turned out per 1983 Project License Amendment - currently full natural flow.											
FERC #120 Big Creek No. 3													
11238600	San Joaquin River below Dam 6 (above Stev. Cr.)	3	3	3	3	3	3	3	3	3	3	3	3
FERC #2017 Big Creek No. 4													
11242000	San Joaquin River above Willow Creek	3	3	3	3	3	3	3	3	3	3	3	3
- -	San Joaquin River below Willow Creek[5]	20	20	20	20	20	20	20	20	20	20	20	20
FERC #2085 Mammoth													
								(April 1-15) / (April 16-30)					(Sep 1-15) / (Sep 16-3
11234760	San Joaquin River above Shakeflat Creek[6]	25	10	10	10	10	10	10 / 25	25	25	30	30	30 / 25
FERC #2086 Vermilion								12.5					
11231500	Mono Creek below Lake T. A. Edison[7]	10	10	10	10	10	10	10	10	10	10	10	10
11231700	Warm Creek below Diversion[8]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
FERC #2175 Big Creek No's 1 & 2													
				(Dec. 1-15) / (Dec. 16-31)				(April 1-14) / (April 15-30)					
11237000	Big Creek below Huntington Lake[9]	2	2	2 / --	--	--	--	-- / 2	2	2	2	2	2

(1) When natural flow is at/or below the minimum instream flow requirement, the diversions are turned out. Therefore, flows in a diverted reach may drop below the minimum instream flow requirement when SCE is not diverting.

(2) Included in So. Fk. San Joaquin River below Hooper.

(3) Intersection of No. Fk. Stevenson Creek and Shaver Lake perimter road.

(4) West Fork Balsam Crk. As measured in downstream channel immediately below project forebay.

(5) Computed combination of SCE Sta. Nos. 125 plus 137 (USGS 112465 Willow Creek at Mouth).

(6) Measured approximately 1/2 mile below the dam and above the confluence of Shakeflat Creek. Per USGS, revert to SCE Sta. No. 158 (USGS 11234750; Mammoth Pool fishwater turbine).

(7) Between Vermilion Valley Dam and Mono Creek Diversion Dam.

(8) Pass over, by or through diversion dam on Warm Creek.

(9) Big Creek below Huntington Lake (Dam 1) at existing gaging point located approximately 0.9 mile below Dam 1.

Table 3.3-1b. FERC License Dry Water Year Minimum Instream Flow Release Requirements[1]

(Shaded areas denote where dry criteria apply. Dry year releases are the same as normal releases for unshaded areas.)

USGS STA. NO.	STREAM REACH	Minimum Instream Flow Release Requirements (cfs)[1] Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Dry Year Criteria (Refer to Table 3.3-1c)
FERC # 67, Big Creek 2A, 8 & Eastwood			(Nov1-15 / Nov 16-30)											
11230215	South Fork San Joaquin River below Hooper Creek	13	11	11	11	11	11	11	20	20	20	20	20	(A)
11230530	Bear Creek below Diversion	1	1	1	1	1	1	1	2	2	2	2	2	
11231600	Mono Creek below Diversion	6	5	5	5	5	5	5	9	9	9	9	9	
11237700	Pitman Creek near Tamarack Mountain	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
11241500	Stevenson Creek below Shaver Lake	3	3 / 2	2	2	2	2	3	3	3	3	3	3	
11238500	Big Creek near Mouth (below Dam 5)	2	2 / 1	1	1	1	1	2	2	2	2	2	2	(A)
11230600	Camp 62 Creek below Diversion	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
11230560	Chinquapin Creek below Diversion	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	
11230670	Bolsillo Creek below Diversion	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
11230200	Hooper Creek below Diversion[2]	2	2	2	2	2	2	2	2	2	2	2	2	
11230120	No. Slide Cr. Below Diversion	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
11230100	So. Slide Cr. Below Diversion	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
11239300	No. Fk. Stevenson Creek above Shaver Lake[3]	3	3	3	3	3	3	4	4	4	3.5	3.5	3.5	(B)
1128270	Balsam Creek below Balsam Meadow Forebay[4]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1	
--	Tombstone Creek from Diversion to So. Fk. San Joaquin	Diversion turned out per 1983 Project License Amendment - currently full natural flow.												
FERC #120 Big Creek No. 3														
11238600	San Joaquin River below Dam 6 (above Stev. Cr.)	3	3	3	3	3	3	3	3	3	3	3	3	
FERC #2017 Big Creek No. 4														
11242000	San Joaquin River above Willow Creek	3	3	3	3	3	3	3	3	3	3	3	3	
- -	San Joaquin River below Willow Creek[5]	20	20	20	20	20	20	20	20	20	20	20	20	
FERC #2085 Mammoth								(April 1-15 / April 16-30)					(Sep 1-15 / Sep 16-30)	
11234760	San Joaquin River above Shakeflat Creek[6]	12.5	10	10	10	10	10	10 / 12.5	12.5	12.5	30	30	30 / 12.5	(C)
FERC #2086 Vermilion														
11231500	Mono Creek below Lake T. A. Edison[7]	10	10	10	10	10	10	10	10	10	10	10	10	
11231700	Warm Creek below Diversion[8]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
FERC #2175 Big Creek No's 1 & 2				(Dec. 1-15 / Dec. 16-31)				(April 1-14 / April 15-30)						
11237000	Big Creek Below Huntington Lake[9]	2	2	2 / --	--	--	--	-- / 2	2	2	2	2	2	

(1) When natural flow is at/or below the minimum instream flow requirement, the diversions are turned out. Therefore, flows in a diverted reach may drop below the minimum instream flow requirement when SCE is not diverting.

(2) Included in So. Fk. San Joaquin River below Hooper.

(5) Computed combination of SCE Sta. Nos. 125 plus 137 (USGS 112465 Willow Creek at Mouth).

(4) West Fork Balsam Crk. As measured in downstream channel immediately below project forebay.

(5) Computed combination of SCE Sta. Nos. 125 plus 137 (USGS 112465 Willow Creek at Mouth).

(6) Measured approximately 1/2 mile below the dam and above the confluence of Shakeflat Creek. Per USGS, revert to SCE Sta. No. 158 (USGS 11234750; Mammoth Pool fishwater turbine).

(7) Between Vermilion Valley Dam and Mono Creek Diversion Dam.

(8) Pass over, by or through diversion dam on Warm Creek.

(9) Big Creek below Huntington Lake (Dam 1) at existing gaging point located approximately 0.9 mile below Dam 1.

Table 3.3-1c. Criteria for Dry Water Year Minimum Instream Flow Release Requirements

Dry Year Criteria (Referenced in Table 3.3-1b)	Applicable Project/ Watershed Area	Forecasting Agency	Forecast Date	Forecast Period	Dry Year Releases Criteria	Release Year
(A)	San Joaquin River	USBR	April 1	Apr-Jul	900,000 acre-feet or less @ Friant Dam	May 1 to Apr 30
(B)	San Joaquin River	USBR	April 1	Apr-Jul	900,000 acre-feet or less @ Friant Dam	May 1 to Apr 30 *****
(C)	San Joaquin River	CDWR	April 1	Apr-Jul	900,000 acre-feet or less (@ Friant Dam)	Apr 16 to Apr 15**

* *But, a dry year reverts to a normal year within 7 days of a subsequent CDWR February 1 or March 1 forecast of normal runoff.*

** *May be applied for a period not to exceed the subsequent 12 consecutive months commencing on April 16.*

from SCE's reservoirs, maximum year-end storage allowed, and minimum flow annually out of Dam No. 7 (release and diversion).

PHYSICAL CONSTRAINTS

Along with the contractual and regulatory constraints, the characteristics of the reservoirs and water chain combinations are factors limiting SCE's flexibility in the operation of its hydroelectric generation facilities. For example, it is possible to create spill at Dam 6 and Dam 7 by operating Mammoth Pool Powerhouse at its maximum capacity if the flows on the Big Creek and Shaver Lake water chains are operated at maximum levels, (further description of water chains is presented in the Water Management section, below). Also, prolonged operation of Eastwood Power Station could cause spill to occur over Shaver Lake Dam, while too little operation of Eastwood Power Station could result in spill at Florence Lake.

3.3.3 WATER MANAGEMENT

The snow pack in the Big Creek System drainage area is carefully monitored throughout the winter and spring months. A proprietary computer model is used to compare the current year snow pack to previous years of similar snow pack and to predict the water runoff timing and quantity that will be entering the reservoirs. This allows SCE to estimate how much water to release from storage in the reservoirs prior to runoff to maximize the generation benefit of the water.

Water from the upper South Fork San Joaquin River drainage is stored in Lake Thomas A. Edison and Florence Lake. Water is diverted from these two lakes and various other small backcountry diversions into Huntington Lake via the Ward Tunnel and the Mono-Bear Siphon. The volumes that can pass through Ward Tunnel and the Siphon are limited by the physical size of these conduits. First priority for water delivery to Huntington Lake is given to water from the Camp Creek diversions (Camp 61 Creek, Camp 62 Creek, Chinquapin Creek, and Bolsillo Creek) and from Bear Diversion, as they have no storage. Second priority is given to water from Florence Lake, due to the reservoir's smaller size and larger annual inflow than Lake Thomas A. Edison. This water passes through Portal Powerhouse at the exit of the Ward Tunnel prior to entering Huntington Lake.

The Big Creek System operates as three interlinked water chains, including:

1. Huntington Water Chain: This chain consists of Portal Powerhouse, Powerhouse No. 1, Powerhouse No. 2, Powerhouse No. 8, Powerhouse No. 3, and Powerhouse No. 4.

2. Shaver Water Chain: This chain consists of Portal Powerhouse, Eastwood Power Station, Powerhouse No. 2A, Powerhouse No. 8, Powerhouse No. 3, and Powerhouse No. 4.

3. Mammoth Water Chain: This chain consists of Mammoth Pool Powerhouse, Powerhouse No. 3, and Powerhouse No. 4.

Water passing through Portal Powerhouse becomes part of either the Huntington Chain, or the Shaver Chain. If the generation from the powerhouses of either chain is increased or decreased proportionally, the changes in load will have no affect on the levels of the storage reservoirs and forebays within the chain. Changes in total loading conditions of the two chains can affect Florence Lake and Lake Thomas A. Edison and can affect the amount of water leaving the project at Powerhouse No. 4. If the generation from the powerhouses of either chain is changed disproportionally, the levels of Huntington Lake, Shaver Lake, and Redinger Lake can be increased or decreased.

Waters from the Middle Fork and North Fork San Joaquin River drainages, and spills from Florence Lake, Lake Thomas A. Edison, and Bear Creek Forebay are collected in Mammoth Pool Reservoir and become part of the Mammoth Chain.

Generally, the three water chains of the Big Creek System are operated around the clock in the spring, except in dry years. Operational flexibility is limited during this time because the amount of water runoff exceeds both generation and storage capacity of the project, resulting in water flowing over spillways or “spill”. Mammoth Pool Powerhouse is usually run at maximum during the high flow or runoff period to prevent or delay spill at Mammoth Pool Reservoir.

After the end of the spill period, daily unit plant load schedules are established to maximize hydro resources during system peak load periods. This scheduling maximizes the benefit to the SCE ratepayer by reducing the use of other higher cost generating sources. The proprietary computer model used for predicting inflow is also used to plan monthly throughput of water through the project to meet the operating constraints on the system while maximizing generation during the peak load periods. In addition, computer programming of load schedules to use the most efficient units first, further enhances these operating activities and improves system integrity and efficiency. These activities ensure the efficient use and availability of hydro-generation resources from these reservoir storage plants.

3.4 EXISTING PROGRAMS, MEASURES, AND FACILITIES MAINTAINED BY SCE

3.4.1 GENERAL OVERVIEW

SCE develops and implements environmental improvement and protection programs, measures and facilities that ensure Big Creek project activities are compatible with the area’s environmental and social goals. The following sections summarize programs, measures and facilities maintained by SCE for the protection and enhancement of the Big Creek System Basin resources.

3.4.2 Endangered Species Alert Program

The Endangered Species Alert Program (ESAP) is designed to provide SCE personnel with a means for identifying the potential occurrence of legally protected plant and animal species in the SCE Service Territory. For each sensitive species within the SCE Service Territory, the ESAP Manual (SCE, 1998) includes a photograph, description, natural history information, and map showing the species' distribution in relation to SCE's facilities. The manual and maps are reviewed prior to implementing any ground disturbing activities in the project area. Should a proposed activity have a potential to conflict with a known sensitive species population, SCE Environmental Affairs staff is notified to evaluate the situation and, if needed, coordinate the appropriate permits with the resource agencies.

3.4.3 Raptor Protection Program

SCE implements the Raptor Protection Program to help protect susceptible raptors from electrocution or injury. This program includes the installation of equipment to help prevent raptor mortality and implementation of program procedures to avoid and report raptor mortality. To help prevent raptor mortality, SCE routinely installs bird screens and guards on problem poles to discourage nesting and perching. Nest cages may be installed on poles subsequent to the removal of a nest to prevent the birds from rebuilding the nest the following season. The program recommends that transmission line operation and maintenance personnel follow raptor protection protocol, including:

- All incidents of facility-related raptor mortality should be reported to SCE Environmental Affairs on a raptor mortality report form.
- Raptor nests should not be removed or disturbed from February to June. Eagle nests should not be removed at any time during the year.
- If a nest is discovered during the February-June period that presents a hazardous situation for the continued safe operation of the line, field personnel should first try to trim the nest. If the nest must be removed, SCE Environmental Affairs department will obtain permits for removing the nest.

3.4.4 Spill Prevention Control and Countermeasure Plans

SCE prepares Spill Prevention Control and Countermeasure plans (SPCCs) to address and minimize the potential, for possible oil spills. These plans describe procedures and available equipment for mitigating any oil spills that might occur.

SCE also has specific provisions for periodic inspection of all oil-containing equipment and devices that prevent spilled oil from escaping the project building or grounds. In addition, all oil transfer operations follow applicable U.S. Department of Transportation regulations.

All SCE Northern Hydro Division operation and maintenance personnel receive annual training on spill prevention, control and containment procedures. The training includes instruction in the operation and maintenance of equipment applicable to spill prevention, applicable spill protocol, and pollution control laws, rules and regulations.

3.4.5 Minimum Instream Flow Measures

SCE ensures that minimum instream flows for fish habitat protection are provided from their facilities located in the Basin, in accordance with existing FERC license conditions. Tables 3.3-1 a, b and c summarize the minimum instream flow releases that are maintained by SCE.

3.4.6 Wildlife Habitat Enhancement

SCE piles or windrows brush cleared from roads and firebreaks or from under transmission lines on project lands, within or adjacent to cleared areas. These activities provide cover and improve the habitat for quail, rabbits and other wildlife.

SCE sponsors a Habitat Area Planning (HAP) Team, and provides funding through a HAP Maintenance Fund. This account has a funding cap of $100,000 and is used to maintain and improve wildlife habitat on SCE lands around Shaver Lake, associated with FERC Project 67. Habitat conditions are regularly monitored and enhancement or mitigation projects are approved and overseen by a cooperative team of biologists from SCE, the USFS and the CDFG.

3.4.7 Annual Planning Meetings with the Sierra National Forest

An annual meeting is held each spring between the Sierra National Forest and SCE to discuss and coordinate operations and maintenance projects planned for the coming year. These meetings allow the two organizations to be aware of upcoming activities and to make sure that proper contacts and preparations are made to avoid or mitigate possible adverse effects on natural and cultural resources.

3.4.8 Facilities

Big Creek Fish Hatchery

SCE operates and maintains a trout hatchery, or rearing facility, at Big Creek to supplement and augment the fisheries stock in the local streams and lakes. SCE stocks approximately 60,000 additional fish per year into Basin waters.

SCE's Forest Tree Nursery

To enhance and protect the timber resources on SCE lands, SCE operates a forest tree nursery and plants about 20,000 seedlings each year to ensure that reforestation occurs in the forest. The nursery produces seedlings from seeds collected from selected trees surrounding Shaver Lake. These seedlings are used to reforest areas as needed, as well as areas that at the turn of the century had been burned or heavily logged.

SCE Maintained Recreation Facilities

SCE constructed and cooperates with the Sierra National Forest in maintaining facilities for recreationists in the Basin, including: developed campgrounds, boat launching facilities, picnic areas, snow-skiing and hiking trails, and access to key hunting, winter play, and fishing locations.

SCE has developed recreational facilities and opportunities, including:

- Camp Edison, maintained and operated by SCE, located along the western shore of Shaver Lake, for public use, providing 252 overnight camping facilities and picnic facilities for 75 families, hot and cold running water, showers, toilet and laundry facilities, disposal stations, electricity, and boat launching facilities. The Camp Edison Information Center provides displays on Native Americans, native fish and wildlife, and timber programs in the Basin;

- a snow play area located just off State Highway Route 168 at the entrance road to the Balsam Meadow Forebay site, with a 20 to 30-car paved parking lot and vault toilets;

- a walk-in day-use area at the Balsam Meadow Forebay site, with 5 picnic sites and vault toilets;

- a snow play area, located off State Highway Route 168 near Pinchot Knob, with portable toilets provided in the winter;

- 12 miles of cross-country ski trails, varying in difficulty, near Shaver Lake;

- free tours of the Big Creek No. 1 Powerhouse and Big Creek Trout Hatchery in the summer;

- many other campgrounds or day-use areas surrounding Huntington, Shaver, and Florence Lakes, and Portal Forebay;
- the Eastwood Overlook Information Center and parking area near Portal Powerhouse and Huntington Lake; and
- fishing access stairs and trails near Mammoth Pool Powerhouse.

4.1 GENERAL DESCRIPTION OF THE BIG CREEK SYSTEM BASIN

4.1.1 BASIN GEOGRAPHY

The Big Creek System Basin is located in central California on the west slope of the Sierra Nevada mountain range within the Sierra National Forest, about 25 miles northeast of the City of Fresno. Yosemite National Park, a popular tourist destination in central California, is located approximately 20 miles north of the Basin, and Kings Canyon National Park is located approximately 20 miles south of the Basin. The headwaters of the South Fork San Joaquin River, the primary river in the Basin, originate in Kings Canyon National Park. Immediately east of the Basin are the eastern slopes of the Sierra Nevada, forming the boundary of the Basin and the geologic province that extends east into Nevada. To the west, the Basin is bounded by the eastern foothills of the San Joaquin Valley.

The Basin has an elongated oval shape and is approximately 40 miles long by 20 miles wide. The Basin encompasses the South Fork San Joaquin River downstream of Florence Lake and extends northward around Kaiser Ridge to the confluence with the North Fork San Joaquin River, located upstream of Mammoth Pool Reservoir. Below Mammoth Pool Reservoir, Big Creek and Stevenson Creek join the main stem San Joaquin River and the Basin extends generally southwestward to a location immediately downstream of the Big Creek No. 4 Powerhouse. PG&E's Kerckhoff Project and the U.S. Bureau of Reclamation's Friant Dam (Millerton Reservoir) are located southwest and downstream of the Basin. PG&E's Crane Valley Project is located northwest of the Basin.

The Basin is located near the exact geographical center of California within an approximate six hour drive from either San Francisco or Los Angeles, and a three hour drive from Sacramento. The closest major urban areas to the Basin include the City of Fresno, (population approximately 415,000) located about 25 miles southwest and the City of Madera, (population approximately 36,650) located about 37 miles west of the Basin. Small communities located within the Basin are Shaver Lake, Auberry, North Fork, South Fork, Big Creek, and Huntington Lake.

The majority of SCE's Big Creek projects are located in northeastern Fresno County, which is separated from Madera County by the San Joaquin River. Mammoth Pool (FERC License No. 2085), Big Creek No. 3 (FERC License No. 120), and Big Creek No. 4 (FERC License No. 2017) are located near the county line (the San Joaquin River) between southern Madera County and northern Fresno County.

Land holdings in the Basin consist predominantly of federal land in the Sierra National Forest with some private in-holding parcels. Existing land uses within the Basin can be characterized as rural, and consist of small communities and private residences or vacation homes, hydroelectric power generation, range land, timber production, mining, research areas, floodplains, Wilderness areas, recreation and transportation systems.

4.1.2 Topography of the Big Creek System Basin

Elevations of Big Creek System waters range from about 1,000 feet above mean sea level (msl) at Big Creek Powerhouse No. 4 to about 9,000 feet msl at Crater Creek Diversion Forebay. The large elevation change in the Basin over its relatively short length of approximately 40 miles served as the initial attraction for hydroelectric development in the area.

The western half of the Basin generally consists of gentle to steep hills and valleys deeply incised by the San Joaquin River and its tributaries (e.g., Big Creek, Stevenson Creek, and Willow Creek). The precipitous and narrow gorge in which the river presently flows in the area north of Shaver Lake actually lies within an older wide valley formed during a long tectonically inactive period during the Miocene Epoch (7-26 million years ago). Remnants of the Miocene valley are present 1,600 to 2,000 feet above the river. Renewed uplift and westward tilting of the Sierra Nevada following the Miocene stability instigated severe downcutting of the river (Lockwood and Bateman 1976).

Lithological[1] variability in terms of resistance to erosion is one of the primary controls of topographical features in the Basin. A series of irregular “steps” have formed, ranging in thickness from a few hundred to a few thousand feet, where resistant rocks outcrop. For example, the 4,082-foot Castle Peak is composed of resistant metasedimentary rocks that have remained mostly intact, while the more weatherable mafic[2] granitics surrounding it have eroded away (Lockwood and Bateman 1976). As another example, the high resistance of old sedimentary and volcanic rocks and the alaskite of Graveyard Peak to weathering was a major factor in the formation of Kaiser Ridge and Silver Divide (north of Huntington Lake and Lake Thomas A. Edison, respectively). These ridges range in elevation from about 7,000 to 12,000 feet msl and form the boundaries of a northwest-trending valley which has been incised about 1,500 feet (in the downstream reaches) by the South Fork San Joaquin River (Bateman *et al*. 1971). In its upstream reaches, the South Fork San Joaquin River is progressively less deeply entrenched, probably as a result of glacial rounding and widening of its surrounding valleys at the higher altitudes (Bateman *et al*. 1971).

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[1] Related to the gross physical character of a rock or rock formation.

[2] Containing or relating to a group of dark-colored minerals, composed chiefly of magnesium and iron, that occur in igneous rocks.

In the eastern half of the Basin above 6,000 feet msl, glaciation has been responsible for the formation of many topographically important features. Glaciers occupied the upper parts of Big Creek and Bear Creek and carved U-shaped valleys in their upper reaches (Bateman and Wones 1972). These contrast strongly with the more deeply incised reaches of the San Joaquin River at lower elevations. At the head of some glaciated valleys, tarns (lakes) such as Cirque Lake and Ward Mountain Lake have formed in cirques (amphitheater-shaped basins formed by glacially induced frost wedging and plucking).

Relatively recent volcanism has also impacted the topography of the Basin in certain areas. For example, about 3.5 million years ago in the Pliocene Epoch, lavas erupted in several portions of the Basin. Many volcanic deposits were subsequently eroded, but several peaks including 8,709-foot Chinese Peak and 9,874-foot Red Mountain (both southeast of Huntington Lake) are comprised of resistant volcanics. The Crater Lake Meadow Geological Area owes its steep-sided nature to the resistance of Pliocene volcanics. Excellent examples of terminal moraines (areas covered by glacier-deposited rocks and debris) from the retreat of the glaciers can be seen at Lake Thomas A. Edison.

4.1.3 CLIMATE

The Basin's Mediterranean climate (comprised of cool, moist winters and warm, dry summers) is variable due to the range in topography. Temperature decreases and precipitation significantly increases with increasing elevation. Extreme precipitation events can deposit more than double the average amount of rainfall and, when coupled with spring snowmelt, can initiate slides in the Basin (ESA 1985). Winds in the upper San Joaquin River basin are less predictable than surface winds in the San Joaquin Valley (Valley) and can attain high velocities (FERC 1982).

TEMPERATURE

The mean temperature in the Forest is approximately 80 degrees Fahrenheit (°F) in the summer and 20°F in the winter (USFS, 1991b). At lower elevations, summer weather is hot and dry with daytime temperatures ranging from 90°F to greater than 100°F and winter daytime temperatures ranging from 20°F to 50°F. At higher elevations of the Basin, temperatures are cooler. Generally, with every 1,000 feet of elevation gain, average air temperature will decrease about 3^0F.

PRECIPITATION

Precipitation in the Basin varies from year to year. The average annual precipitation in the area (rain and snow) is about 42 inches, with over half falling in January, February, and March. Higher elevations may receive over 80 inches of precipitation (mostly snow), while lower elevations receive about 20 inches of rainfall each year (USFS 1991b). Summers are usually dry, with the exception of isolated thunderstorms at higher elevations that are typically of high intensity, short duration, and limited coverage (FERC 1982). Overall, summer storms only account for about 3 percent of the total annual precipitation (USFS 1991b). In the winter months, precipitation comes as both rain and snow. The snowline is at an elevation of about 3,500 to 4,000 feet msl.

Precipitation records of rainfall and snowfall accumulation are available for review on the California Data Exchange Center (CDEC) Internet web page at http://cdec.water.ca.gov/snow_rain.html. The CDEC website presents the data for many precipitation stations in the state including those in the Sierra Nevada. Average annual rainfall recorded at the National Weather Station operated at the town of Auberry from 1960 to the present is 25.21 inches per year. Average monthly rainfall ranges from 0.05 inches to 5.18 inches, with most rain falling between November and April. These rainfall records are summarized in Table 4.1-1 and presented graphically in Figure 4.1-1. Snowfall records from a SCE operated station at Lake Thomas A. Edison indicate that average monthly snow accumulations between February and April (1960 to present) ranges from 38 to 48 inches. The greatest accumulation measured for this same period was 147 inches in March, 1968. These snowfall records are summarized in Table 4.1-2 and presented graphically in Figure 4.1-2.

Elevation is not the only factor affecting the amount of precipitation falling in different areas of the Basin. Kaiser Ridge, which runs approximately through the center of the Forest, creates a rain shadow. The aspect of the ridge influences storm systems approaching from the west so that most of the precipitation is released over the western slopes. In the case of Kaiser Ridge, about twice as much precipitation falls on the range's western slopes as on the eastern slopes (ESA 1985).

WINDS

Solar radiation drives the development of thermal gradients and pressure gradients that create wind and weather patterns. Intramountain winds vary based upon the degree of solar radiation directed toward the mountain sides, as well as elevation, terrain composition, and plant cover. In general, air above the mountain sides in the upper San Joaquin River basin heats up more quickly than air above the Valley floor, creating updrafts of air to higher elevations. This process reverses in the evening, when mountain sides cool more quickly than the Valley, creating downdrafts of air that flow along the mountain slopes. At this time, relatively warm air wells up from the Valley to replace the downdrafted, cooler air. As a result, air currents develop and rather high velocity winds can occur. At high elevations, winds can exceed 100 miles per hour when accompanied by winter storms (FERC 1982). In the summer, the project area occasionally experiences summer winds known locally as Monos. The Monos are strong, dry winds originating in the east that greatly increase the summer fire hazard (USFS 1991b).

AIR BASIN AND CIRCULATION

The Basin is located in the San Joaquin Valley Air Basin (SJVAB), which is a 27,000 square mile basin comprised of eight counties. The SJVAB is bounded by the Sierra Nevada mountain range on the east, the Tehachapi Range on the south, and the Coast Range on the west, forming a bowl-shaped valley topography. The binding mountain ranges interfere with air circulation to the east from Pacific Ocean coastal weather patterns, and they restrict movement of air pollutants by blocking air flow out of the Valley (Fresno County 2000). Complex daytime up-valley and up-slope winds and nighttime down-valley and down-slope winds occur in these mountain ranges due to the rugged terrain and due to intense daytime solar radiation during the summer (Ewell *et al.* 1989).

The topography of the SJVAB has a dominant effect on seasonal wind flow patterns in this region. Prevailing northwesterly winds develop during spring and early summer, resulting from a combination of the Pacific coast summer monsoon, a land-sea breeze, and air flow from the Sierra Nevada mountain range. In Fresno and surrounding areas, morning winds are generally light and flow from the south or from the west toward the Sierra Nevada. In the afternoons, the northwest wind prevails and as temperature increases, wind speed increases. These winds transport pollutants into the Valley from other regions, and disperse locally generated pollutants out of the Valley and up into the Sierra Nevada (Ewell et al. 1989).

Surface-based inversions occur most mornings throughout the year in the SJVAB, as the surrounding mountain ranges prevent marine air from entering into the bowl-shaped basin and dispersing air pollutants. In the winter, storm systems moving through the area create variable wind direction patterns that move the stagnant air. However, between these low pressure storm systems, high pressure systems develop, which decrease wind speed and cause thick inversion layers to develop. When winds return and air temperature increases, convective heating of the earth’s surface lifts and mixes pollutants in the air, the inversion layer dissipates, and the complex winds in the region disperse pollutants out of the Valley and up into the surrounding mountain ranges (Fresno County General Plan 2000).

Figure 4.1-1
Monthly Average Precipitation Near Auberry,1960-Present

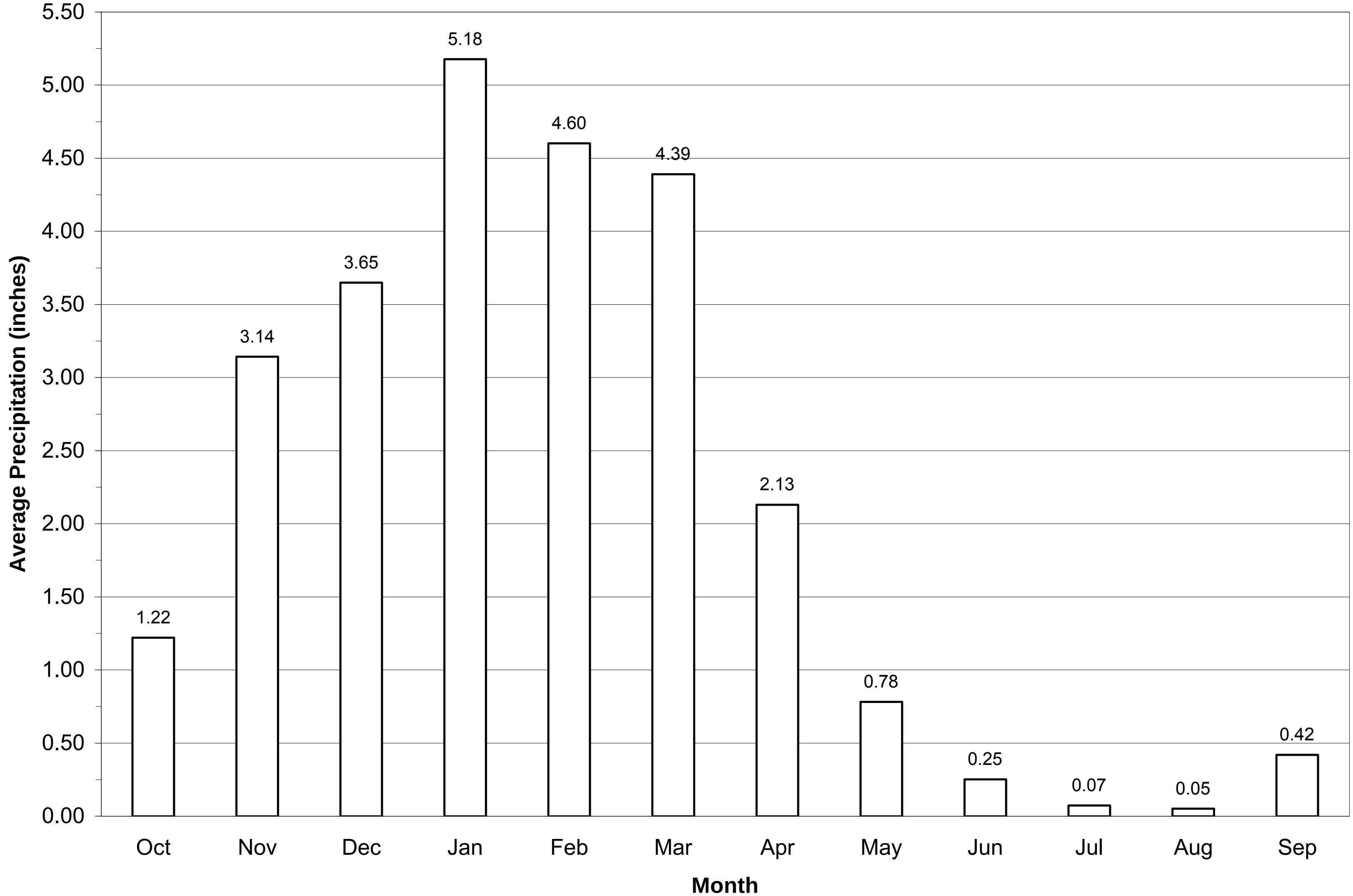

Table 4.1-1 Monthly Average Precipitation (in.) Measured near Auberry, California, 1960 to Present - Elevation: 2090'

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1960	0.02	4.90	1.40	3.69	5.74	2.52	2.45	0.35	0.00	0.03	0.00	0.00	21.10
1961	0.27	3.43	2.08	2.54	1.16	2.54	1.15	0.89	0.07	0.07	0.00	0.17	14.37
1962	1.27	0.11	0.55	3.02	12.42	3.38	0.44	0.37	0.04	0.15	0.00	0.03	21.78
1963	1.90	6.11	0.46	7.27	4.68	4.60	4.71	0.76	0.02	0.00	0.11	0.36	30.98
1964	1.98	4.62	5.84	2.32	0.00	3.45	1.73	1.32	0.34	0.07	0.34	0.27	22.28
1965	0.31	7.33	4.03	4.82	1.47	3.05	4.71	0.22	0.00	0.08	0.15	0.00	26.17
1966	0.00	3.66	9.36	1.50	2.93	0.34	1.16	0.79	0.15	0.01	0.00	0.12	20.02
1967	0.00	2.70	2.86	5.11	0.70	7.72	10.90	0.80	0.02	0.00	0.00	0.69	31.50
1968	2.00	2.95	6.42	2.87	1.46	2.42	0.88	1.41	0.12	0.00	0.00	0.00	20.53
1969	N/A	N/A	N/A	14.43	10.94	3.35	4.12	0.00	N/A	N/A	N/A	N/A	32.84
1970	0.07	5.26	7.11	N/A	N/A	1.79	0.63	0.00	0.81	0.00	0.00	0.00	15.67
1971	0.01	2.23	7.11	2.55	0.48	1.51	1.16	3.02	0.00	0.01	0.00	0.04	18.12
1972	0.50	5.64	2.73	1.00	0.10	0.00	0.81	0.01	0.54	0.01	0.00	1.03	12.37
1973	2.88	4.98	5.02	5.51	9.20	5.07	0.52	0.00	0.00	0.00	0.00	0.00	33.18
1974	3.31	1.79	3.22	6.26	0.76	5.54	3.62	0.00	0.00	0.00	0.00	0.00	24.50
1975	3.51	0.93	0.43	1.81	5.22	7.31	2.45	0.12	0.00	0.00	0.40	0.55	22.73
1976	0.50	0.50	1.31	0.19	8.75	1.93	1.68	0.00	0.01	0.04	0.21	1.63	16.75
1977	0.03	1.60	9.20	1.66	0.65	1.13	0.08	2.06	0.74	0.00	0.00	0.00	17.15
1978	0.00	1.61	2.04	8.80	9.58	9.29	7.09	0.00	0.00	0.00	0.00	2.14	40.55
1979	1.69	2.34	1.98	6.76	5.31	7.66	0.18	0.44	0.00	0.55	0.00	0.00	26.91
1980	0.40	0.28	1.27	8.53	6.16	3.53	1.23	1.05	0.00	0.03	0.00	0.00	22.48
1981	1.62	4.42	3.03	5.96	1.72	5.35	1.27	0.35	0.00	0.00	0.00	0.00	23.72
1982	3.27	6.84	5.98	8.11	3.57	8.53	4.23	0.09	0.75	0.00	0.30	2.39	44.06
1983	0.86	7.48	7.81	8.77	8.66	10.86	3.43	0.55	0.01	0.00	0.21	1.89	50.53
1984	1.49	5.20	2.88	0.36	1.74	2.28	0.62	0.00	0.35	0.07	0.15	0.00	15.14
1985	1.33	5.82	2.26	1.02	1.97	4.69	0.64	0.01	0.09	0.05	0.01	0.67	18.56
1986	0.00	0.11	0.65	4.12	11.63	6.25	0.81	0.18	0.00	0.02	0.00	0.79	24.56
1987	3.04	1.32	3.60	3.92	4.45	4.80	1.05	0.15	0.06	0.00	0.00	0.00	22.39
1988	0.00	3.70	3.69	4.48	1.57	0.73	4.27	1.46	0.08	0.17	0.00	0.00	20.15
1989	2.10	1.70	0.00	0.91	2.15	4.31	0.34	1.94	0.00	0.00	0.07	2.44	15.96
1990	0.10	0.67	1.72	4.98	4.26	1.55	1.11	2.87	0.00	0.00	0.00	0.02	17.28
1991	3.36	1.22	2.67	1.17	1.14	13.78	0.63	0.24	0.21	0.00	0.00	0.04	24.46
1992	3.63	0.00	6.74	1.91	7.09	4.21	0.28	0.08	0.02	1.38	0.00	0.00	25.34
1993	0.83	2.03	2.42	10.96	6.80	3.80	0.55	0.51	1.40	0.00	0.00	0.00	29.30
1994	1.70	4.50	3.19	2.11	5.36	0.93	2.05	0.92	0.00	0.00	0.00	0.50	21.26
1995	0.00	0.06	5.84	13.35	1.68	14.22	3.80	3.01	0.52	0.09	0.00	0.01	42.58
1996	2.85	7.04	10.85	5.97	6.25	4.06	2.60	1.54	0.04	0.01	0.00	0.00	41.21
1997	0.44	3.61	2.90	13.19	0.19	0.42	0.00	0.00	0.24	0.00	0.00	0.16	21.15
1998	0.28	1.64	1.60	10.43	10.77	7.31	3.08	3.62	2.53	0.00	0.00	0.38	41.64
1999	0.02	2.26	0.06	6.17	3.59	1.37	2.72	0.15	0.68	0.00	0.03	0.00	17.05
2000				8.60	11.78	2.44	N/A						
Average	1.22	3.14	3.65	5.18	4.60	4.39	2.13	0.78	0.25	0.07	0.05	0.42	25.21

Notes:
NA = Not available
Source = California Data Exchange Center

Figure 4.1-2
Monthly Average Snow Depth at Lake Thomas A. Edison, 1960 to Present

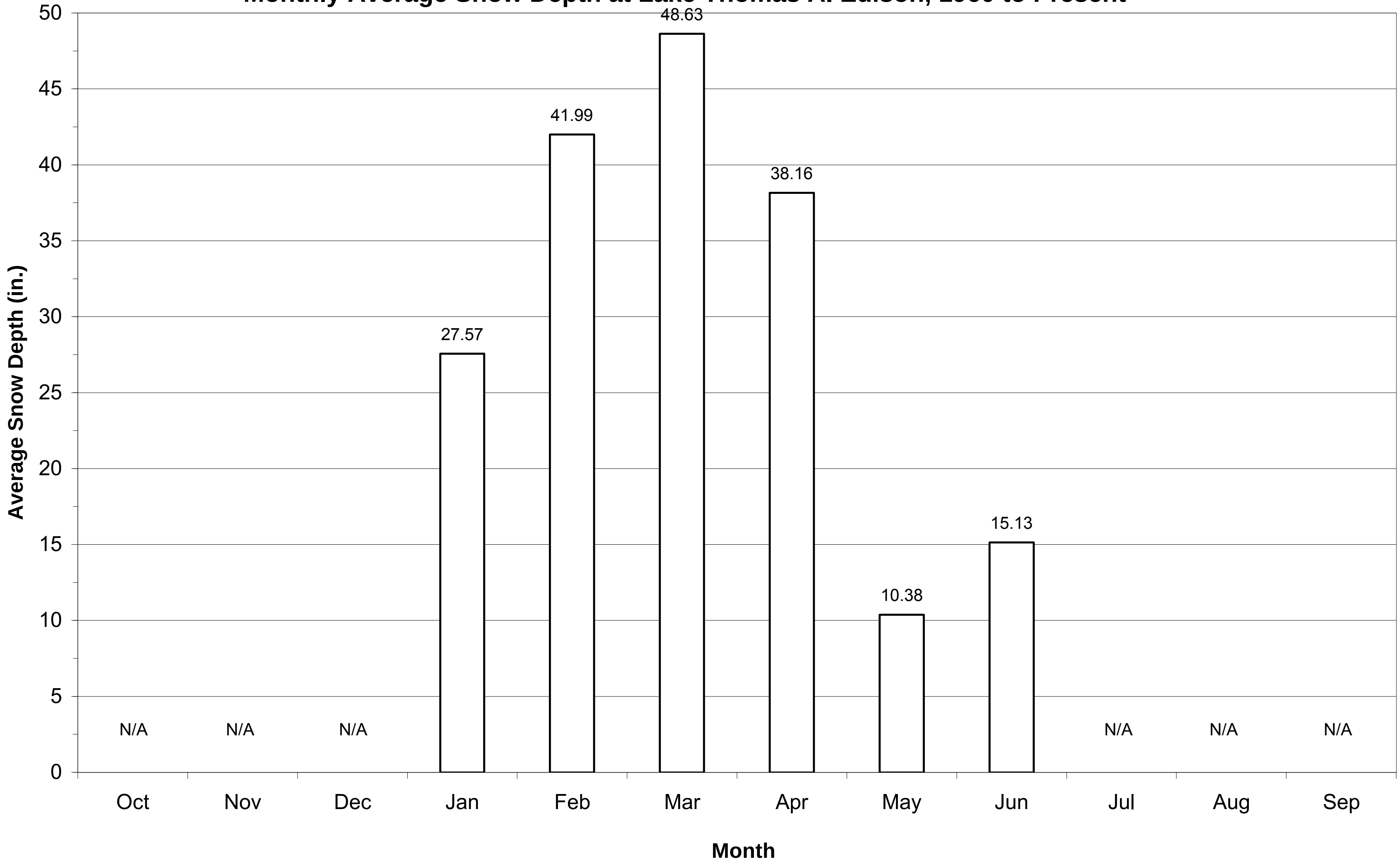

Table 4.1-2 Monthly Average Snow Depth (in.) Measured at Lake Thomas A. Edison - Elevation:7800'

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1960	N/A	N/A	N/A	N/A	27.10	30.40	14.20	0.00	N/A	N/A	N/A	N/A
1961	N/A	N/A	N/A	N/A	22.50	15.80	20.90	0.00	N/A	N/A	N/A	N/A
1962	N/A	N/A	N/A	N/A	28.80	69.80	65.80	0.00	N/A	N/A	N/A	N/A
1963	N/A	N/A	N/A	N/A	N/A	20.30	30.00	29.30	N/A	N/A	N/A	N/A
1964	N/A	N/A	N/A	N/A	28.10	17.80	17.20	0.00	N/A	N/A	N/A	N/A
1965	N/A	N/A	N/A	N/A	48.20	39.70	29.00	0.00	N/A	N/A	N/A	N/A
1966	N/A	N/A	N/A	N/A	49.00	47.20	0.00	N/A	N/A	N/A	N/A	N/A
1967	N/A	N/A	N/A	N/A	61.80	42.30	53.70	60.50	0.00	N/A	N/A	N/A
1968	N/A	N/A	N/A	N/A	34.80	21.70	6.00	0.00	N/A	N/A	N/A	N/A
1969	N/A	N/A	N/A	N/A	103.20	147.70	106.80	62.20	0.00	N/A	N/A	N/A
1970	N/A	N/A	N/A	N/A	34.80	45.40	22.70	0.00	N/A	N/A	N/A	N/A
1971	N/A	N/A	N/A	N/A	38.50	39.40	19.70	0.00	N/A	N/A	N/A	N/A
1972	N/A	N/A	N/A	N/A	42.10	34.80	0.00	0.00	N/A	N/A	N/A	N/A
1973	N/A	N/A	N/A	N/A	52.20	74.20	63.80	N/A	N/A	N/A	N/A	N/A
1974	N/A	N/A	N/A	N/A	45.30	44.50	57.00	13.90	N/A	N/A	N/A	N/A
1975	N/A	N/A	N/A	N/A	21.00	39.80	45.70	N/A	45.40	N/A	N/A	N/A
1976	N/A	N/A	N/A	N/A	N/A	9.80	0.00	N/A	N/A	N/A	N/A	N/A
1977	N/A	N/A	N/A	N/A	N/A	0.00	0.00	N/A	N/A	N/A	N/A	N/A
1978	N/A	N/A	N/A	N/A	65.50	94.40	75.20	N/A	N/A	N/A	N/A	N/A
1979	N/A	N/A	N/A	N/A	48.00	60.80	53.00	N/A	N/A	N/A	N/A	N/A
1980	N/A	N/A	N/A	0.00	36.40	76.60	69.10	N/A	N/A	N/A	N/A	N/A
1981	N/A	N/A	N/A	N/A	N/A	32.60	42.80	0.00	N/A	N/A	N/A	N/A
1982	N/A	N/A	N/A	N/A	52.50	52.70	74.10	N/A	N/A	N/A	N/A	N/A
1983	N/A	N/A	N/A	54.80	90.40	111.40	105.40	N/A	N/A	N/A	N/A	N/A
1984	N/A	N/A	N/A	N/A	29.40	39.50	19.80	0.00	N/A	N/A	N/A	N/A
1985	N/A	N/A	N/A	27.90	32.50	30.00	46.00	N/A	N/A	N/A	N/A	N/A
1986	N/A	N/A	N/A	N/A	32.00	77.70	53.00	N/A	N/A	N/A	N/A	N/A
1987	N/A	N/A	N/A	N/A	12.80	37.20	22.10	0.00	N/A	N/A	N/A	N/A
1988	N/A	N/A	N/A	N/A	39.10	33.70	12.00	0.00	N/A	N/A	N/A	N/A
1989	N/A	N/A	N/A	N/A	27.00	28.30	17.80	0.00	N/A	N/A	N/A	N/A
1990	N/A	N/A	N/A	N/A	25.80	29.40	10.50	N/A	N/A	N/A	N/A	N/A
1991	N/A	N/A	N/A	N/A	11.20	0.60	37.50	2.40	N/A	N/A	N/A	N/A
1992	N/A	N/A	N/A	N/A	17.20	33.70	22.10	N/A	N/A	N/A	N/A	N/A
1993	N/A	N/A	N/A	N/A	73.00	94.90	66.40	N/A	N/A	N/A	N/A	N/A
1994	N/A	N/A	N/A	N/A	21.70	38.10	18.80	N/A	N/A	N/A	N/A	N/A
1995	N/A	N/A	N/A	N/A	71.00	54.00	88.20	49.70	N/A	N/A	N/A	N/A
1996	N/A	N/A	N/A	N/A	41.00	54.80	39.70	N/A	N/A	N/A	N/A	N/A
1997	N/A	N/A	N/A	N/A	78.40	61.70	37.70	0.00	N/A	N/A	N/A	N/A
1998	N/A	N/A	N/A	N/A	34.70	105.30	N/A	N/A	N/A	N/A	N/A	N/A
1999	N/A	N/A	N/A	N/A	N/A	39.80	22.50	N/A	N/A	N/A	N/A	N/A
2000	N/A	N/A	N/A	N/A	34.80	66.00	40.00					
Average	N/A	N/A	N/A	27.57	41.99	48.63	38.16	10.38	15.13	N/A	N/A	N/A

Notes:
NA = Not Available
Source = California Data Exchange Center

AIR QUALITY

The influences of topography, climate, and wind flow patterns in the San Joaquin Valley Air Basin, which includes Fresno and Madera counties, play a significant role in the dispersion and dilution of air pollutants from the Valley up to the Sierra National Forest and surrounding national forests.

The Forest is located downwind from pollutant sources within the San Francisco Bay (Bay) area and the San Joaquin Valley. Visibility and scenic quality of the Forest have been greatly reduced in comparison to historical conditions. This is a result of the high concentrations of particulates and oxidants transported by wind to the Forest and surrounding Sierra Nevada from the urban settings of the Bay area and the Valley (USFS 1991b).

Vehicle emissions account for a large proportion of total emissions of key air pollutants transported into the Sierra Nevada national forests. These pollutants include ground-level atmospheric ozone (O_3), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and particulates. Fresno County is a non-attainment area (does not meet federal air quality standards) for oxidants and specific particulates and Madera County is a non-attainment area for ozone and specific particulates (Fresno County 2000; Madera County 1995). The entire San Joaquin Valley Air Basin often violates state and federal ozone standards (Fresno County 2000). Peak ozone levels occur during warmer periods of the year, and ozone is known to travel long distances from its source and to reduce vegetation growth rates. Evidence of ozone pollution includes needle damage to Ponderosa Pine and Jeffrey Pine in mid-elevation conifer forests at Shaver Lake and throughout the Sierra Nevada mountain range (CARB 1996).

Particulates such as windblown dust and road dust, can remain suspended in the atmosphere for long periods of time and, along with sulfur dioxide, cause visibility degradation in the Forest and surrounding areas. Lakes and streams in the Sierra Nevada national forests are prone to acidification by fugitive dust and acidic precipitation containing nitrate, sulfur dioxide, and carbon monoxide. Acid deposition may impair lake and stream water quality and destroys wildlife habitat and forest stands (Fresno County General Plan 2000). Monitoring of pH is conducted for various streams and lakes within the Forest (USFS 1991b).

Climate, topography, wind patterns, chemical constituents in the atmosphere and their interactions with each other, as well as types of industry, population size, and automobile use in the Bay area and the Valley are some important regional factors contributing to the reduced air quality in the Forest. Important local sources of air pollutants that directly affect air quality within the Forest include road construction, road traffic, winter sports activities and smoke from prescribed fires, wildfires, campfires, and fireplaces (USFS 1991b).

The Forest practice of prescribed burning, to reduce woody materials and other vegetation, emits particulates and aerosols into the local atmosphere, causing short periods of reduced air quality. Wildfires and prescribed fires, in particular, have a significant periodic effect on Forest air quality that is noticeable to the Forest visitor. The California Air Resources Board specifies conditions for accomplishing prescribed burns to limit or exclude smoke from sensitive areas of the Forest. Along with the adjoining Sequoia and Inyo National Forests, the Sierra National Forest also monitors vegetative resources for smog damage and can quantify air quality trends. USFS air quality designations exist to protect the Forest from anthropogenic present and future impairments of air quality (USFS 1991b).

4.2 GEOLOGY AND SOILS OF THE BIG CREEK SYSTEM BASIN

4.2.1 GENERAL OVERVIEW

The Sierra Nevada is comprised predominantly of granitic rock that intruded approximately 200 million years ago (Ma) forming the Sierra Nevada batholith[1]. The granitic intrusion metamorphosed older overlying sedimentary and volcanic rocks, which are observed today as roof pendants[2] on the high peaks. Formation of the modern Sierra Nevada began about 50 Ma when uplifting of the earth's crust commenced, followed by periods of extensive weathering and glaciation forming the current topography and geologic features in the region. Although portions of the Sierra Nevada are still tectonically active, no known active or potentially active fault zones are located within the Basin.

4.2.2 REGIONAL SETTING

The Sierra Nevada geomorphic province is dominated by a westerly-tilted fault block extending 400 miles in a northwesterly direction from the Mojave Desert in the south to the Cascade Range in the north. The extensive uplift of the block on its eastern border created much steeper relief on the eastern side of the range compared to the western side. Consequently, drainages on the eastern flank tend to be steeper and narrower than those on the western flank (USFS 1995). Altitudes along the west slope of the Sierra Nevada vary from the few hundreds of feet msl in the foothill areas of the Sacramento and San Joaquin Valleys to 14,496 feet msl at Mount Whitney. The mountain range varies in width from about 40 to 80 miles (Feth et al. 1964; SCE 2000).

REGIONAL GEOLOGY AND HISTORY

Three general rock groups occur in the Sierra Nevada mountain range: 1) old metamorphosed sedimentary and volcanic rocks, 2) granitic rocks, and 3) younger sedimentary and volcanic rocks. Most of the Basin is comprised of granitic outcroppings of the Sierra Nevada batholith. Glacial deposits exist only in the eastern half of the Basin above 6,000 feet msl. Limited outcroppings of young volcanics occur near Lake Thomas A. Edison, Mammoth Pool Reservoir, and Huntington Lake. Older metavolcanics are exposed just south and east of Florence Lake.

During the Paleozoic Era (about 500 Ma), thick deposits of sediments began collecting in a shallow ocean in the region and eventually hardened into sedimentary rock. Over a period of about 300 million years, these sedimentary

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[1] Batholith - A large mass of igneous rock that has melted and intruded surrounding strata at great depths.
[2] Roof pendant - Hanging or exposed sedimentary rocks on mountain peaks.

rocks were crumpled and folded by tectonic forces. Then, in the Mesozoic Era (roughly 80-225 Ma), volcanic eruptions partially metamorphosed and buried the sedimentary rocks. Meanwhile, hundreds of intrusive granite plutons[3] of various sizes, shapes, and mineralogy cooled and solidified beneath the layers of sedimentary and volcanic rocks to create the Sierra Nevada batholith. Heat and pressure generated from the granitic magma and associated tectonic forces metamorphosed the overlying sedimentary and volcanic rocks, remnants of which are present today mainly as elongated units (Bateman 1992). Both the metamorphic remnants and granitic plutons strike in a northwesterly direction, which is termed the Sierran Trend.

Extensive weathering and erosion followed the emplacement of the Sierra Nevada batholith. Westward tilting of the Earth's crust during the Miocene and Pliocene Epochs (10-50 Ma) metamorphosed some rocks while also uplifting the range. Repeated and extensive glaciation during the Pleistocene Epoch (about the last 2.5 Ma) scoured the surficial rocks of high elevation areas and deposited glacial debris as ice advanced and retreated. Westward tilting of the Sierra Nevada continues today and is occurring at the most rapid rate ever (Huber 1981).

Regional Faulting and Seismicity

The portion of the Sierra Nevada including the Basin is generally an area of low seismicity. No known active or potentially active fault zones are located within the Basin (USFS 1991). However, several regionally active fault zones exist. In 1872, the Owens Valley fault, located about 80 miles to the southeast of the Basin, broke and generated an estimated magnitude 8.2 (Richter scale) earthquake (Ellsworth 1990). Other important fault zones in the general region include the Hilton Creek, Round Valley, Sierra Nevada, Foothills, and San Andreas systems. The Hilton Creek and Round Valley systems are located approximately 30 miles northeast of the Basin. The Hilton Creek fault marks the eastern front of the Sierra Nevada just south of Crowley Lake. The Round Valley fault also marks the eastern front of the Sierra Nevada to the southeast of the Hilton Creek fault. Both of these zones have been recently active, producing a series of magnitude 6 plus (Richter scale) earthquakes near the Mammoth Lakes area in the early 1980s (Ellsworth 1990) and smaller-magnitude tremors even more recently. The Sierra Nevada fault zone marks the southernmost extent of the mountain range and is approximately 180 miles south of the Basin. The Foothills fault system trends in a northwestward fashion and is located about 40 miles northwest of the Basin in the western foothills of the Sierra Nevada mountain range.

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[3] Pluton - A body of igneous rock formed beneath the surface of the earth by consolidation of magma.

REGIONAL SOILS

Soil is unconsolidated surficial material developed over time from the combined effects of climate and biological activity acting on parent rock materials. Soil development in the Sierra Nevada mountain range is generally weak (little horizonation, low clay content, and weak structure) due to the cold winter temperatures, steep slopes, dry summers, resistant parent materials, and the short time period since deglaciation. Direct erosion and mass wasting into drainages (before further weathering and soil formation can occur) is the primary reason that angular to subangular, medium to coarse-grained sands, and large boulders make up most of the substrate in the watercourse drainages in granitic watersheds. Fine-grained silts and clays are typically lacking from these drainages, due to the lack of favorable conditions in the watershed for chemical weathering.

Since granitic rocks dominate the lithology of the Sierra Nevada, silica in the form of quartz and other silica-bearing primary minerals such as feldspar, hornblende, and biotite[4] are ubiquitous. Weathering of granitic rocks in the drainage area produces a condition of low dissolved-solids content (25 to 200 parts per million) in the runoff (Feth et al. 1964), resulting in nutrient-poor waters. Chemical weathering of mineral assemblages in the acidic igneous rocks of the Sierra Nevada influences local soil development. Basic rocks contain minerals (e.g., plagioclase[5], biotite, amphiboles[6], and pyroxenes[7]) that are more susceptible to weathering, while the locally dominant acidic rocks typically contain more resistant minerals (e.g., quartz, orthoclase[8], and muscovite[9]). The effects of such lithological differences are generally masked above 8,000 feet msl since cold conditions limit the potential for chemical weathering rates relative to physical weathering. Thus, regardless of lithological differences, coarse-textured, low-fertility, high-permeability, weakly developed soils generally exist above 8,000 feet msl throughout the Sierra Nevada (USFS 1995).

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[4] Biotite - A dark-brown to black mica, $K_2(Mg,Fe,Al)_6(Si,Al)_8O_{20}(OH)_4$, found in igneous and metamorphic rocks.

[5] Plagioclase - Any of a common rock-forming series of triclinic feldspars, consisting of mixtures of sodium and calcium aluminum silicates. Also called *oligoclase.*

[6] Amphiboles - Any of a large group of structurally similar hydrated double silicate minerals, such as hornblende, containing various combinations of sodium, calcium, magnesium, iron, and aluminum.

[7] Pyroxenes - Any of a group of crystalline silicate minerals common in igneous and metamorphic rocks and containing two metallic oxides, as of magnesium, iron, calcium, sodium, or aluminum.

[8] Orthoclase - A variety of feldspar, essentially potassium aluminum silicate, $KAlSi_3O_8$, characterized by a monoclinic crystalline structure and found in igneous or granitic rock. Also called *potash feldspar.*

[9] Muscovite - A potassium aluminum silicate mineral, $KAl_2(AlSi_3O_{10})(OH)_2$, the most common form of mica, which ranges from colorless or pale yellow to gray and brown, has a pearly luster, and is used as an insulator. Also called *white mica.*

Biological activity is important in soil formation in the Sierra Nevada. Burrowing animals and insects physically mix the soil and incorporate surficially deposited organic materials into deeper soil horizons. Krotovinas (filled-in burrows and root channels) are nutrient-rich and often comprise up to one-third of the soil volume in these otherwise shallower coarse-textured soils (USFS 1995). In addition to creating voids in which krotovinas eventually form, plant roots also affect physical weathering and provide avenues for water to aid chemical weathering.

Most Sierran soils belong to the Entisol and Inceptisol soil orders, but some Alfisols, Mollisols, and Andisols exist. Entisols are young soils, which may show geological stratification but no soil horizon development. Inceptisols are slightly more developed than Entisols. Entisols and Inceptisols within the Basin are formed primarily in granitic materials at mid to high altitudes. Alfisols are moderately well-developed soils that contain a zone of clay accumulation. Mollisols are soils containing an organic-matter rich surface horizon. Alfisols and Mollisols within the Basin are generally limited to localized meadow regions in depressions, wide valley bottoms, and unglaciated volcanic plateaus. Lower altitudes favor soil development in these areas due to the lack of glaciation, warmer temperatures, and gentler slopes. Andisols are formed in areas containing sufficient quantities of volcanic ash and cinders (tephra). Near the Basin, Andisols are located at the Volcanic Knob area east of Lake Thomas A. Edison.

4.2.3 Basin Setting

Basin Geology

The Basin consists mainly of Mesozoic Era granitic rocks (Granite and Granodorite) of the Sierra Nevada batholith. Other major rock types found in the basin are glacial deposit, volcanic, and metavolcanic rocks. Glacial deposits from the Quaternary Period (up to 2 Ma) are found in the eastern half of the Basin above 6,000 feet msl; no evidence of glaciation is apparent west of Huntington Lake (Feth et al. 1964; Bateman and Wones 1972; ESA 1985). Outcroppings of Pliocene Epoch volcanics (2-12 Ma) are found near Lake Thomas A. Edison, Mammoth Pool Reservoir, and Huntington Lake. Metavolcanics rocks of the Jurassic and Triassic Period (135-225 Ma) are exposed just south and east of Florence Lake. These metavolcanics are elongated in a northwesterly direction, in accordance with the Sierran Trend (Lockwood and Bateman 1976).

Strand (1967) compiled a geologic map of the west-central Sierra Nevada mountain range, including the Basin, and more detailed maps are also available (Bateman 1965 and 1989; Bateman and Moore 1965; Huber 1968; Bateman et al. 1971; Bateman and Wones 1972; Lockwood and Bateman 1976; Bateman and Busacca 1982).

Several unique geological features located near the Basin are: 1) the 11-acre Courtright Intrusive Contact Zone Geological Area adjacent to the dam forming Courtright Reservoir, 2) the Dinkey Creek Roof Pendant (10 miles northwest of the Courtright area), and 3) Crater Lake Meadow Geological Area (7 miles west of Lake Thomas A. Edison).

BASIN SOILS

Most soils of the Basin were mapped in a third-order[10] soil survey of the Sierra National Forest in 1983 (USFS 1983). Portions of the Kaiser, Ansel Adams, and John Muir Wilderness areas north of Huntington Lake were not mapped until 1995 when the fourth-order (1:63,360 scale) soil survey of the High Sierra Area was published (USFS 1995). For the general purposes of this IIP and because of the fairly small scales used in these soil surveys, the following information regarding Basin soils is based on the general soil map in the 1983 survey printed at a scale of approximately 1:425,000. Soils of the Basin are listed in Table 4.2-1 and are categorized by parent material, since lithological differences are primarily responsible for differences in soil development, except at the highest altitudes.

Basin soils are organized into the following six groups based on the type of parent material. Residual granitic soils are those formed from the weathering of granitic bedrock. These are the oldest and most common soils in the Basin. Granite typically weathers into coarse-grained sands with little clay. These soils are considered weakly developed. The non-granitic residual bedrock soils are similar to their granitic counterparts, but are formed from the weathering of basalt and andesite[11] bedrock. Glacial soils in the Basin have formed either in ice-deposited (till) or melt water deposited (outwash) materials. Till-derived soils commonly have a wide range of particle sizes (from clays to boulders) and are not sorted. Conversely, outwash soils are stratified because flowing water sorts the particle sizes but contain a wide range of particle sizes overall compared to alluvial soils. Alluvial soils are accumulations of water-transported deposits and may occur in active drainageways and floodplains, localized depressions such as former lakes, and at higher elevations or beneath slopes where there may be collections of glacial debris or colluvium. Colluvial soils are those formed in parent material deposited as a result of gravitational movement. Volcanic soils occur in areas with significant accumulations of volcanic ash and cinders.

Sub-categorization of the Basin's soils is based mainly on topography, since this soil forming factor correlates well with localized climatic conditions, biological activity, and landscape position. In general terms, the most developed soils

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[10] Five orders of soil surveys are recognized, ranging from first order (very detailed) to fifth order (reconnaissance scale). Third order soil surveys are considered "semi-detailed," having a scale between 1:20,000 and 1:65,000 (Brady and Weil 1996). The scale of the Sierra National Forest soil survey is 1:24,000.

[11] Andesite - gray, fine-grained volcanic rock, chiefly plagioclase and feldspar.

occur at lower altitudes due to the lack of glacial disturbance, gentler slopes, and warmer year-round temperatures.

Table 4.2-1 Basin Soils Categorized by Parent Material

Soil Name	Order	Topographic Location	Basin Location	Soil Characteristics	Elevation (ft)	Slope (%)
RESIDUAL GRANITIC SOILS						
Auberry-Ahwahnee families	Alfisols	Granitic bedrock on foothills, mountain sides, and ridges	Around the confluences of Big Creek and San Joaquin River	Moderately deep to deep, well drained	1,000-2,800	5-35
Tollhouse family-Rock outcrop-Chawanakee family	Inceptisols/ Mollisols	Steep mountain sides and ridges	Western half of Basin (west of Huntington Lake)	Shallow, well to somewhat excessively drained, and less developed than Auberry-Ahwahnee (above)	2,000-6,400	15-85
Chaix-Chawanakee families- Rock outcrop; Shaver-Chaix families; Holland- Chaix families	Inceptisols/ Alfisols	Mountain sides and ridges	Western half of Basin (west of Huntington Lake)	Shallow, well to somewhat excessively drained, and less developed than Auberry-Ahwahnee (above)	3,000-7,000	5-65
Gerle, Ledford, Cagwin, and Umpa families; Lithic Xeropsamments	Entisols/ Inceptisols	Mountain sides and ridges	Eastern half of Basin (east of Huntington Lake)	Excessively drained, coarse grained	5,500-8,500	2-85
Rock outcrop-EnticCryumbrepts	Entisols/ Inceptisols	Mountain sides and ridges	Eastern half of Basin (east of Huntington Lake)	Excessively drained, coarse grained	8,500-10,600	5-60

Table 4.2-1 Basin Soils Categorized by Parent Material (continued)

Soil Name	Order	Topographic Location	Basin Location	Soil Characteristics	Elevation (ft)	Slope (%)
RESIDUAL BEDROCK SOILS (NON-GRANITIC)						
Ultic Haploxeralfs	Alfisols	Basalt and andesite mountain sides and ridges	Throughout the mid-elevations of the Basin	Deep, well drained	1,700-8,200	15-60
Neuns, Holland, and Umpa families	Inceptisols/ Alfisols	Metamorphic rock mountain sides and ridges	Throughout the mid-elevations of the Basin	Moderately deep to deep, well drained	2,700-8,000	3-65
Typic Xerumbrepts	Inceptisols	Volcanic flows, mountain sides, and ridges	Throughout the mid-elevations of the Basin	Deep, well drained	6,700-8,800	5-55
GLACIAL SOILS						
Sirretta family	Entisols	In granitic glacial till deposited on moraines or mountain sides	Above 6000 feet msl and east of Huntington Lake	Deep, somewhat excessively drained, coarse textured	6,000-8,500	3-65
Umpa family	Inceptisols	In metamorphic glacial till colluvium on moraines and mountain sides	Above 6000 feet msl and east of Huntington Lake	Well drained or moderately well drained	6,000-8,600	3-60
Stecum family	Entisols	In granitic glacial till deposited on moraines, mountain sides, colluvial slopes, outwash plains	Above 6000 feet msl and east of Huntington Lake	Deep, excessively drained	8,000-10,600	3-65
Aquic Dystric Xerochrepts and Aquic Cryumbrepts	Inceptisols	Granitic outwash plain deposits	Above 6000 feet msl and east of Huntington Lake	Deep to very deep, somewhat poorly drained, coarse textured	6,700-9,600	1-15

Table 4.2-1 Basin Soils Categorized by Parent Material (continued)

Soil Name	Order	Topographic Location	Basin Location	Soil Characteristics	Elevation (ft)	Slope (%)
ALLUVIAL SOILS						
Alluvial soils	Entisols or Inceptisols	Former or active drainageways, their associated floodplains, localized depressions, and meadows	Limited occurences throughout the Basin	Very deep, well stratified, relatively free of rock fragments, rich in organic material, poorly drained	N/A	N/A
COLLUVIAL SOILS						
Neuns, Umpa (deep), and Holland families	Inceptisols/ Alfisols	Metamorphic colluvium on colluvial slopes, ridges, and mountain sides	Throughout the mid to high elevations of the Basin	Moderately deep to deep, well drained	2,700-8,600	3-65
Ultic Haploxeralfs	Alfisols	Basaltic or andesitic colluvium on mountain sides and ridges	Throughout the mid to high elevations of the Basin	Moderately deep to deep, well drained	1,700-8,200	15-65
Stecum family	Entisols	Granitic colluvium on moraines, mountain sides, colluvial slopes, and outwash plains	Throughout the mid to high elevations of the Basin	Deep, excessively drained	8,000-10,600	3-65
VOLCANIC SOILS						
Volcanic Soils	Andisols	Mountain sides and ridges	Just outside the Basin near Volcanic Knob immediately east of Lake Thomas A. Edison	Deep to very deep, well drained to somewhat excessively drained	7,300-10,800	0-55

4.3 WATER QUALITY AND WATER USE

4.3.1 GENERAL OVERVIEW

The Big Creek System Basin is located in the upper San Joaquin River watershed, which is identified by the Central Valley Regional Water Quality Control Board (CVRWQCB) as the San Joaquin River Hydrologic Unit, (Hydrologic Unit Number 540.00) (CVRWQCB 1998). The hydrological unit is further subdivided in hydrological areas and subareas based on flow patterns resulting from topographical constraints in the Basin. The San Joaquin River and its North, Middle, and South Forks are the primary water courses in the watershed/hydrologic unit.

Water quality within hydrologic units is under the regulatory authority of local regional water quality control boards (Regional Boards). The San Joaquin Hydrological Unit is under the authority of CVRWQCB. The CVRWQCB determines the beneficial uses of waters in the Basin and, in turn, establishes and adopts water quality standards to protect those beneficial uses with the approval of the SWRCB.

Water quality within the Basin is generally of high quality and in conformance with the water quality objectives and standards for beneficial uses identified for the water resources in the Basin. The surface waters are low in mineral and nutrient content, which is characteristic of regions composed of granitic bedrock with shallow infertile granitic soils. These soils do not contain abundant nutrients and minerals either. In addition, melting snow, which provides most water in the Basin, is low in nutrients and provides most of the inflow to the reservoirs. This high quality water is conveyed to lower elevations partially through the pipelines and tunnels of the Big Creek System, as well as using the natural stream courses, which move through the granitic rock watershed. Therefore, these high quality low nutrient characteristics also are observed in the water when it reaches lower elevations.

Surface water uses in the Basin are predominantly non-consumptive and include hydroelectric generation and recreational activities such as fishing, swimming, and boating. Water used by SCE for hydroelectric generation, a non-consumptive use, is diverted and used pursuant to various contracts, agreements and water rights and then returned to the river.

4.3.2 GROUNDWATER

The Big Creek watershed is underlain by crystalline rocks of the Sierra Nevada batholith. Groundwater occurrence in such rock is generally restricted to open fracture systems in the rock body or, to a minor extent, the surficial weathered zone of the rock. The fracture systems that carry the majority of the groundwater are classified as primary or secondary. Primary fractures are related to the regional stresses that occurred during formation of the rock through crystallization. Secondary fractures are caused by stresses due to faulting and folding after crystallization.

Groundwater movement through crystalline rock is controlled by the orientation of the fracture systems and the amount of lateral and vertical communication between them. Groundwater levels may be highly variable under both confined and unconfined conditions, depending on the extent and location of interconnecting fractures.

Groundwater recharge is principally obtained from precipitation as snow and rainfall. The rainfall percolates into the fractures at the surface, then travels downward and laterally, to the extent possible, entering the zone of saturation.

There are numerous minor springs and seepage areas in the Basin. The springs are generally associated with rock fractures that allow the flow of groundwater from the zone of saturation to the ground surface. Seepage areas are generally restricted to meadows where the water table meets the ground surface.

4.3.3 BENEFICIAL WATER USES

The State of California, in Water Code Section 13050(f), defines beneficial uses of California water that may be protected against quality degradation to include domestic, municipal, agricultural and industrial supply, power generation, recreation, aesthetic enjoyment, navigation, and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. Hydroelectric power generation is considered a beneficial use. The protection and enhancement of beneficial uses requires that certain quality objectives be met for surface and ground waters.

The beneficial uses for the waters of a particular area are identified in the local Regional Board water quality plans for the numerous watershed basins throughout the state. The existing and potential beneficial uses that apply to surface waters within the Big Creek System watershed are identified in Table II of *The Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board –Control Valley Region Fourth Edition 1998*.

The Regional Boards also establish and identify beneficial uses for the groundwater in the state. Unless otherwise designated by the Regional Board, all groundwaters in the region are considered as suitable or potentially suitable for municipal and domestic supply (MUN), agricultural supply (AGR), industrial service supply (IND), and industrial process supply.

These beneficial use designations serve as a basis for establishing water quality standards. Beneficial uses for the tributary waters to Millerton Reservoir are listed as municipal and domestic water supply, agricultural uses (irrigation and stock watering), hydroelectric power generation, water contact recreation, non-contact water recreation, commercial and sport fishing, cold and warm freshwater fish habitat, and wildlife habitat. These beneficial uses are described in the Basin Plan as follows:

- Municipal and Domestic Supply (MUN) – Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

- Agricultural Supply (AGR) – Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.

- Hydropower Generation (POW) – Uses of water for hydropower generation.

- Water Contact Recreation (REC-1) – Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

- Non-contact Water Recreation (REC-2) – Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beach combing, camping, boating, tidepool and marine life study, hunting, sightseeing,

- Commercial and Sport Fishing (COMM) – Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

- Warm Freshwater Habitat (WARM) – Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

- Cold Freshwater Habitat (COLD) – Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

- Wildlife Habitat (WILD) – Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

4.3.4 Water Quality Criteria

The Regional Boards are required to establish water quality objectives that are protective of the designated beneficial uses of the waters for the basins under their jurisdiction. When establishing such water quality objectives, the Regional Board must consider the following factors: 1) past, present and probable future beneficial uses; 2) environmental characteristics of the hydrographic units (watershed) under consideration; 3) water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area; 4) economic considerations; 5) the need for developing housing in the region; and 6) the need to develop and use recycled water.

To protect beneficial uses, water quality in the Big Creek System watershed must meet the objectives identified in the Basin Plan. The Basin Plan considers background water quality levels and the objectives are based on criteria that protect both human health and aquatic life. If these criteria are not exceeded, the beneficial uses should be protected and nuisances should be prevented.

The minor non-power consumptive uses of surface water and groundwater within the Basin include domestic use by the Sierra National Forest facilities, SCE facilities, the communities of Big Creek, Shaver Lake, Huntington Lake, and the Sierra Summit Resort. In 1991, the Sierra National Forest used approximately 6,000 af of water for facilities, residences, and operations. The USFS has identified the most important uses of water in the Sierra National Forest to be predominantly non-consumptive recreational activities, which include fishing, swimming, boating and other water related activities (USFS 1991).

After passing through the Big Creek System, the Basin's surface waters flow to downstream water users. The downstream users include:

1) the Pacific Gas & Electric Company for hydropower generation;

2) the U.S. Bureau of Reclamation Friant Power Authority, which administers agreements with irrigators in the San Joaquin Valley through the operations of Friant Dam and Millerton Reservoir; and

3) other irrigators in the San Joaquin Valley, whose agreements for water rights pre-date those of USBR.

Irrigation is a major water use in the San Joaquin Valley, an area supplying produce that is distributed to much of the western United States and exported throughout the world.

Water Quality Studies

Numerous water quality studies have been performed on the lakes, rivers and streams within the watershed. Most studies were performed in conjunction with the preparation of previous license applications and evaluation of modifications to existing projects in the Basin. Based on the results of past studies, the water quality conditions in the Basin can be described as of high quality and in conformance with the Regional Board's water quality objectives and standards.

Primary productivity in lakes within the Basin is limited by the lack of nutrients and by the short residence time of waters in the reservoirs. Melting snow is low in nutrients and provides most of the inflow to the reservoirs. This low nutrient content inflow is conveyed to the lower elevation water bodies partially through pipelines and tunnels for the hydroelectric projects or through the natural granitic bedrock channels.

Factors that may alter water quality include contamination from external sources, modifications of temperature or chemical compositions, and increased sedimentation. The USFS has identified sedimentation as the greatest threat to increasing turbidity in water quality and subsequently impacting aquatic habitat within the Forest (USFS 1991). The beneficial uses affected by sedimentation are fish habitat and reservoir storage. Land disturbing activities such as road building and timber harvesting have the greatest potential to cause erosion resulting in sedimentation.

RESERVOIR STUDIES

In the summer of 1968, Nicola and Cordone performed a limnological survey of 26 high mountain reservoirs in the Sierra Nevada in California. This study included four lakes associated with the SCE's hydroelectric developments in the Big Creek System watershed: Lake Thomas A. Edison, Mammoth Pool Reservoir, Huntington Lake, and Shaver Lake. Nicola and Cordone concluded that the majority of these lakes were oligotrophic (nutrient poor) due to their size, depth, and drainage of relatively infertile granitic soils. Temperatures of the lakes were typical of the altitude, depth of the lakes, and climatological conditions. Stratification was generally moderate to weak, and temperatures ranged from about 15°C to 22°C. Colder water temperatures were observed in Lake Thomas A. Edison and Huntington Lake (high elevation lakes at about 7,000 feet msl) and warmer temperatures were observed in Mammoth Pool Reservoir and Shaver Lake (lower elevation lakes at about 3,400 feet msl and 5,000 feet msl, respectively). Table D-1 (Appendix D) presents a summary of the chemical and physical characteristics of water samples collected from these four lakes (Nicola and Cordone 1972).

Limnological studies of Huntington Lake and Shaver Lake were performed by the California Department of Water Resources (DWR) in the summer and fall of 1979. These studies were conducted to develop baseline limnological data for Huntington Lake, Shaver Lake and the streams entering these lakes. Six sampling stations were established at Huntington Lake, four were located in the lake and two located at Big Creek and Rancheria Creek, the two largest streams entering the lake. Six sampling stations were established at Shaver Lake, four in the lake and two located along North Fork Stevenson Creek and Pitman Creek. The physical and chemical water quality results from water samples collected during this study are summarized in Table D-2 (Appendix D).

Based on the results of the study, the quality of water in Huntington Lake and Shaver Lake is considered excellent. Both lakes are low in nutrient and mineral content. Huntington Lake is well mixed and its high flow-through rate results in low nutrient levels. Shaver Lake has a much lower flow-through rate than Huntington Lake and its physical characteristics are not conducive to thorough mixing. Each year, both Shaver Lake and Huntington Lake are drawn down to provide storage space for the spring snowmelt. This flushing helps maintain the excellent water quality in the lakes. Water temperatures are warmer in Shaver Lake than those observed in Huntington Lake. These warmer temperatures are attributed to the lower elevation and a much lower flow-through rate in Shaver Lake (DWR 1980).

Further studies were performed on Shaver Lake by BioSystems in 1987 as part of the proposed but not implemented Big Creek Expansion Project (BiCEP) (BioSystems 1987). These studies focused exclusively on Shaver Lake and its watershed. Limnological studies were conducted to document existing conditions in Shaver Lake and consisted of performing temperature and oxygen profiles, and collecting water samples for chemical analysis and measuring physical parameters. Three sampling stations were established in the lake; near the dam, mid-lake, and near the inflow. Table D-3 (Appendix D) presents a summary of previous limnological data from Shaver Lake including the results of the 1987 BioSystems studies.

The BioSystems draft report presented study results indicating that Shaver Lake was thermally stratified in May 1986 with the warmer near surface waters extending down two to four meters, and in August extending down four to six meters. Dissolved oxygen concentrations measured in October 1986 revealed substantially lower concentrations at depth, confirming the results of the temperature profiles. The pH in Shaver Lake ranged from 7.4 to 6.4 from June to December 1986, which is consistent with previous studies. Other parameters measured (conductivity, total dissolved solids, turbidity, sodium, calcium, and magnesium) were also consistent with past studies and did not create issues of concern regarding the fishery or human health (BioSystems 1987).

The waters of Shaver Lake and its tributaries (Tamarack Creek, Pitman Creek, North Fork Stevenson Creek, and Balsam Creek) were sampled and measured for physical water quality parameters (temperature, dissolved oxygen, conductivity, and pH) during four sampling events performed in 1978 and 1979 by SCE as part of environmental studies in support of the Balsam Meadow Project. The results of this study are summarized in Table D-4 (Appendix D). The results of the analysis indicate the water quality conditions in Shaver Lake and inflow tributaries meet basin standards (FERC 1982).

Iron accumulation in Mono Creek was first noted during a 1984 flow study and was observed originating from drain seepage at the base of Vermilion Valley Dam (BioSystems 1986). A study was performed to determine the effects of iron in benthic invertebrates and impacts on fisheries in Mono Creek below the dam. This study included the collection of water quality samples from eleven locations in the area. Water samples were collected from control sites on Bear Creek and upper Mono Creek, at the toe drain below the dam, the confluence of the toe drain and Mono Creek, and at an unnamed creek with iron accumulation. The laboratory results of the water sample analyses are summarized in Table D-5 (Appendix D).

Concentrations of iron found in the toe drain from the dam were 3.4 and 3.6 mg/l total iron during March 1984 and 3.6 and 3.7 mg/l during July 1984 (BioSystems 1986). These concentrations exceeded the EPA standard of 1 mg/l. Elevated concentrations were only detected in the toe drain samples. At the confluence of the toe drain and Mono Creek, the total iron concentrations decreased to 0.2 mg/l and 0.75 mg/l in March and September 1984, respectively. This concentration was below the EPA criteria. The exact cause of the iron was not identified, however, it was suggested that the fill material or the impervious clay liner may be the source and that slightly acidic lake water passing through may have dissolved the iron.

Additional water quality studies were performed on the waters of Lake Thomas A. Edison and Mono Creek in 1984. Five water sampling stations were established as follows: two stations in Lake Thomas A. Edison near the dam at depths of 0.5 meters and 40 meters; and three sample stations in Mono Creek. The stations in Mono Creek were located immediately below the dam, in the diversion forebay, and below the diversion forebay. Water samples were collected for chemical analysis of calcium, magnesium, sodium, total dissolved solids, nitrate nitrogen, orthophosphate, and chlorophyll (EA Engineering 1984). The results of these laboratory analyses are summarized in Table D-6 (Appendix D). The results indicated that the waters in Lake Thomas A. Edison and Mono Creek are low in nutrients and minerals (with the exception of iron in the toe drain of the dam discussed above).

A water quality study of physical and chemical parameters was performed on the Big Creek No. 3 project waters in 1985 and 1986 as part of BiCEP. Water samples were collected from waters impounded above Dam 6, from the San Joaquin River below Dam 6, above Powerhouse No. 3, and in the tailrace below Powerhouse No. 3. Three sampling events were performed in August 1985, October 1985, and July 1986. The results of the water quality analyses performed on these were compiled from the draft report of the study and are summarized in Table D-7 (Appendix D). The draft study results indicate that the project waters of Big Creek No. 3 are low in nutrients, minerals, and suspended materials, and contain high concentrations of dissolved oxygen (EA Engineering 1987a).

Water quality studies were performed on the Big Creek No. 4 project waters in 1985 and 1986 as part of BiCEP (EA Engineering, 1987b), and in 1994 and 1995 in support of the preparation of the application for new license (SCE 1997). Water samples were collected from Redinger Lake and from the diverted reach of the San Joaquin River in both studies. Sampling stations were established in the lake and vertical profiles of water quality parameters were measured at the stations. The results of water quality analyses and measurements from these stations were compiled from draft reports and are summarized in Table D-8 (Appendix D). This table summarizes physical and chemical data from the draft report of the 1985/1986 study, and Table D-9 (Appendix D) summarizes the physical and chemical data from the 1994/1995 study.

Both studies indicate that the waters in Redinger Lake are low in nutrients and minerals. This is attributed to the granitic bedrock, and shallow decomposed granitic soils (see Section 4.2). The lake was stratified during the 1985/1986 study and during the 1994 study. In 1995, the inflow into the lake was high and resulted in vertical mixing through the water column through early August. Surface heating and stratification began to take place in late August after the inflows into the lake decreased.

The waters of the diverted reach of the San Joaquin River below Dam 7, is comparable to the high quality water of Sierra Nevada rivers in the relatively undisturbed western slope watershed (SCE 1997). The water entering the San Joaquin River below Dam 7 is very similar in physical and chemical composition to deep water in Redinger Lake. Between Dam 7 and Big Creek Powerhouse No. 4 there is an increase in temperature, pH and dissolved oxygen. This is due to heating during the warm summers and movement and agitation of water in the river.

4.3.5 Water Rights

Each of SCE's Big Creek hydroelectric projects has either its own separate water right or shares one or more water rights with one or more projects for the diversion, use, and, at times, storage of water. The vast majority of the water rights are for non-consumptive uses associated with the generation of power. A few locations, such as the Big Creek Camp community, have minor amounts of consumptive water rights. These consumptive rights allow for incidental domestic, sanitation, and irrigation (landscape) use of water by employees. SCE does not hold water rights for the consumptive use of water by any party other than SCE, nor does SCE sell any water rights associated with the hydropower projects to other parties.

SCE's water rights were all obtained pursuant to state law. The majority of the water rights are documented by licenses and permits issued to SCE, or its predecessors, by the SWRCB. Other water rights were obtained through appropriation of water prior to the implementation of the Water Commission Act of 1914, and by prescriptive use against other parties after 1914. Certain other water rights are held by SCE as a riparian land owner, authorizing SCE to divert and use the water on land owned by SCE. Table E-1 (Appendix E) presents a summary of the Big Creek System water rights licenses and permits.

SCE operates reservoirs in accordance with the Mammoth Pool Operating Agreement, which specifies reservoir storage and minimum flow constraints based on the computed natural runoff for the water year at Friant Dam. Table E-2 (Appendix E) summarizes the storage and flow constraints contained in the Mammoth Pool Operating Agreement.

Additionally, SCE has entered into a number of contracts and agreements with downstream water rights holders addressing the diversion and use of water for the SCE hydroelectric projects. Generally, the water rights holders with senior rights were diverting and using water for consumptive purposes prior to SCE, or its predecessors, diverting the water for storage and use at hydroelectric projects. To protect the rights of the downstream water rights holders, SCE entered into agreements that restrict the use of water to non-consumptive purposes, like hydroelectric generation. Certain agreements limit the time and amount of water that SCE can store in its hydroelectric project reservoirs. In a few instances, SCE's non-consumptive water use is a senior water right, and other users hold junior water rights.

SCE operation of the Big Creek System is subject to the water rights described above and a large number of regulatory agency permits and orders and through various contracts with other parties. The permits include FERC licenses for the seven Big Creek hydroelectric projects, waste water discharge permits, burning permits, air quality permits, USFS Special Use Permits granting certain rights to use land, hazardous waste permits, transportation permits, and approvals of various plans for compliance with regulatory mandates, such as the Spill Prevention Control and Countermeasure plans. The contracts include agreements to use another person's property, including the diversion and non-consumptive use of water to which downstream water rights holders have a superior claim. None of these permits, orders, or contracts, or the rights granted thereunder, will change with the relicensing of the Big Creek System by SCE.

4.3.6 Hydrology

Watershed

The upper San Joaquin River watershed begins at the crest of the Sierra Nevada and extends in a generally westerly direction to Millerton Lake, northeast of Fresno. Millerton Lake is located in the eastern foothills of the San Joaquin Valley. The upper watershed contains the North, Middle, and South forks of the San Joaquin River, in addition to numerous tributaries. The headwaters of the San Joaquin River are at the high peaks of the Sierra Nevada and have extensive snow cover in the winter, extending into the summer. The watershed ranges from an elevation of 560 feet msl at Millerton Lake to about 14,000 feet msl at the headwaters.

Within the upper San Joaquin River watershed is the Big Creek System Basin. The Basin includes the storage, diversion, and power facilities that comprise the SCE hydropower system. The Basin includes the South Fork San Joaquin River downstream to the San Joaquin River and Big Creek Powerhouse No. 4 on the San Joaquin River main stem. The elevation of the Big Creek facilities range from about 9,000 feet msl at the Crater Creek Diversion to about 1,000 feet msl at Big Creek Powerhouse No. 4. The contributing watershed for the Big Creek System facilities encompasses the tributaries of the upper San Joaquin River, including Big Creek and Stevenson Creek. The total contributing drainage area upstream of Redinger Reservoir is 1,292 square miles.

Runoff in the Basin is derived from the snow pack, which remains unmelted at high elevations throughout much of the year, and rainfall. The average annual precipitation in the watershed area is about 42 inches, with over half of that falling in January, February, and March. Higher elevations of the watershed may receive over 80 inches of precipitation, while lower elevations of the project area receive about 20 inches of rainfall each year (USFS 1991). In the winter months, precipitation comes as both rain and snow. The typical winter snowline is at an elevation of about 3,500-4,000 feet msl. The snowmelt period is typically from April through July. Rainfall events can occur throughout the remainder of the year but predominately occur from November through March. Runoff also occurs from rainfall on snow events. The mean annual runoff for the watershed is about 1,700,000 af.

Precipitation and snowfall accumulation are recorded in the San Joaquin River watershed through a network of monitoring and recording stations operated by the National Weather Service, U.S. Forest Service, U.S. Bureau of Reclamation and SCE. Stations are located throughout the Basin ranging from low elevation locations near Auberry, to upper watershed locations such as the snow station operated by SCE at Lake Thomas A. Edison. Real-time and historical precipitation data of rainfall and snowfall accumulation are available on the California Data Exchange Center website (http://cdec.water.ca.gov/cgi-progs/).

WATER YEAR TYPES

Hydrologic conditions (i.e., river flow, reservoir storage) are typically recorded based on a water-year extending from October 1 through September 30 of the following year. The total runoff volume for a water-year is used as a measure of how wet or dry the past year was relative to other years. For the entire San Joaquin River watershed, the California Department of Water Resources uses a system that classifies the water-years into one of five hydrologic year types: wet, above normal, below normal, dry, and critical. The water-year type is a measure of the amount of runoff in the San Joaquin River watershed upstream of the Sacramento/San Joaquin Delta and is computed by summing the runoff from the Stanislaus, Tuolumne, Merced, and San Joaquin rivers at specified locations. SCE, operating under FERC license conditions, uses a similar definition of normal and dry years, as measured by the projected runoff at Millerton Lake on

April 1st to determine certain instream flow and reservoir storage requirements at some Big Creek projects. This definition classifies years as normal or dry, depending on whether the April 1st, forecast is greater than or equal to 900,000 af.

The year types for the 1960 to 1999 period (presented in Table 4.3-1) display high inter-annual variability with slightly more than one-half of the years (51 percent) being wet and above normal water-year types. The greatest percentage of water-year types were the extreme ends, either wet (38 percent) or critical (very dry) (28 percent) water-years. For the 39-year period shown, there are 15 wet, 5 above normal, 3 below normal, 5 dry, and 11 critical water-year types.

STREAMS AND RESERVOIRS

An extensive network of stream and lake gaging stations are located in the Basin to monitor and record the storage and flow of water. This network consists of 19 stations that measure flow in rivers and creeks, six stations that measure reservoir elevation and storage on SCE's major reservoirs, and nine gaging stations that measure flow through the tailraces of SCE's nine hydroelectric powerhouses. Gaging station locations are depicted in Figure 2.4-1 and summarized in Tables E-3, E-4, and E-5 in Appendix E. The hydrologic data for the period of record from 1980 to 1998 for the rivers, streams, and reservoirs in the Basin are summarized on the exceedance graphs in Figure E-6 in Appendix E. This period of record is inclusive of the most recent hydrologic data obtained from stream gages operating in the Basin that has been reviewed, approved and published by the USGS.

Table 4.3-1 Hydrologic Year Types in the San Joaquin River Watershed

Water Year	Hydrologic Year Type	Water Year	Hydrologic Year Type	Water Year	Hydrologic Year Type	Water Year	Hydrologic Year Type
1960	Critical	1970	Above Normal	1980	Wet	1990	Critical
1961	Critical	1971	Below Normal	1981	Dry	1991	Critical
1962	Below Normal	1972	Dry	1982	Wet	1992	Critical
1963	Above Normal	1973	Above Normal	1983	Wet	1993	Wet
1964	Dry	1974	Wet	1984	Above Normal	1994	Critical
1965	Wet	1975	Wet	1985	Dry	1995	Wet

1966	Below Normal	1976	Critical	1986	Wet	1996	Wet
1967	Wet	1977	Critical	1987	Critical	1997	Wet
1968	Dry	1978	Wet	1988	Critical	1998	Wet
1969	Wet	1979	Above Normal	1989	Critical		

PERCENT OF TIME FOR EACH WATER YEAR TYPE (1960-1998)
Wet - 38 percent
Above Normal - 13 percent
Below Normal - 8 percent
Dry - 13 percent
Critical - 28 percent

SCE uses hydrologic forecasting for real-time operations of reservoirs and diversions consistent with existing water rights, license conditions, agreements, and other restrictions. Both past and projected runoff in the Basin is used in determining the operation of the SCE reservoirs. The reservoirs are operated by the Mammoth Pool Operating Agreement to regulate storage, to meet instream flow requirements, to comply with physical constraints, and to meet power production needs.

The Mammoth Pool Operating Agreement uses the watershed runoff projected for the current year and measured runoff from the previous year to determine storage and flow constraints in the Big Creek System. For example, the minimum allowable storage in the Big Creek System on March 1 of any year is determined from the computed natural runoff at Friant Dam for the previous water year and the Big Creek System storage at the start of the water year. The maximum annual allowable flow passing Dam 7 is set in the Mammoth Pool Operating Agreement based on the March 1 forecast of runoff. The forecasted runoff is an attempt to identify the type of water year that will occur in the upper San Joaquin River watershed on a near real-time basis.

Minimum instream flow releases are made by SCE from the diversions and impoundments to protect fish habitat and instream beneficial uses in the project bypass reaches. These releases occur throughout the year and the volumes of minimum instream flow may change by water-year type (normal or dry years) depending upon project and license conditions.

PRIMARY WATERCOURSES

The South Fork San Joaquin River drains the highest elevation region in the Basin. The South Fork San Joaquin River and it tributaries contain storage reservoirs and diversions. The flow in the river is highly regulated and is typically controlled to maximize power production.

Additional flow enters the South Fork San Joaquin River from Bear, Mono, Hooper, North and South Slide, Crater, Chinquapin, Camp 62, Bolsillo, Rock, and Warm creeks. Diversion facilities are present on many of these tributaries and a portion of the flow is diverted to the Ward Tunnel, which conveys water through Portal Powerhouse and into Huntington Lake. Water not diverted to Ward Tunnel flows to the South Fork San Joaquin River and on to the mainstem San Joaquin River. Runoff that is not regulated by project facilities also enters the river.

The mainstem of the San Joaquin River receives inflow from North, Middle, and South Forks of the San Joaquin River, Willow Creek, Stevenson Creek, Big Creek, and numerous other smaller tributaries. Streamflow in the San Joaquin River from Mammoth Pool downstream to Redinger Reservoir responds to snowmelt runoff in the upper and lower watershed, and rainfall. Snow in the lower watershed (elevation of 1,000-7,000 feet msl) typically melts and enters the river in April-June. In the upper watershed (above 7,000 feet msl), the snowmelt may be later in the spring (June-July). Rainfall events contribute to peak flows from January-April. Peak flows at Redinger Reservoir tend to last longer and be larger in magnitude than flows observed at the upstream locations. Rain on snow events during warm springs result in high peak run-off over short periods.

RESERVOIRS

The hydrologic cycle of the watercourses mentioned above is influenced by the reservoirs and diversions that are part of the hydropower system. The reservoirs store water during high runoff periods and release water to meet instream flow requirements, to produce power, and then to provide storage capacity for runoff from the succeeding year.

There are approximately 560,000 af of storage in the Basin contained within six large reservoirs and several small diversion impoundments (Table 4.3-2). The reservoir operations are controlled by power production needs, the Mammoth Pool Operating Agreement, FERC licenses, contracts, and water rights. The volume of water stored in project facilities is about one-third of the average annual runoff in the watershed. Because of the small storage volume relative to overall watershed runoff, the natural runoff in many years exceeds system capacity and cannot be completely controlled. This results in spills from project reservoirs, especially in lower parts of the Big Creek System.

Table 4.3-2 Summary of SCE Reservoirs and Forebays in the Basin

Reservoir	Storage Capacity (af)	Elevation (feet msl)
Lake Thomas A. Edison	125,035	7,643
Mono Diversion Reservoir	46	7,350

Reservoir	Storage Capacity (af)	Elevation (feet msl)
Bear Diversion Reservoir	103	7,350
Florence Lake	64,406	7,328
Portal Forebay	325	7,180
Huntington Lake	89,166	6,950
Balsam Meadow Forebay	1,547	6,670
Shaver Lake	135,568	5,370
Dam No.4 on Big Creek	60	4,810
Mammoth Pool	119,940	3,330
Dam No. 5 on Big Creek	49	2,943
Dam No. 6 on San Joaquin River	993	2,230
Redinger Reservoir	26,119	1,403

At the upstream end of the Big Creek System is Florence Lake, at an elevation of 7,328 feet msl. Typical operation of Florence Lake is to fill the reservoir in the spring, hold elevation through the summer and then draw the lake down to minimum pool in the fall. This operation preserves the lake storage for recreation use and hydropower operations. During dry and critical water-year types, the reservoir may not fill completely. Lake Thomas A. Edison, at an elevation of 7,643 feet msl on Mono Creek, also is a high-elevation storage facility. The typical operation of the lake is to fill the reservoir in the spring, hold the lake elevation during the summer recreation season, and reduce water levels by releasing water in the fall. The lake fills in wet and some above normal water-year types, but does not fill in critical years. Releases from the lake can be rediverted at the Mono Creek Diversion or can flow to the South Fork San Joaquin River.

Also situated in the Basin are numerous small diversion dams on the tributary creeks. These dams hold small amounts of water (less than 100 af) and assist in diverting water to power facilities.

Huntington Lake, at an elevation of 6,950 feet msl, is filled and substantially drawndown on an annual basis. Unlike Florence Lake and Lake Thomas A Edison, Huntington Lake approaches maximum storage every year. Huntington Lake is on Big Creek, but also receives inflow from the South Fork San Joaquin River through the Ward Tunnel and Portal Powerhouse. Releases from Huntington Lake flow to Big Creek, Big Creek Powerhouse No. 1, and Shaver Lake.

Shaver Lake is a mid-elevation reservoir on Stevenson Creek. Situated at an elevation of 5,370 feet msl, Shaver Lake receives runoff from North and South Forks Stevenson Creek, and releases from Huntington Lake through the

Eastwood Powerhouse. Water is released from Shaver Lake to Stevenson Creek and through Tunnel 5 to Big Creek No. 2A Powerhouse.

Mammoth Pool Reservoir on the mainstem San Joaquin River regulates the flow from all three forks of the San Joaquin River for power production and instream flows, consistent with the Mammoth Pool Operating Agreement. Water is released from Mammoth Pool directly from the dam and through the project powerhouse. The Mammoth Pool Tunnel conveys water from the dam downstream to the Mammoth Pool Powerhouse near the confluence with Big Creek before releasing the water back to the river. Releases from the fishwater generator return water to the river immediately downstream of the dam. Typical operation of Mammoth Pool is to fill the reservoir in the spring, hold a relatively high water surface elevation over the summer and release water in the fall. The reservoir does not completely fill in dry and critical years. This is because in dry years, the inflow to the reservoir following fall drawdown is not sufficient to refill the reservoir and still meet existing water use requirements.

Dam No. 6 and Redinger Reservoir (including Dam No. 7) are at the downstream end of the Big Creek System. Dam No. 6 serves as an afterbay for water discharged through Mammoth Pool Powerhouse and Big Creek Powerhouse No. 8. It impounds water for diversion to Big Creek Powerhouse No. 3 and releases water to the San Joaquin River. Redinger Reservoir collects the flow from Big Creek Powerhouse No. 3 and (at Dam No. 7) releases water to Big Creek No. 4 Powerhouse through Tunnel No. 4, and to the Horseshoe Bend reach of the San Joaquin River. Big Creek No. 4 Powerhouse is the most downstream facility in the Big Creek System and is situated at an elevation of approximately 1,000 feet msl.

FLOW PATTERNS IN THE BIG CREEK SYSTEM BASIN

The runoff patterns for several stream gages in the Basin are represented in Figures E-7, E-8, and E-9 (Appendix E). These figures show the measured flow for two mainstem San Joaquin River gages and one South Fork San Joaquin River gage. The plots of historic flow show the variation in flow from day to day at these points in the Basin.

In Appendix E, Figure E-6 presents exceedance plots of the historic data from 1980 to 1998[1]. Exceedance plots are helpful in displaying the median, wet, and dry hydrologic conditions in the watershed. The median condition (50 percent exceedance) represents monthly average values where half of the recorded days for that month have exceeded these flows and half have been less. The 20 percent exceedence value represents wetter than normal conditions for each month. These flows would only be exceeded by 20 percent of the recorded

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[1] This period of record was chosen for review because the hydrologic data from all the gages operating in the Basin during this period have been reviewed for accuracy by the USGS and SCE.

days for that location and month. The 80 percent exceedence value reflects dry conditions. For each month, these are flows that were exceeded by 80 percent of the days during the 1980 to 1998 period of record.

The streamflow conditions in the Basin respond rapidly to rainfall, snowmelt, and rain on snow events. Runoff during rainfall and rain on snow events is often quick and of short duration. This creates a runoff pattern that quickly reaches peak flow and rapidly returns to a controlled flow condition (Figures E-7, E-8, and E-9 in Appendix E). During the snowmelt season, the peak flow may last one to two months but returns to controlled flow after that point.

Most of the water-year types from 1961 to 1999 have been wet or above normal (51 percent). Because of the limited storage capacity in SCE reservoirs, relative to the average runoff, the available reservoir capacity is insufficient to control the runoff in many years. If the reservoir operation can not accommodate the peak inflow, then spills occur consistent with the amount of runoff. The inflow typically reaches peak levels from May to July and returns to controlled flow in July.

After the peak flow, runoff decreases and returns to controlled flow. This flow condition is typically observed from July to January when the watershed runoff has decreased to a level the reservoir system can control. The controlled flow generally reflects maximizing power generation over the remainder of the year, consistent with meeting other obligations such as the required instream flows and the Mammoth Pool Operating Agreement. Runoff downstream of the reservoirs is at dry year release levels during dry and critical water year types when Basin runoff is small relative to the available reservoir storage and can be controlled in the reservoirs. The exceedance graphs for the period 1980 to 1998 show that peak flows are typically present during the snowmelt season for median flow conditions. For wet conditions (20 exceedence values), peak flows are distributed over a larger range of months (January to July) than for the median conditions. During dry year conditions, 80 percent exceedance flows are typical of what might be expected each month.

4.4 FISHERIES

4.4.1 GENERAL OVERVIEW

Fish communities in the area represent several community types corresponding to the range of elevations, gradients and habitat conditions present in Basin waters. Generally, Basin waters at higher elevations are cooler and favor various species of trout. At lower elevations, warmer conditions favor native minnows and suckers. The native community inhabiting a specific elevation range or location will consist of species having similar tolerances and recognized as being a part of a distinct "zone." Fish zones described for the Basin include the Rainbow Trout Zone, Transition Zone, and Native Cyprinid-Catostomid Zone. In present times, introduced species having similar ecological requirements to native fish of a particular community-type can often be found with that community.

Stocking has resulted in the introduction of a wide variety of species throughout the Basin. Trout have been introduced to waters that were once devoid of fish. Introductions include many species of game fish including non-native rainbow trout, brown trout, brook trout, golden trout, and kokanee salmon. Largemouth and smallmouth bass have been established in basin waters, as well as sunfish.

4.4.2 HISTORICAL CONTEXT[1]

At the time Euro-Americans first viewed the San Joaquin River, conditions were very different to those of the river today (W.H. Brewer in Farquar 1930). The river was then free-flowing over a broad range of elevations, with a fish fauna largely determined by the constraints of upstream access, extremely high seasonal discharges, and downstream seasonal temperature regimes.

The river was formed by the hydraulic and weathering action of flows arising out of Pacific storms, captured into an annual snowpack by the higher Sierra Nevada peaks. The weathering action occurred during and between dramatic glaciation events during several major ice ages. These ice ages spanned more than ten million years, the most recent occurring about 15,000 years ago (Preston 1981). The glaciers produced scoured bedrock streambeds that, early-on, were radically influenced by volcanic eruptions at the eastern edge of the Sierra Nevada batholith. These magmatic flows ran down and plugged the then-forming San Joaquin River canyon, and forced radical side-cutting of the stream. The substrate in the river originating from the erosion of resistant granite was, and still is, generally comprised of large boulders, larger cobbles of four inches or larger, and fine sand, with a paucity of intermediate gravel sizes.

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[1] The following account in Section 4.4.2 was taken from the draft Native Aquatic Species Management Plan co-authored by CDFG, SCE, and the USFS Sierra National Forest. This material was primarily authored by Mr. Dale Mitchell of CDFG.

At the location where the San Joaquin River leaves the mountains, a very large cobble-sand alluvial fan was deposited, extending most of the way to the San Joaquin Valley trough (Preston 1981). This deep alluvium gradually relieved the gradient in the river's lower reaches; particularly downstream of the lava flows, by back-watering and progressive meandering (stream lengthening). Gradually, these flattening gradients afforded free access to upstream-moving fishes, which in turn enabled establishment of anadromous fish populations within the San Joaquin watershed. Anadromous fishes probably included chinook salmon (fall, late fall, winter, and spring-run), steelhead, white sturgeon and other species (Yoshiyama et al. 1996). In particular, salmon would seasonally dominate the watershed's mid-elevation reaches, given their comparatively large body size and huge seasonal biomass.

The anadromous fish would have been a significant imposition on the river's spatial habitats and food availability, but this would have been at least partially offset by the fish population's significant contribution to the river's overall nutrient loads and productivity. The population's dominance of these river reaches probably took place at the disadvantage of other native species. However, at the end of each season, after expiration of the adult salmon and after most of the adult steelhead had returned downstream, a reciprocal advantage would accrue to the resident species; particularly the predatory ones. The abundance of salmon and steelhead fry in the late spring would present a ready food source for adults of piscivorous species, such as rainbow trout or Sacramento pikeminnow. Less-piscivorous species such as suckers would greatly benefit from production of nutrient inputs from decaying adult salmon carcasses. Food supply would have been a substantial factor favorable to the persistence of the native resident fish populations.

The upper reaches of the San Joaquin River watershed, above 5,000 feet msl elevation, were originally barren of fish, owing to the precipitous upstream access (State Fish and Game Commission Biennial Report 1913-14). Many species of trout were stocked in these alpine reaches by settlers, soldiers, fishermen, and government agencies over the past 150 years, with the intent to establish consumptive use and sport fisheries (State Fish and Game Commission Biennial Reports 1913-14, 1915-16, 1919-20).

Within the mid-elevation reaches, between the elevations of 500 and 2,000 feet msl, the river was seasonally transitional with regard to water temperatures. In cooler seasons (November to February) and seasons of cold Sierra Nevada snow runoff (March through July or August), the river supported native rainbow trout populations, along with other cold-water tolerant species, including Cottids (riffle sculpins), and anadromous salmon, white sturgeon and steelhead. Other more eurythermal species were also present, including: adult cyprinids (e.g., Sacramento pikeminnow and hardhead), and adult catostomids (Sacramento sucker) (Moyle 1976).

In most years, trout would typically experience temperatures during September and October that would have stressed, although probably not excluded them from habitats between 1,000 feet and 2,500 feet msl. Below 1,000 feet msl, other species such as pikeminnow, hardhead, and suckers, more tolerant of warmer temperatures, would have thrived by utilizing the spatial habitat seasonally vacated by trout.

Major changes in the San Joaquin River watershed prevented the access of anadromous fishes to the river's upstream reaches. The construction of Kerckhoff Dam in 1913 by Pacific Light and Power Company (later Pacific Gas and Electric Company) virtually eliminated the salmon and steelhead runs upstream of that point by precluding access to cold water habitat located upstream above the 1,000 feet msl. This also probably resulted in the loss of upstream access to lampreys including the Pacific lamprey (*Lampetra tridentata*) and the Kern Brook lamprey (*Lampetra hubbsi*). Other developments on the mainstem San Joaquin River, downstream of Kerckhoff Dam, including Mendota Dam (1906), "Sack Dam" near Chowchilla (1910), and Friant Dam (1954), further restricted salmon access to their historical spawning habitats (State Fish and Game Commission Biennial Report 1953-1954).

The net effects of these water developments were: 1) to remove the influence of anadromous fish from the middle-elevation San Joaquin River habitats; 2) to reduce the magnitude of peak run-off from the snow-melt period at higher elevations; 3) to reduce base streamflows and spatial habitats downstream of Friant Dam; and 4) to generally cool the late summer and fall water temperatures.

4.4.3 Fish Communities

Fish communities in the Basin represent several community types corresponding to the range of elevations, gradients and habitat conditions present in the system. The community inhabiting a specific elevation range or location will consist of species having similar tolerances for the environmental conditions of that area. These species often occur together and interact regularly to partition the available habitat. The groups of native species that occur together in a given geographic region are recognized as being a part of a distinct "zone." Fish zones described for the Basin are adapted from Moyle (1976). Introduced species having similar ecological requirements to fish of a particular community-type can be often found with the native species of that community due to human intervention including stocking. Fish zones within the Basin include the Rainbow Trout Zone, Transition Zone and Native Cyprinid-Catostomid Zone.

Rainbow Trout Zone

The Rainbow Trout Zone occupies the higher elevations and upper headwaters of California stream systems. Habitat is composed of clear, cool waters (typically less than 21°C) in streams with a relatively high stream gradient (Moyle and

Nichols 1973, Moyle 1976). Rainbow trout (*Oncorhynchus mykiss*), for which the zone is named, are the dominant species of fish for this area. Other native fishes that often can be found co-inhabiting the lower reaches of this zone are riffle sculpin (*Cottus gulosus*), and in some lower streams, Sacramento sucker (*Catostomus occidentalis*).

The Rainbow Trout Zone community has been greatly extended by human activities. Rainbow trout are the most heavily stocked species in California and are routinely distributed outside of their native range. Marginal or "barren" (waters with no fish species present) high mountain lakes and streams have been planted with many salmonid species. The Rainbow Trout Zone now extends from high lakes and streams in the Sierra Nevada mountain range into the Transition Zone or even the valley floor. In addition to physically distributing fish species to new waters, dams and their reservoirs have also created additional trout habitat. The cold, deep waters of reservoirs and cold, clear outflows usually associated with them tend to favor species such as trout. To take advantage of the cold water releases from dams, tailwater fisheries were created at many sites in California. Tailwater fisheries replace a native non-game fish community below a dam or powerhouse with the desired gamefish, usually rainbow trout, brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmoides*), and green sunfish (*Lepomis cyanellus*). Other species stocked into Rainbow Trout Zone waters are golden trout (*Oncorhynchus mykiss aguabonita*) (and rainbow trout hybrids), cutthroat trout (*Oncorhynchus clarki henshawi*) and kokanee salmon (*Oncorhynchus nerka)*. Figure 4.4-1 presents the general distribution of trout species in streams of the Basin. As indicated in this figure, trout are extremely widespread.

TRANSITION ZONE

Stream and river characteristics for the Transition Zone are similar to the stream characteristics described in the Native Cyprinid-Catostomid Community but are transitional (intermediate) with that of the Rainbow Trout Zone. One of the main features of the Transition Zone is the ability for the habitat to support rainbow trout for much of the year during a normal water-year. During the summer months in normal to dry water-years, reduced streamflow and warm temperatures may limit the presence of trout in this zone. In wetter years, higher flows and cooler water temperatures provide adequate habitat conditions through the summer months for rainbow trout.

The dominant native fish in the Transition Zone are Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker and hardhead (*Mylopharodon conocephalus*). Pikeminnow and suckers are usually the most abundant fishes in this zone. The distribution of hardhead is scattered in low to mid-elevation main tributary streams of the San Joaquin River drainage, but is absent from the valley reaches and mainstem of the San Joaquin River. The hardhead is recognized by the California Department of Fish and Game as a Species of Special Concern

(Moyle et al. 1995) and by the U.S. Forest Service Region 5 as a sensitive species. Other native species that may occur in this zone are prickly sculpin (*Cottus asper*) and rainbow trout. Introduced species such as smallmouth bass, largemouth bass, green sunfish, carp (*Cyprinus carpio*), white catfish (*Ictalurus catus*) and channel catfish (*Ictalurus punctatus*) may also be found in the Transition Zone.

Figure 4.4-1 presents the general distribution of the native cyprinids of the Transition Zone community. As shown in this figure, these species are generally found in the lower elevations of the Basin. In general, this community does not appear to occur upstream of Mammoth Pool Dam.

The Native Cyprinid-Catostomid Zone

The community of fish in the Native Cyprinid-Catostomid (Minnow-Sucker) Zone is characterized by the presence of hardhead, Sacramento pikeminnow and Sacramento sucker. Streams in this zone are small to large tributaries at intermediate altitudes characterized by warm summer stream temperatures (20 to 25°C). Smaller streams can be intermittent and fish confined to stagnant pools may experience temperatures of more than 30°C during the day. Larger streams are characterized by deep rocky pools and wide shallow riffles. During the winter, runoff is cold (10°C or less) and flows can be very high, with peak flood flows passing quickly. The presence of rainbow trout is limited in this area due to low summer flows and warm stream temperatures. Introduced species now common to this zone are hatchery rainbow trout, brown trout, largemouth bass, smallmouth bass, and green sunfish.

This community generally occurs at lower elevations and overlaps the Transition Zone community in the lowest elevations at the downstream portion of Horseshoe Bend. Figure 4.4-1 indicates the distribution of native cyprinids that belong to this and the Transition Zone community in the Basin.

Introductions of Species and Stocking

Most fish introductions in California occur as a means of “enhancing” recreational and commercial fishing opportunities. Other reasons for introductions include: provide forage for game species or bait for fishermen, provide insect or weed control, as pets, for aquaculture, or by accident.

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Placeholder for Figure 4.4-1
Big Creek Basin Fisheries

<u>Non-Internet Public Information</u>

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California reservoir fisheries exist almost entirely upon introductions and stocking of game and forage fish. In the Big Creek System Basin, reservoirs were created across a range of zones and communities. A majority of introductions into these waters either as game or forage fish have included hatchery rainbow trout, golden trout hybrids, brown trout, brook trout, kokanee, golden shiner, largemouth bass, smallmouth bass, bluegill and black and brown bullhead. Other species introduced into one or more of the project reservoirs that have been attempted but were unsuccessful include threadfin shad (*Dorosoma petenense*), coho salmon (*Oncorhynchus kisutch*) and striped bass (*Morone saxatilis*). Fish plantings have also been preceded by chemical treatments to eradicate non-native and native non-game fishes from reservoirs and create more favorable conditions for the target species. As such, select locations within Shaver and Redinger Lakes have been treated at least once (CDFG 1965 and 1959). Table F-1 (in Appendix F) presents a more complete list of species that occur (or have occurred at some point in the past) in reservoirs and streams in the Basin.

Much of the high mountain lakes and streams in the Sierra Nevada mountain range previous to fish introductions (primarily rainbow trout, golden trout, rainbow/golden hybrids, and brook trout) were “fishless.” Potentially, the only native aquatic species at such high elevations were aquatic insects, larval lifestages of some terrestrial insects, mountain yellow-legged frogs or Yosemite toads.

4.4.4 Fish Species

Species List and Status

The species found in the streams and reservoirs of the Basin are listed in Table F-1 (Appendix F). This list gives the common and scientific names of the fish found in the Basin, as well as their status. As indicated in Table F-1, many of the fish species found in the Basin are introduced from other areas. In addition, hardhead, a native minnow, is a California Species of Special Concern and is listed by the US Forest Service Region 5 as a Sensitive Species. Golden trout, a species introduced to the area, has special status within its home range. That range does not include the Basin.

Brief Life Histories of Key Species

Key species within the Basin include rainbow trout, brown trout, brook trout, kokanee salmon, hardhead, Sacramento pikeminnow, Sacramento sucker, largemouth bass, smallmouth bass, and riffle sculpin. The life history information presented here is adapted from Moyle (1976), Moyle and Baltz (1985) and Brown and Moyle (1993), except where noted.

Rainbow Trout (*Oncorhynchus mykiss*)

Rainbow trout are the most abundant widely distributed species of western trout. Their wide distribution is, in part, the result of their popularity as a gamefish and their adaptable biology and life history patterns. Rainbow trout typically require cool water temperatures to complete their life cycle, but are tolerant of warmer temperature differences. The rainbow trout is native to the Basin area and is found throughout all its major waterbodies. Many non-native strains of rainbow trout have also been introduced into the Basin. The Kamloops Lake strain, native to British Columbia, has been planted throughout California reservoirs, including those in the Basin.

In the San Joaquin River system, rainbow trout can be found from the high lakes and streams to the transition zone, lower in the watershed. Temperature conditions in the transition zone often approach the thermal limits of trout, but cold releases below reservoirs can extend their range.

In streams, rainbow trout are commonly associated with brown trout, sculpins, Sacramento suckers, and Sacramento pikeminnow. Their flexible behavior and habitat requirements allow the rainbow trout to avoid direct competition for food and space with brown trout. Where the two species occur together, brown trout will occupy the slow, deep pool habitat and the rainbow trout will use the faster water. Rainbow trout will also feed at the water surface on drift organisms, while brown trout feed by picking prey from the substrate. In the absence of competitor species, however, rainbow trout may also feed on benthos.

The highly aggressive behavior of rainbow trout also makes it successful at interacting with other fish species. The rainbow trout will defend its territory in streams with either a threat display or physical contact. The other trout may react by fleeing or challenging the aggressor with similar displays. The victor of such interactions depends on a number of factors, but the most important are the relative size of the fishes and habitat preferences. Aggressive behavior is normally enough to drive off any native species encountered.

In lakes and reservoirs, territories are probably not an excessively important factor to survival, as rainbow trout tend to school and roam in these habitats. Rainbow trout will partition the available food resources and utilize the resources left unused by competing species. Individual trout will also have their own preferences for specific prey items. Thus, the stomach contents of a sample of rainbow trout may vary widely from fish to fish.

In the winter, feeding slows compared to the high summer activity and benthic prey items become more important. Active benthic invertebrates or those that live in exposed conditions (e.g., mayfly larvae, caddisfly larvae, amphipods, etc.) are the most common organisms preyed upon. Although rainbow trout will feed throughout the day, feeding activity is most active at dusk.

As demonstrated by their flexible biology and life history behavior, growth in rainbow trout can also be variable. In small streams and high mountain lakes, rainbow trout seldom live longer than six years of age or grow larger than 40 cm total length (TL). Rainbow trout grow quickest in large reservoirs and lakes reaching approximately 51 cm TL by their third year.

Most wild rainbow trout mature in their second or third year and spawn in the spring, from February to June. Colder temperatures in high mountain lakes and streams can delay spawning until July or August. Rainbow trout spawn in gravel riffles, where the female trout first selects a site and begins to dig a redd (nest) by turning on her side and digging with her tail (termed "cutting"). This activity attracts a male rainbow trout, which defends the redd and the female from other interested males. The male will also court the female as she digs the redd. Once the redd is deep enough, the female signals the male that she is ready to spawn when she lowers herself into the depression of the redd, touches her anal fin to substrate and opens her mouth. The male swims alongside the female, opens his mouth and violently quivers releasing sperm at the same time the female releases her eggs. The female builds a new nest above the old one and buries the fertilized eggs from the previous spawning. The spawning act is repeated (possibly with a different male each time) until all the eggs are released and buried.

The eggs hatch in three to four weeks (at 10 to 15°C), and the fry emerge from the gravel another two to three weeks later. Before moving into the open stream or lake, the fry will inhabit the quiet shallow water close to shore.

Brown Trout (*Salmo trutta*)

Brown trout are a popular gamefish introduced into most of the waters in the Basin. They inhabit the Basin's large reservoirs and streams.

For most of the year (when they are not spawning), brown trout remain in small home ranges, rarely moving more than a few meters from an area. Brown trout less than 25 cm TL defend feeding territories from other fish and establish a dominance hierarchy among the fish in a given area. As the fish grow larger, they become more selective of their prey. Fish greater than 25 cm TL often feed on other fish, including their own species, and large aquatic invertebrates like crayfish and dragonfly larvae. Though feeding may occur at all times of the day, they are usually most active during dusk.

Brown trout growth is variable and is dependent on habitat conditions. At a given age, lengths of brown trout reared in productive waters may be twice as large as those reared in marginal waters. Brown trout grow faster in large lakes and reservoirs than in streams, and they grow poorly in high mountain lakes and streams.

Brown trout mature in their second or third year and will spawn, depending on water levels and stream temperature, in the fall or winter. The spawning behavior of brown trout is similar to that of rainbow trout.

Eggs hatch after four to twenty-one weeks, but more typically seven to eight weeks, depending on water temperature. Newly emerged fish inhabit quiet water close to the shore among large rocks or overhanging vegetation.

<u>Brook Trout (*Salvelinus fontinalis*)</u>

Brook trout were introduced into California waters in the 1890's and have become established throughout most of the waters in the Sierra Nevada mountain range. In the Basin, they have been stocked in all the larger reservoirs and most of the streams with rainbow trout and brown trout.

Brook trout are the most cold tolerant trout of California waters and inhabit mostly clear cold streams and reservoirs, but are most abundant in the many small high lakes and streams in the Sierra Nevada mountain range.

In streams, brook trout maintain territories by defending them against all invading species of fish. All prey items within the territory are the domain of the trout holding the area. Many of these territories are located in areas where stream velocities are broken by an instream structure like boulders or logs. Brook trout in reservoirs do not hold or defend specific territories, but swim about individually, schooling only when alarmed. In lakes and reservoirs, they will congregate in areas where colder water seeps into the main body of water.

Brook trout feed mostly on aquatic insect larvae and terrestrial insects and take whatever is most abundant. In lakes and reservoirs feeding habits are similar to streams, except young brook trout will feed on zooplankton and larger trout will prey on other fishes. Brook trout will feed whenever light is sufficient, but become most active at dusk when insect activity peaks. In the winter, when high mountain lakes freeze over, brook trout may feed on insect larvae, mollusks, or zooplankton under the ice. In shallow lakes and small streams, fish become inactive when water temperatures become too warm.

Growth in brook trout is dependent on a number of factors, including: length of growing season, water temperature, population density, and food availability. Brook trout grow fastest in mid-elevation reservoirs and lakes that do not contain large populations of fish. In these conditions, brook trout can reach 23 to 25 cm TL by their third year. However, slower growth is more typical of streams and lakes in California. Competition with other introduced salmonids, including other brook trout, and other factors, prevents brook trout from growing larger than 30 cm TL in most locations. Brook trout rarely live longer than four to five years of age.

Maturity in males can occur at the end of their fist year of life, but is more common in their second year. Females may mature between their second and fourth year of life. Brook trout spawn in the fall, but specific timing is dependent on water temperatures.

Female brook trout select spawning sites in lakes and streams in areas that have some cold upwelling water, pea to walnut sized gravels and cover nearby. Cold water flowing through the nest provides oxygen to the eggs and postpones hatching until early spring. If the locations available do not meet all the criteria, brook trout will select a location that has the best chance of producing offspring. In lakes, brook trout have been observed spawning in sandy bottom springs, shallow-water gravels, and gravel riffles. Spawning behavior is similar to that of other trout, except that both the male and female will defend the nest against intruding fish.

Eggs hatch after three to four months at water temperatures of 2 to 5°C. At 13°C, the eggs will hatch in 35 days. After hatching, the fish remain in the gravel for three to four days until the yolk sac is absorbed. In streams and lakes, the fry move to the shallow edges among vegetation or backwater areas and feed on small crustaceans.

Kokanee (*Oncorhynchus nerka*)

Kokanee are the non-anadromous form of sockeye salmon and have been stocked in lakes and reservoirs within the Basin. Kokanee prefer cool, well-oxygenated water. In the late fall though spring, kokanee will inhabit the surface waters of lakes and reservoirs as long as the temperature remains in their preferred range or colder. In the summer months, when the surface water of lakes begins to warm, kokanee move into deeper water. During this period, in most mid-elevation reservoirs, kokanee can be found in the hypolimnion below the warmer surface waters. If the oxygen at this level is depleted, heavy kokanee mortalities may occur.

Kokanee salmon feed almost exclusively on pelagic zooplankton. Their long fine gill rakers are well suited to filter Daphnia spp. and copepods, but emergent aquatic insects and larval fish may also be taken on occasion. Feeding habits change little in adult kokanee. In the late fall and early winter, all feeding ceases as kokanee prepare to spawn.

The timing of the spawning run in kokanee is partially dependent on the genetic history of the fish. Also important to the run is the temperature and condition of the lake and stream. Spawning requires cool stream temperatures and usually occurs in small tributary streams. Kokanee will use gravel riffles for spawning but may also use shallow gravel areas (less than 8 meters) in the lake if necessary.

Prior to spawning, kokanee will congregate at the mouth of streams or in the vicinity of lake spawning sites. As in other salmon, kokanee return to the stream in which they hatched or were planted as fry. Females build redds by vigorously fanning the gravel repeatedly with their tail. The female will defend the redd from other females while the male partner defends it from intruding males. When the nest is finished the female signals the male that she is ready to spawn by lowering into the redd and touching her anal fin to the gravel substrate. The male will swim alongside the female and the two will quiver and gape as the eggs and sperm are released into the nest. Only a portion of the eggs is spawned in a single act. The female builds a new nest above the old one and buries the fertilized eggs from the previous spawning. The spawning act it repeated (possibly with a different male each time) until all the eggs are released and buried. Many females die before releasing all their eggs. The low spawning success is compensated by the high survival rates of the eggs that are laid.

Fry emerge in April through June and move downstream immediately. Most fry emigrate during the night and begin to feed when they reach the lake.

Hardhead (*Mylopharodon conocephalus*)

Hardhead are typically found in undisturbed low to mid-elevation streams in Transition Zone areas in the Basin. Hardhead are usually found in the same habitat as Sacramento pikeminnow and Sacramento sucker and are almost never found where pikeminnow are absent. Hardhead do very poorly or are absent where introduced fishes, particularly centrarchids (i.e. largemouth bass, smallmouth bass, or green sunfish), are present or in many environments impacted by human activity. As such, hardhead are listed as a California Department of Fish and Game Species of Special Concern (Moyle et al. 1995) and U.S. Forest Service Region 5 Sensitive Species (USFS 1998). In the Basin, the hardhead have become permanently established in the Horseshoe Bend and Stevenson reaches of the San Joaquin River and in Redinger Lake.

Hardhead are found in warm, well-oxygenated streams with pools that are large and deep (greater than one meter in depth) and have sand-gravel-boulder bottoms. In laboratory studies, hardhead were shown to prefer water temperatures of 28.4°C (Knight 1985) and in the Pit River they were found inhabiting stream temperatures of 17 to 21°C, the warmest available. Hardhead prefer moderate stream velocities (approximately 0.13 to 0.52 meters per second (m/s) for adults and less than 0.06 m/s for juveniles), compared to preferences for species such as rainbow trout.

Hardhead feed mostly from the bottom, taking small invertebrates and aquatic plants in the quiet water of streams. They may also feed on plankton or surface insects on occasion. Younger, smaller hardhead in streams feed primarily on aquatic insect larvae, especially baetid mayfly or caddisfly larvae, and small snails. In lakes and reservoirs, young hardhead will feed mainly on planktonic cladocerans. The success of year classes is highly variable among different water year types, as young hardhead need to put on sufficient growth before their first winter to maximize their chances of surviving. This growth is affected by the need for sufficient water temperatures and sufficient refuge from high velocities. Thus, hardhead population may actually depend on the drier water years for successful recruitment. As hardhead grow larger, their diet shifts to aquatic plants, especially filamentous algae. The fish probably do not get much nutrition from the aquatic plants, but rather get it from the small invertebrates that are incidentally taken with the plants.

Hardhead grow relatively quickly between one and three years of age. As the fish age, however, growth tends to slow. By their sixth year, hardhead may attain lengths of 46 cm FL[2], though this is uncommon in most locations.

Hardhead are sexually mature after their third or fourth year and generally spawn in the spring, although they can spawn as late as August in some areas in the upper San Joaquin River. Spawning migrations from larger streams and reservoirs into smaller tributary streams are common. Hardhead are most likely mass spawners in gravel riffles. After hatching, the fry inhabit warm shallow water at the edges of streams or backwater.

Sacramento Pikeminnow (*Ptychocheilus grandis*)

The Sacramento pikeminnow is a native species common in the larger intermittent and permanent streams of the Sierra Nevada foothills. They spend much of their time in deep, well-shaded pools of clear streams. They are a member of the Transition Zone community and are commonly associated with hardhead and Sacramento suckers. Pikeminnow are predatory fishes, and prior to the introduction of other large piscivorous species, were undoubtedly at the top of the aquatic food chain in the Central Valley and surrounding foothills. While pikeminnow do best in undisturbed streams, they are still found in some foothill and regulated streams. Today, the Sacramento pikeminnow is much less abundant in the lower elevations of the Central Valley where introduced species predominate.

Pikeminnow feed throughout the water column on a variety of prey. Prey item selection is dependent on availability, season and other species present. Pikeminnow will exploit potential prey not being utilized by other competing species. Typically, pikeminnow less than 18 cm SL[3] will feed on aquatic insects, while pikeminnow greater than 18 cm SL will feed on other smaller fish.

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[2] Fork Length (FL) The length of a fish measured from the most forward part of the head to the fork or notch of the tail fin.

[3] Standard Length (SL) The measurement of the length of a fish from the front of its head to the end of the bony area called the caudal peduncle situated just in front of the tail.

Adult pikeminnow are rather sedentary in habit; they can be found in the same habitat for much of their life. Adults prefer deep habitats (approximately one meter in depth) with moderate stream velocities of approximately 0.36 m/s. They spend much of their time under submerged rocks or logs, where they ambush their prey. At dusk, they will come out and actively forage for food. Juvenile pikeminnow swim about in schools in the shallow waters of large streams, pools or reservoirs. Juveniles prefer shallower depths (approximately 0.5 meters in depth) and stream velocities of 0.19 m/s. In laboratory studies, pikeminnow were shown to prefer water temperatures of 26.3°C (Knight 1985).

Growth in Sacramento pikeminnow varies by season and habitat. Some growth takes place again during the winter months when stream flows increase, though colder temperatures probably keep the fish from growing as fast as they do in the early summer months. Fish in larger permanent streams also grow faster than in small intermittent streams. Sacramento pikeminnow are capable of attaining large sizes of up to one meter in length and can live nine years. Despite their ability to reach large sizes and apparent longevity, their growth is slow when compared to other large minnows such as hardhead.

Sacramento pikeminnow are sexually mature by the third or fourth summer. Ripe fish migrate upstream in April and May to spawn in gravel riffles or the shallow tails of pools when water temperatures begin to warm (approximately 15 to 20°C). In reservoirs, they may spawn in gravel areas close to shore.

Spawning behavior is probably similar to that of the closely related northern pikeminnow. During spawning large numbers of pikeminnow congregate over a gravel substrate where a single female may be pursued by up to six males. Spawning takes place when the female dips close to the bottom and releases a small amount of eggs, which are simultaneously fertilized by one or more males that are in her company. The fertilized eggs continue to sink, and they adhere to the gravel substrate.

In northern pikeminnow, the eggs hatch in four to seven days at 18°C. In another seven days, the fry then begin schooling in the shallows of streams.

<u>Sacramento Sucker (*Catostomus occidentalis*)</u>

Sacramento sucker can be found in a wide variety of habitats throughout the Basin and are a native species in the Transition Zone community. They may occupy cool, clear streams or warm backwater but are probably most common in pools of clear, cool streams and reservoirs at moderate elevations. Adult suckers are abundant in the reservoirs of the Basin. Juvenile suckers are more commonly found in the tributary streams where they hatched. Native fishes typically associated with Sacramento sucker are hardhead and Sacramento pikeminnow.

The different sizes of suckers inhabit different microhabitats. Postlarval suckers can be found in warm, shallow detritus covered bottoms at the stream margins. Juvenile suckers, approximately 2 to 10 cm, can be found in shallow, slow moving water with sandy bottoms. Adults are mostly sedentary during the day and are typically found at the bottom of deep pools or beneath undercut banks.

Young of the year suckers have a tendency to school and may feed almost continuously throughout the day. In streams, most of the day is spent on the bottom of deep pools; in lakes they are found in fairly deep water. At night, however, suckers are most active and move into the shallows to feed.

The diet of suckers is composed of algae, detritus, and invertebrates associated with the substrate. Postlarval suckers, with their short digestive tract and terminal mouths, feed primarily at the surface and in the midwater on early instars of insects. As they develop into juveniles and their mouths become subterminal and digestive tracts lengthen, their diet shifts toward diatoms, filamentous algae and protozoans. The diet of adult suckers is made up of filamentous algae, diatoms, and detritus. Invertebrates consumed by adult suckers make up less than 20 percent of their diet.

Growth in Sacramento suckers is highly variable. Generally, suckers grow more slowly in small, cold streams with low productivity, than in larger warmer streams. In addition, adult suckers may depress the growth and survival of juvenile suckers by forcing the juvenile fish into less favorable habitats. Thus, yearling fish may be 5 to 8 cm in length, depending on the habitat in which they rear. Large Sacramento suckers may grow to approximately 45 cm and reach ten years of age.

Sacramento suckers spawn for the first time at four to five years of age. Spawning usually takes place between February and June, but may be as late as July. Most spawning takes place in streams over gravels. Prior to the spawning migration, ripe suckers will often congregate at the mouth of streams and rivers. Temperature is the key to the migration and begins when stream temperatures start to noticeably warm. A sudden cooling can also stop the run until warmer temperatures return. In reservoirs, suckers may spawn along the shoreline.

Spawning behavior in Sacramento suckers is typical of most suckers. Large numbers of suckers gather in the spawning area and each female is accompanied by two to five males. The eggs are broadcast over the gravels to which they adhere. Vigorous activity by the spawners creates a slight depression in the substrate in which the eggs fall; further activity may cover the eggs with the shifting gravel.

The eggs hatch in three to four weeks and the young soon drift downstream into the warm shallows. They will typically reside and rear here until they are three to four years of age, when they will move downstream into reservoirs or larger streams during the fall/winter high water.

Largemouth Bass (*Micropterus salmoides*)

Largemouth bass are a popular warmwater gamefish introduced into many streams and reservoirs in California. Largemouth bass are typically found in low to mid-elevation lakes and reservoirs, but are also common in foothill streams in the San Joaquin Valley. They prefer slow moving water with abundant aquatic vegetation, but occur mostly in disturbed areas.

Adult largemouth bass are solitary hunters and frequently establish home ranges around a submerged structure. Young bass school in the open shallows close to shore. Largemouth bass are most active during the day, and feed most actively during dusk.

Largemouth bass fry begin feeding on rotifers and crustaceans. As they grow, their diet includes fish fry (including their own species) and aquatic insects. Bass larger than 10 cm TL will feed almost entirely on other fishes, but other prey items may include crayfish, frogs and tadpoles. Individual bass may also be selective in their feeding habits, preferring one prey item over another, or one species of fish to another.

Growth is dependent on a number of factors. Genetic background, competition, food availability and water temperature are among the more important variables that affect growth in largemouth bass. Younger bass are probably most affected by competition for the available food. Their food preferences are widely shared with other species of fish.

Largemouth bass mature during their second or third year. Males begin to build nests when water temperatures begin to warm in the spring. Nests are shallow depressions in rock, gravel or debris-littered substrate in water 1 to 2 meters in depth. Nests are solitary, and guarded and maintained by the males. Females signal their readiness by repeatedly returning to the nest. After the male accepts her, the two will circle the nest, and the male will nip at her sides. When the two are ready, the female lowers herself to the bottom of the nest and rubs her abdomen there. The two then release sperm and eggs and the eggs adhere to the substrate. The female then leaves the nest or is chased away by the male.

The nest is guarded by the male until the eggs hatch, which is usually three to ten days. The male continues to guard the newly hatched fish by herding them inside the nest. By the time the fry are approximately 3 cm, they are too active to keep inside the nest, and they disperse into shallow water.

Smallmouth Bass (*Micropterus dolomieui*)

Smallmouth bass are typically found in large, clear reservoirs and clear, cool streams with many large pools and abundant cover. They are common in large tributaries to the San Joaquin River, in the Transition Zone. They may be associated with the native fish of that area, Sacramento sucker, Sacramento pikeminnow, and occasionally rainbow trout. Much of the stream habitat in the Transition Zone has been diminished by the construction of dams in those areas. In reservoirs, smallmouth bass occur at the upstream end of the impoundment, or narrow bays with rocky shelves.

Smallmouth bass are less solitary than largemouth bass and may live in small, localized populations. Feeding habits are similar to those of largemouth bass. Smallmouth bass fry feed mostly on rotifers and small crustaceans until they reach 5 cm TL, when they begin feeding on aquatic insects and small fish. Despite being mostly piscivorous, other prey items may include crayfish and amphibians.

Smallmouth bass spawn for the first time in their third or fourth year. Spawning behavior is similar to that of largemouth bass.

Riffle Sculpin (*Cottus gulosus*)

In the Basin, riffle sculpin are most common in headwater streams where riffles are the predominant habitat. If riffle sculpin and prickly sculpin occupy the same stream, riffle sculpin typically prefer the cool, upper reaches of streams while prickly sculpin can be found in the warmer, lower reaches.

Riffle sculpin are opportunistic bottom feeders, and will feed on isopods, amphipods, chironomid larvae, snails and a variety of aquatic insects. They only rarely feed on fish eggs and small fish. Most growth occurs during the spring and summer months. Riffle sculpin seldom live beyond four years when they are approximately 7.5 cm TL.

Maturity in riffle sculpin sets in at the end of their second year, and spawning takes place from late February through April. Spawning habitat is characterized as the underside of rocks in swift riffles or the inside cavities of submerged rotted logs. Multiple females may lay their eggs in one nest. The male will remain in the nest and guard the eggs and fry. Eggs will hatch in eleven (at 15°C) to twenty-four days (at 10°C). Newly hatched sculpin do not leave the nest until the yolk sac is absorbed, at which point they will assume a benthic existence.

4.4.5 FISH DISTRIBUTION

Presence and distribution of fish species within streams and reservoirs of the Basin are summarized in Tables F-2 and F-3 (Appendix F) respectively. Figure 4.4-1 presents the locations of the streams and reservoirs identified in Tables F-2 and F-3. Fish distribution, as well as presence/absence information is limited to certain streams, stream reaches and reservoirs of the project waters. Available information includes data collected for the SCE Big Creek No. 4 Water Power Project, Vermilion Powerhouse Studies (Powerhouse was not constructed) and Balsam Meadow Pumped Storage Project, BiCEP Technical Draft Reports, and CDFG stream surveys and stocking records. A summary of recent fishery data collection is provided in Table F-4 (Appendix F). Records starting in the 1930s to the present were utilized to prepare the fish distribution tables.

The most recent and quantitatively oriented studies, utilizing electrofishing, snorkeling, and a variety of nets and traps, were conducted between 1985 and 1995 (SCE 1997, BioSystems 1993, BioSystems 1987 a, b, c). These studies produced population and biomass estimates for fish species within selected Basin waters. In addition, fish entrainment studies for Shaver Lake also yielded quantitative data (ENTRIX 1992). Some of the reports, particularly older records, assessed fish distribution on a presence/absence basis, often through visual observations, and thus offer limited inference on population size. In such cases, the lack of fish presence may indicate more about the limitations of the methodology than the absence of fish.

Since some of the data represented in Tables F-2 and F-3 (Appendix F) were collected over 50 years ago, current fish distributions may be different from the species presented in the tables. Furthermore, some of the older records tend to focus mostly on game species, such as trout and bass, providing limited information on native fishes.

STREAMS

The distribution of fish species has been assessed at varying degrees of detail for 28 out of the 34 project-affected streams and stream reaches of the Basin. Fish have been observed in 26 stream reaches (Table F-2). North Slide and South Slide Creeks appear to be devoid of fish (CDFG unpublished data). No data are available for the two unnamed tributaries to Big Creek, as well as, Balsam Creek, Ely Creek and Adit No. 8 Creek.

A total of 19 fish species have been observed in streams of the Basin (Table F-2). The most frequently encountered species were rainbow trout, brown trout and brook trout, present in 23, 17 and 15 stream reaches, respectively. Kokanee, rainbow-golden trout hybrids, golden shiner, green sunfish, and smallmouth bass have a much more restricted distribution. A number of species once stocked in Basin waters may no longer be present. These include striped bass, coho salmon, and several species of catfish.

Trout inhabit streams of the entire Basin, whereas the other species (i.e., minnows, sucker, catfish, sunfishes, bass and sculpins) occur almost exclusively in lower elevation waters or in specific reservoirs. The total number of species is also highest at lower elevations, and in larger streams; with the greatest number of species having been reported for the San Joaquin River Horseshoe Bend and Stevenson reaches (13 and 10 species, respectively although not all species previously reported or stocked may still be present). Only a single trout species has been found in each of Tombstone, Crater, and Camp 62 creeks. However, due to the nature and age of some of the available information, fish distribution and presence/absence comparisons among the different stream reaches are not completely reliable.

Population and biomass estimates were computed for Big Creek, Stevenson Creek, and the San Joaquin River Mammoth Pool, Stevenson and Horseshoe Bend reaches (SCE 1997; BioSystems 1987 a,b,c). A quantitative five-year study also was conducted in North Fork Stevenson Creek (BioSystems 1993).

LAKES AND RESERVOIRS

Twenty-eight reservoirs and diversion forebays exist in the Basin; fish distribution data has been collected for 14 of those waters (Table F-3). The major project reservoirs in the Basin include: Shaver, Thomas A. Edison, Huntington, Florence and Redinger Lakes and Mammoth Pool Reservoir. Large forebays (approximately 300 to 1500 af) include Balsam Meadows Forebay, Big Creek Powerhouse No. 3 Forebay (Dam 6) and Portal Forebay. Other smaller forebays (less than 100 af) include Big Creek Powerhouse No. 2 Forebay (Dam 4), Big Creek Powerhouse No. 8 Forebay (Dam 5), Mono Creek Diversion Forebay, Hooper Creek Diversion Forebay, and Bear Creek Diversion Forebay. Several diversion forebays can be characterized as simple diversion points along the stream, containing little impounded water, including: Tombstone, South Slide, North Slide, Crater, Chinquapin, Camp 62, Bolsillo, Warm, Rock, Ross, Pitman, Balsam, Ely, and Adit No. 8 creek diversions.

A total of 25 fish species exist or existed in the lakes and reservoirs of the Basin. Rainbow trout were present in all of the 14 reservoirs surveyed and are stocked in Portal Forebay, which was not surveyed. Brown trout and brook trout were the next most frequently encountered species, occurring in 13 and 12 reservoirs, respectively. The rarest species, in terms of presence, appear to be rainbow-golden trout hybrids, carp, goldfish, hardhead, hitch, Sacramento pikeminnow, and brown and black bullhead. All of these have been observed in one or two reservoirs only. However, it should be noted that some of these species, such as hitch, may no longer be present. Although no sampling data exists for most of the small diversions, it is likely that some or all of the fish species present upstream and/or downstream of some of these diversions could also be found at the diversion.

In the past, coho salmon have been introduced into Mammoth Pool Reservoir and striped bass and threadfin shad into Redinger Lake. Coho salmon, striped bass, and threadfin shad are now absent from Basin waters. Kokanee, have been planted in Shaver, Huntington, and Florence lakes and are present in Balsam Meadow Forebay. Stocking programs for this species continue. Their status in Florence Lake is uncertain at this time, but are common in the other three reservoirs. Smallmouth bass have been planted in Shaver and Redinger lakes and are present in Balsam Meadows Forebay. They maintain populations in Shaver Lake and Balsam Meadow Forebay. Smallmouth bass are no longer present in Redinger Lake.

The greatest number of fish species exist in Redinger Lake, Shaver Lake and Mammoth Pool Reservoir (17, 16 and 13 species, respectively), all of which also have been stocked heavily in the past (CDFG Stocking Records). Only two species (rainbow and golden trout) have been observed in the Hooper Creek Diversion Forebay.

Quantitative fish population studies (Table F-5, Appendix F) have been conducted for Shaver Lake, Lake Thomas A. Edison, Mammoth Pool Reservoir, Huntington Lake, Florence Lake, Redinger Lake, Big Creek Powerhouse No. 3 Forebay, Big Creek Powerhouse No. 2 Forebay and Big Creek Powerhouse No. 8 Forebay (SCE 1997; ENTRIX 1992; BioSystems 1987a,b,c).

4.4.6 Macroinvertebrates

Many fish species in rivers and streams utilize aquatic macroinvertebrates as their primary food source. Furthermore, macroinvertebrates comprise a significant part of the diet of several fishes and their different lifestages in the Basin. The abundance and availability of these organisms can indicate the potential productivity of the fishery of a particular area.

Available Information

Macroinvertebrate sampling was conducted in November 1995 for the San Joaquin River Horseshoe Bend Reach (SCE 1997), and in March 1984 in Mono and Bear Creeks (Garcia 1986).

In the Horseshoe Bend Reach macroinvertebrates were collected at three sites: 1) between Redinger Reservoir and the confluence of Willow Creek, 2) 0.5 miles downstream of the confluence with Willow Creek, and 3) 0.5 miles upstream from Big Creek Powerhouse No. 4. Each sample location consisted of a riffle and

a run habitat. A modified Hess sampler was used to obtain five random samples at each of the six stations (SCE 1997).

Garcia (1986) compared macroinvertebrate displacement volumes, used to approximate biomass, of stream reaches above Vermilion Dam (e.g., Upper Mono Creek and Bear Creek) with those present at several stations in Mono Creek downstream of Lake Thomas A. Edison. Samples from the main stream sites were collected twice during May 1984, using a “rock lifting technique”. Specimens were washed from 4 to 12-inch diameter freely resting rocks. A dip net was utilized to sample macroinvertebrates in the two smaller drainage streams below Vermilion Dam, because low stream gradients and heavy precipitate coating prevented the application of the “rock lifting technique”. Macroinvertebrates were taken from measured areas of stream bottom at each of the drainage stream sites.

4.4.7 Zooplankton

Zooplankton are small pelagic animals, usually of nearly microscopic size that feed on algae and other small organic particles. Most fish species inhabiting the reservoirs of the Basin rely heavily on zooplankton as a food source for at least some of their lifestages. Adequate zooplankton densities are necessary to support self-sustaining fisheries within these reservoirs.

Available Information

Studies to assess zooplankton abundances in several project reservoirs of the Basin were conducted by SCE (1997) and FERC (1982) and the California Department of Water Resources (1980).

Zooplankton sampling was conducted by SCE at three stations in September 1995 in Redinger Reservoir. Samples were taken during the day and after sunset using a submersible pump sampler and plankton net. At each station, zooplankton were collected with the submersible pump sampler just below the surface, as well as throughout the water column to obtain an integrated sample. In addition, integrated plankton tows from 30 ft depth were taken at all stations (SCE 1997).

In Huntington and Shaver Lakes, the California Department of Water Resources measured zooplankton densities in June, August and October of 1979. Samples were taken throughout the water column by lowering a small plankton net into the lake and pulling it to the surface (CDWR 1980).

4.4.8 Fish Habitat

Geomorphology

The Basin lies on the western flank of the south central Sierra Nevada mountain range and foothills, and includes waters tributary to the upper San Joaquin River. Elevation ranges from about 1,000 feet msl at Big Creek Powerhouse No. 4 to about 9,000 feet msl at Crater Creek Diversion. The drainage of the Basin includes primarily those waters associated with the South Fork San Joaquin River. The characteristics of streams in the Basin are determined by a combination of flow regime, substrate and gradient.

Stream substrate and gradient are the result of geologic and geomorphic history. In the Basin, steep gradients occur where small streams enter deeply incised valleys. The channel type and gradient of streams is influenced by the weathering pattern of the granitic landform.

"Stepped topography" is an important morphological process in the evolution of the Sierra Nevada landscape. This develops as a result of the weathering patterns on different slopes and soils. The combination of stream gradient and differentiated zones of rock weakness help form the areas of granitic alluvial meadows and low gradient stream reaches. Since the end of the Pleistocene, these meadows have experienced several cycles of aggregation and degradation. The substrate in streams in these areas is typically composed of decomposed granite in the form of coarse sand, gravels and cobbles.

The geomorphology of the Sierra Nevada has also been greatly influenced by its glacial history. Hanging valleys (valleys elevated above the main valley floor) and their low gradient stream reaches are composed chiefly of smaller sized granitic alluvium. Stream channels with steep gradients are mostly devoid of fine alluvium and are usually composed of boulder or bedrock substrate. Other stream reaches follow areas of glacial moraine and glacial outwash and contain granitic alluvium of all sizes.

In addition, the geomorphologic structure of streams determines the structure of the aquatic habitats. The combination of width to depth ratio, slope, entrenchment, sinuosity and substrate directly influence the habitat characteristics of a specific stream reach. Each habitat type contains a variety of depth, velocity, substrate, and cover conditions that provide the specific holding and feeding locations selected by fish and other aquatic life. These channel geomorphic units can be assigned to four broader categories (turbulent, non-turbulent, scour pool, and dammed pool habitat) based on depth and velocity, and are often broken down further into different types of pools, runs and riffles/cascades. Habitat types such as pools and riffles vary greatly in depth and velocity from each other, offering aquatic organisms a different set of hydraulic and cover conditions. Typically, different species of fish, amphibians, and macroinvertebrates utilize distinct habitats.

The aquatic habitats of low gradient stream channels found in hanging valleys and alluvial meadows are usually composed of corner pools, runs, and low gradient riffles. At high flows (e.g., during the spring runoff), most of the habitat may be composed of runs or main channel pools, and conversely, riffles and shallow pools may be more abundant at low flows. The substrate in low gradient channels is typically composed of sand, gravels or small cobbles. Larger stream channels found at mid to low-elevations are mostly composed of main channel/corner pool (often influenced by an instream structure), run and high gradient riffle habitats. The granitic geology of much of the Basin results in much of the substrate at lower elevations being composed of sand, cobble, boulders, and bedrock.

Stream channels with steep gradients are mostly devoid of fine alluvium and are usually composed of boulder or bedrock. At high flows these reaches are typically composed of steep runs, chutes and/or cascades. At low flows, small amounts of alluvium may collect in these reaches and bedrock pools and runs are more common.

Habitat and Habitat Models

Habitat

Data have been collected to characterize fish habitat in Basin streams during several previous studies. These are listed in Table F-4. An extensive program of habitat data collection will be a part of the initial information gathered for the ALP. Habitats are classified according to such types as pools, runs, and riffles (McCain et al. 1990). These are commonly referred to as mesohabitats. These are further classified into subtypes that are characterized by stream morphology, gradient, substrate, and instream structures (e.g. boulders, woody debris, etc.). A select combination of habitat types is typically associated with the overall stream channel gradient, flow regime, profile and substrate particle size.

Pools can be created primarily in one of three ways: 1) by eddies formed around obstructions such as boulders or root wads; 2) by streamflow scouring a depression in the substrate; or 3) by a blockage in the stream channel.

Run habitat is typically low gradient and is classified by the velocity and depth of the habitat. Runs are swift flowing reaches with little surface agitation and no major flow obstruction. A “step-run” is a sequence of runs that is broken by short riffle areas. The substrate of a typical run is composed of gravel, cobble and some boulder.

Riffle habitat is classified as either being high gradient or low gradient. It can be subdivided into three types: low gradient riffle, high gradient riffle, and cascade. Low gradient riffles are shallow areas of turbulent, swift flowing water usually with some partially exposed substrate (composed mostly of cobble). Stream gradient is less than 4%. High gradient riffles are moderately deep, swift flowing, very turbulent waters with a large amount of exposed substrate. They are found in steep reaches of more than 4% gradient. The substrate is dominated by the presence of boulders. Cascades are the steepest type of riffle habitat. Cascades are composed of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulder.

Habitat Models

Computer simulations are often performed to estimate how changing the flows within stream reaches might affect the usability of those reaches as habitat for fish. Fisheries scientists attempt to quantify stream habitat as affected by flows by using what is called the Instream Flow Incremental Methodology (IFIM) (Bovee 1982). The IFIM is composed of simulation models of the hydraulics of the stream reaches being analyzed. These models simulate how stream depths and velocities change within a stream reach when the flow through that reach is changed. Several models are involved; collectively they are known as PHABSIM or Physical Habitat Simulation Models.

The IFIM also utilizes quantified estimates of how suitable stream depths and velocities are for each fish species and life stage of concern. These estimates are usually in the form of Habitat Suitability Curves (HSC). HSC's can be obtained from the literature or may be derived for a particular study. The integration of the physical habitat simulation and the HSC's results in an estimate of habitat usability known as Weighted Usable Area (WUA).

PHABSIM input data files are available for representing several stream reaches within the Basin (Table F-4). Actual model decks are available for certain reaches (Trihey 1997). These reaches include 1) the lower Big Creek reach (from Powerhouse 2A to Powerhouse 8); 2) the Mammoth Pool reach of the San Joaquin (from Mammoth Pool Reservoir to Mammoth Pool Powerhouse), and 3) the Horseshoe Bend reach of the San Joaquin River (from Redinger Dam to Powerhouse No. 4).

This database contains data collected for a variety of SCE studies and includes physical habitat data collected for the Big Creek Expansion Project.

Text representations of these PHABSIM input files are also available for upper and lower Big Creek, Mammoth Pool, and Horseshoe Bend (BioSystems 1987 a,b,c). Data were collected for this study during 1985-1986. The PHABSIM models were used to analyze habitat usability for rainbow and brown trout, hardhead, Sacramento pikeminnow, and smallmouth bass. Model outputs are available demonstrating the change in habitat (WUA) with changes in flow. These outputs are in the form of graphs and a table with flow ranging from 10 to 60 cfs.

A text version of a PHABSIM input deck is available for representing Mono Creek downstream of the Vermilion Dam (BioSystems 1984). The PHABSIM models were used to analyze habitat usability for rainbow, brown, and brook trout. Physical habitat data were collected in October 1983.

WATER TEMPERATURE

Water temperatures in California streams and rivers can often affect the usability of stream habitat for fish. Trout and other salmonids have evolved in the presence of cool water temperatures, while the cyprinid and catostomid groups have evolved with the highly variable seasonal discharge and warmer temperatures typical of lower elevation waters of California. California reservoirs are capable of creating different temperature habitats within the reservoir and downstream of the impoundment, depending on the amount and timing of releases from the reservoir. Releases from reservoirs can result in warmer or cooler conditions than might occur naturally depending upon the storage of cold water within the reservoir, whether the reservoir is stratified, and the depth of the release. The amount of flow released also can affect how the temperatures downstream of a reservoir respond to natural warming. Water temperatures can affect growth, timing of spawning, and survival of fish. Water temperatures also may influence the success of predacious fish and competition between species. Water temperature can also influence water quality. The solubility of gases such as oxygen is a function of temperature; colder temperatures are typically capable of carrying more oxygen than warmer water.

Stream temperatures within a stream reach are sensitive to air temperature, flow, shading, day length and other meteorological factors. The suitability of the reach for the fish species of concern is likely to change with changing temperatures.

Available Information

Water temperature data have been collected in the Basin in a variety of locations at various times (Table F-4). Stream temperatures were presented for data collected at four locations within the Mammoth Pool reach of the San Joaquin River, during June through October, 1983 (BioSystems 1987a). This draft document presents these data as plots of mean daily temperature (°C) versus date. These data had been previously presented, along with the partial records for two other Mammoth Pool reach sites, in a draft report (BioSystems 1985).

Another draft document (BioSystems 1987b) from the same study, presented a graph of mean daily stream temperatures (°C) collected at three locations within the upper Big Creek reach for days between May and September, 1986. Two tributaries to upper Big Creek were also monitored; a similar graph is presented for these observed temperatures. This same document presents similar graphs of temperatures observed on the lower Big Creek reach during June through October 1985 (three sites).

Stream temperatures were collected at five locations within the Horseshoe Bend reach of the San Joaquin River and at one location on the Stevenson reach, during June through November, 1985 in a third draft report (BioSystems 1987c). These data are presented as plots of mean daily temperature (°C) verses day.

Recent temperature and meteorological data were collected in the Basin during 1995 and 1997. In 1995, stream temperatures were collected in the Horseshoe Bend reach of the San Joaquin River. In 1997, stream temperatures were collected in the lower Big Creek and Stevenson Creek. These data, when combined with additional meteorological, flow, and stream structure data can be used for initial model calibration. A summary of the collected data is presented in Table F-6 (Appendix F). Initial water temperature data will be collected this year, as part of a monitoring program to support the ALP.

Stream temperature changes can be quantified by using a stream temperature model. One such model that has been widely used in fisheries studies is the Stream Network Temperature Model (SNTEMP) (Theurer et al., 1984). The SNTEMP model is especially effective at simulating the temperatures within a stream system as those temperatures are affected by flow through the system, the local meteorology, and the structure of the system.

A partial SNTEMP data set is available as text for the Mammoth Pool reach of the San Joaquin River (BioSystems 1985). These data were collected in 1983; the data sets were used in calibrating and validating the SNTEMP model.

SNTEMP was applied to the Mammoth Pool reach of the San Joaquin River (BioSystems 1987a) for a variety of flow releases from Mammoth Pool and Rock Creek. A Draft of preliminary model results are presented in the form of graphs and tables depicting mean daily stream temperatures with distance downstream of Mammoth Pool for reach flows between 27 and 175 cfs. The simulations included additional flow releases beyond those originally simulated and presented in BioSystems (1985).

Similar preliminary SNTEMP tabular and graphical output is presented for the Stevenson Reach with flows from Dam 6 ranging from 10 to 200 cfs in a draft report (BioSystems 1987b).

SNTEMP was applied to the Horseshoe Bend reach of the San Joaquin River in a draft report (BioSystems 1987c). Preliminary model results are presented in the form of graphs and tables depicting mean daily stream temperatures with distance downstream of Redinger Lake for flow releases of 20 to 200 cfs. This same document presents similar SNTEMP results for the upper Big Creek reach with flow at Dam 4 ranging from 2 to 35 cfs. A more accurate SNTEMP model was calibrated and verified for the Horseshoe Bend Reach as part of a response to a FERC request for additional information for the Big Creek No. 4 Hydroelectric Project relicensing (SCE 1999). This model was validated to a range of flows up to 13,800 cfs.

NUTRIENTS

The geomorphology of the Big Creek Basin is primarily granite, and as such, associated waters are typically nutrient poor. Organic debris is limiting at higher elevations and contributes little to the chemistry of the water. The headwaters of Big Creek and the South Fork San Joaquin River system are located at or above timberline, and therefore, receive little organic input.

Large mid-elevation reservoirs and tailwaters do not typically exhibit signs of low concentrations of nutrients. Most of these reservoirs are situated in areas that are heavily forested with good insect and fish production.

Prior to the construction of many of the dams, Chinook salmon played a key role in providing nutrients to some of the mid-elevation streams. After spawning, adult salmon carcasses contributed marine-derived nitrogen and phosphorous to the otherwise nutrient-deficient system. Currently, dams downstream of the Basin prevent upstream passage to historic spawning locations.

4.5 BOTANICAL AND WILDLIFE RESOURCES

4.5.1 GENERAL OVERVIEW

The botanical and wildlife resources in the Basin are as diverse as the area itself, and consist of a wide variety of habitats that support many wildlife species. Habitats range from foothill woodlands and lower montane chaparrals at lower elevations, through ponderosa pine and other lower montane forests at mid-elevations, to upper montane fir and pine forests or subalpine forests at the highest elevations. Wetland and riparian habitats, not well developed in many areas, are found in moist areas and along the waterways of the Basin. Wildlife resources in this area include resident and migratory populations of general wildlife species, as well as those considered locally important such as game, raptors, and special-status species of invertebrates, reptiles, amphibians, birds and mammals.

This section describes the botanical and wildlife resources of the Basin, including habitat types, locally important species, and special-status species of plants and animals. Noxious weeds are also discussed briefly, including the known occurrence of these invasive species within the Basin.

4.5.2 BOTANICAL RESOURCES

The diverse botanical resources of the Big Creek System Basin encompass nineteen general vegetation community types. Of the area's nineteen vegetation communities, nine are categorized as forest or woodland, five are shrub and grassland-meadow types, two are wetland types, and three are riparian vegetation types. In addition, 26 special-status plant species have the potential to occur in this area. Seven of these species are listed by the state and federal governments as threatened, endangered, or rare.

Invasive (non-native) plant species, some of which are classified as noxious weeds, have become an issue of concern for the state and federal governments. Twenty-one species of noxious weeds are known to occur within or near the Sierra National Forest, three of which are A-rated by the California Department of Agriculture as weeds of known economic significance. However, the known cumulative coverage in 1999 of the three A-rated weeds within the Forest was less than five acres.

The following presents a brief description of the vegetation types found in the Basin, as well as a discussion of the special-status plant species and noxious weeds that are known to occur or could potentially be found there.

VEGETATION HABITAT TYPES

The general vegetation types found in the Basin are: fir; pine and mixed conifer forests; chaparral; and barren (Figure 4.5-1). The most predominant vegetation type is the fir forest extending from the mid-elevation ranges around Shaver Lake and Mammoth Pool Reservoir to the high elevations around Florence Lake and Lake Thomas A. Edison. Pine forest vegetation is present at the lower elevations around Big Creek No. 3 and Big Creek No. 4. Chaparral is found in the Basin at high elevations along the South Fork San Joaquin River north of Florence Lake and east of Lake Thomas A. Edison, and at low elevations along the San Joaquin River in the vicinity of the Big Creek No. 3 and Big Creek No. 4 projects. Mixed conifer forest is found at the high elevations north of Lake Thomas A. Edison and east of Florence Lake. An occurrence of barren habitat is located at high elevations along Kaiser Ridge north of Huntington Lake. More specific vegetation typing has been completed around the Big Creek System facilities.

Figure 4.5-2 depicts the relative elevations at which the predominant Basin vegetation communities are known to occur. It is worth noting that grasslands, woodlands, and forests typical of California's Central Valley may be found at the lower elevations, whereas subalpine and alpine communities occur at higher elevations.

Information on botanical resources in the Basin was obtained primarily from SCE (2000a), Biosystems (1987*a*, 1987b), ASI (1993), and the Federal Register (1998). The descriptions of the vegetation types were derived from several additional sources (Barbour and Major 1988, Holland 1986, Sawyer and Keeler-Wolf 1995).

Nine forested vegetation communities, five shrub and grassland communities, two wetland communities and three riparian communities are discussed in the following sections.

<u>Forested Vegetation Types</u>

Foothill Pine/Oak Woodlands: Foothill pine/oak woodlands are reported to occur in the vicinity of Big Creek Nos. 1 & 2, Big Creek Nos. 2A, 8 & Eastwood, and Mammoth Pool. This vegetation type is typically found in the foothills below 3,000 to 4,000 feet msl. These woodlands are usually dominated by blue oak (*Quercus douglasii*), or gray pine also known as foothill pine (*Pinus sabiniana*), or both. Other oaks that may be dominant species include valley oak (*Q. lobata*), interior live oak (*Q. wislizenii*), and black oak (*Q. kelloggii*). California buckeye (*Aesculus californica*), mountain mahogany (*Cercocarpus betuloides*), and poison oak (*Toxicodendron diversilobum*) may be present. Where the canopy is open, the understory may consist of grasses and other herbaceous species.

Placeholder for Figure 4.5-1
Big Creek Basin Vegetation

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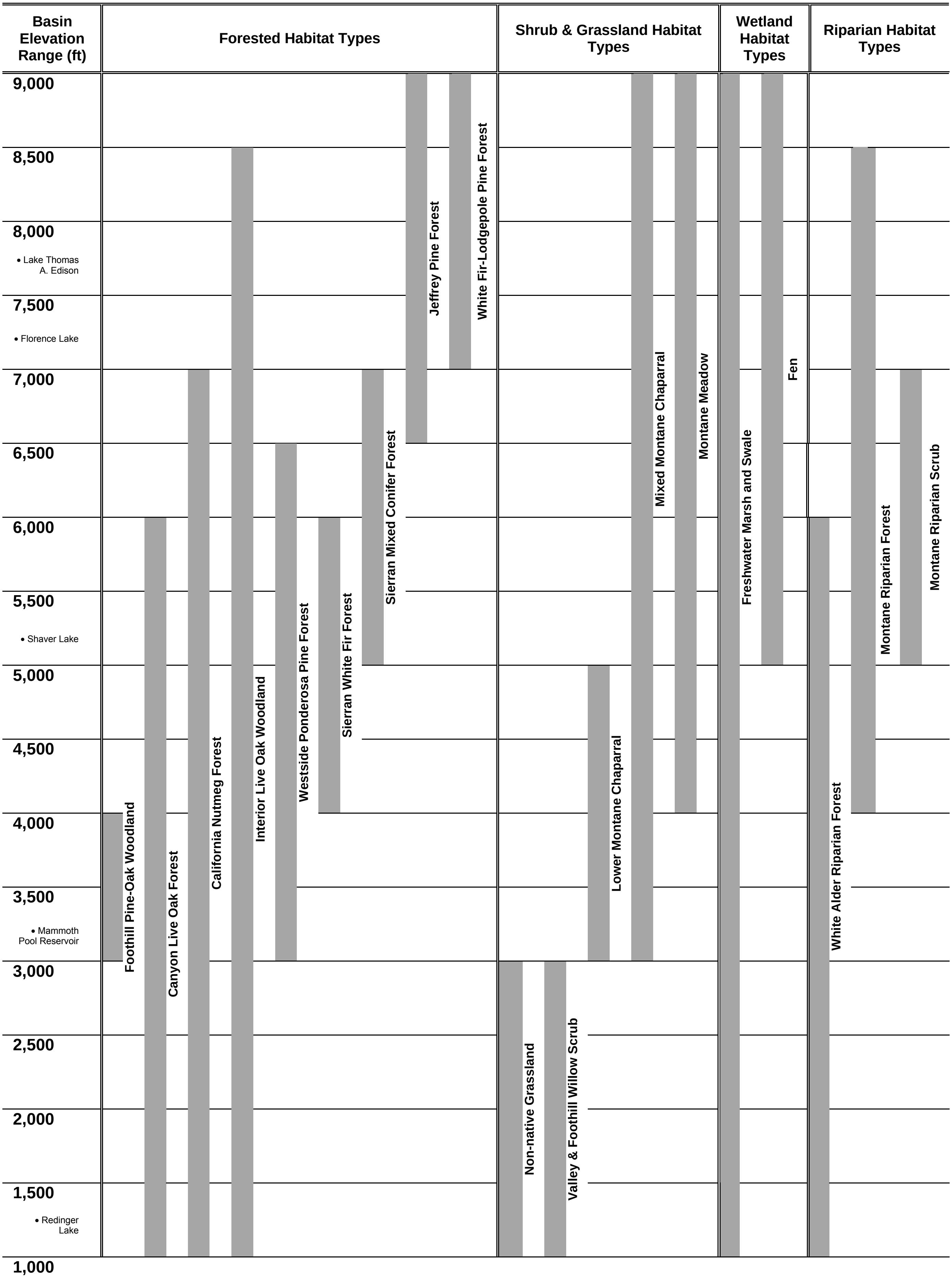
Figure 4.5-2 Approximate Elevation Ranges of Basin Habitat Types



Canyon Live Oak Forest: Canyon live oak forest is reported to occur in the vicinity of Big Creek Nos. 1 & 2 and Big Creek No. 3. Canyon live oak forest is a broad-leaved evergreen forest found below 6,000 feet msl. This forest, dominated by canyon live oak (*Quercus chrysolepis*), is typically found in canyons or on north-facing slopes. The canopy is dense and little understory is present. When present, the understory may include mountain mahogany, buckbrush (*Ceanothus cuneatus*), black oak, and yerba santa (*Eriodictyon* spp.).

California Nutmeg Forest: This vegetation type is reported to occur in the vicinity of portions of Big Creek Nos. 2A, 8 & Eastwood and Big Creek Nos. 1 & 2. California nutmeg (*Torreya californica*) is found between 100 and 6,900 feet msl in shady canyons within forests and woodlands, or sometimes in chaparral. An occurance of California nutmeg has been reported on a slope between the town of Big Creek and the access road to Big Creek Nos. 2 and 2A powerhouses. Understory within this forest type is typically representative of the surrounding forests and woodlands. Marble outcrops have been noted along the access road, and the understory in this area may include species associated with marble substrates.

Interior Live Oak Woodland: Interior live oak woodland is reported to occur in the vicinity of Big Creek No. 4, and Big Creek No. 3. This vegetation type contains broad-leaved, evergreen cismontane woodlands usually found on north-facing slopes below 8,500 feet msl. This woodland is dominated by interior live oak. Blue oak, California buckeye, and California bay (*Umbellularia californica*) may be sub-dominant species. Interior live oak woodland usually has a dense canopy that precludes the development of much herbaceous understory. Woody understory species include redbud (*Cercis occidentalis*), poison oak, and squawbush (*Rhus trilobata*).

Westside Ponderosa Pine Forest: Westside ponderosa pine forest is reported to occur in the vicinity of Big Creek Nos. 1 & 2, Big Creek Nos. 2A, 8 & Eastwood, and Vermilion. This vegetation type, also called yellow pine forest, is a lower montane coniferous forest type, usually found between 3,000 and 6,500 feet msl in the western Sierra Nevada mountain range. Ponderosa pine forests typically occur above oak woodlands, however, jeffrey pine stands can occur interspersed with ponderosa pine on serpentine soils or harsh soils (Mayer and Laudenslayer 1988). Westside pondersosa pine forest is an open forest dominated by ponderosa pine (*Pinus ponderosa*). Other tree species often present in this forest include incense cedar (*Calocedrus decurrens*), Douglas fir (*Pseudotsuga menziesii*), and black oak. The sparse understory of chaparral shrubs and young trees may include whiteleaf manzanita (*Arctostaphylos viscida*), deerbrush (*Ceanothus integerrimus*), and rabbitbrush (*Chrysothamnus nauseosus* ssp. *albicaulis*).

Sierran White Fir Forest: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2, and Big Creek Nos. 2A, 8 & Eastwood. Sierran white fir forest is a lower coniferous forest type, usually found between 4,000 and 6,000 feet msl. This forest typically consists of a nearly pure stand of white fir (*Abies concolor*) with a very sparse understory, including occasional seedlings of white fir. Jeffrey pine (*Pinus jeffreyi*) and lodgepole pine (*Pinus contorta* ssp. *murryana*) may also occur in these forests.

Sierran Mixed Conifer Forest: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2. Sierran mixed conifer forest is a lower montane coniferous forest type, typically found between 5,000 and 7,000 feet msl. Sierran mixed conifer forest is similar to westside ponderosa pine forest, but is more dense and includes firs (*Abies* spp.), madrone (*Arbutus menziesii*), sugar pine (*Pinus lambertiana*), black oak, and Douglas fir, as well as ponderosa pine. The understory is also similar to the understory of westside pondersosa pine forest.

Jeffrey Pine Forest: Jeffrey pine forest is reported to occur in the vicinity of Big Creek Nos. 2A, 8 & Eastwood, Portal, and Vermilion Valley. Jeffrey pine forest is an upper montane coniferous forest type found between 6,500 and 9,000 feet msl. This forest is a tall, open forest dominated by Jeffrey pine, with a sparse understory of chaparral or sagebrush scrub shrubs and young trees. This understory may include white fir, greenleaf manzanita (*Arctostaphylos patula*), mountain whitethorn (*Ceanothus cordulatus*), wax currant (*Ribes cereum*), big sagebrush (*Artemisia tridentata*), and rabbitbrush.

White Fir/Lodgepole Pine Forest: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 2A, 8 & Eastwood, and Vermilion Valley. Lodgepole pine forest is a subalpine coniferous forest type found between 7,000 and 11,000 feet msl. This forest is typically a dense forest of slender trees, often consisting of nearly pure stands of lodgepole pines. Understory vegetation is sparse in the dense forest, but low shrubs and herbs are abundant in forest openings. In the vicinity of the project facilities, lodgepole pine forests include white fir as a co-dominant. The white fir/lodgepole pine mixed forest may be considered an upper montane community rather than a subalpine community. Creeping snowberry (*Symphoricarpos mollis*), huckleberry oak (*Quercus vaccinifolia*), bush chinquapin (*Chrysolepis sempervirens*), and mountain whitethorn are found in the understory.

<u>Shrub and Grassland-Meadow Vegetation Types</u>

Non-native Grassland: This vegetation type is reported to occur in the vicinity of Big Creek No. 4. Non-native grassland is found in valleys and foothills below 3,000 feet msl. This grassland is covered with a dense to sparse cover of mostly non-native annual grasses, often associated with native wildflowers. Dominant species include species of wild oat (*Avena* spp.), ripgut brome (*Bromus diandrus*), foxtail chess (*Bromus madritensis* ssp. *rubens*), soft chess (*Bromus *hordeaceus*), and filaree (*Erodium* spp.). Native wildflowers frequently present include lupines (*Lupinus* spp.), owl's-clover (*Castilleja* spp.), and poppies (*Eschscholtzia* spp.).

Valley and Foothill Willow Scrub: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2. Valley and foothill willow scrub is found along streams between 1,000 and 3,000 feet msl, and provides most of the riparian habitat along Big Creek. This vegetation type is dominated by willows, Fremont cottonwood, and white alder. The understory may include mugwort, California wild grape, and the exotic species Himalayan blackberry.

Lower Montane Chaparral: This vegetation type is reported to occur in the vicinity of Big Creek No. 3, and may occur in the vicinity of Mammoth Pool. Lower montane chaparral is found in the foothills and mountains from below 3,000 feet msl to 5,000 feet msl. This chaparral is typically a dense shrub thicket dominated by a combination of manzanita (*Arctostaphylos spp.*), buck brush (*Ceanothus* spp.), chamise (*Adenostoma fasciculatum*), mountain mahogany, or scrub oaks (*Quercus spp.*). Lower montane chaparral may also be dominated by only one of these species. Nearly pure chamise stands are more common at these lower elevations than within the mixed montane chaparral, described below.

Mixed Montane Chaparral: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2, Big Creek Nos. 2A, 8 & Eastwood, and Mammoth Pool. Mixed montane chaparral is found in the foothills and mountains between 3,000 and 11,000 feet msl. Like lower montane chaparral, mixed chaparral is a dense thicket of shrubs, dominated by a combination of manzanita, buck brush, chamise, mountain whitethorn, Sierran gooseberry (*Ribes roezlii*), bush chinquapin, bittercherry (*Prunus emarginata*), or scrub oaks. Chaparral areas may also be vegetated by a patchwork of shrub thickets, where each patch is dominated by a single species. Widely scattered trees including species such as Jeffrey pine, lodgepole pine, or western juniper may emerge from the thickets.

Montane Meadow: The montane meadow vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2 and Big Creek Nos. 2A, 8 & Eastwood. Montane meadows are found at scattered locations within forests in moist soil, between 4,000 and 9,000 feet msl. The vegetation in these meadows consists of a dense cover of sedges (*Carex* spp.) and other perennial herbs. Montane meadows may be bordered by montane riparian scrub at elevations between 5,000 and 7,000 feet msl.

Wetland Type Communities

Freshwater Marsh and Swale: Freshwater marsh and swale is reported to occur in the vicinity of Big Creek Nos. 2A, 8 & Eastwood and Vermilion Valley. Freshwater marsh and swale communities are found along quiet parts of rivers and streams and at seeps from sea level to over 12,000 feet msl. Vegetation in these marshes and swales primarily consists of a dense growth of cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) in the lower elevation areas where perennial standing water exists, and primarily consists of sedges and rushes (*Juncus* spp.) in slightly drier or higher places.

Fen: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2 and Big Creek Nos. 2A, 8 & Eastwood. Fens are found at widely scattered locations between 5,000 and 9,000 feet msl, typically on peaty accumulations in cold, poorly drained areas. These wetlands are dominated by a dense, low growth of herbaceous perennials and shrubs, including sedges and spikerushes (*Eleocharis* spp.).

Riparian Vegetation Types

White Alder Riparian Forest: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 1 & 2, Big Creek Nos. 2A, 8 & Eastwood, Big Creek No. 3, and Big Creek No. 4. White alder riparian forest is found along rapidly flowing, perennial streams in incised canyons from sea level to 6,000 feet msl. This forest is a medium-tall broad-leaved deciduous forest dominated by white alder (*Alnus rhombifolia*) and willows. Fremont cottonwood (*Populus fremontii*), California bay, and Oregon ash (*Fraxinus latifolia*) may also be present. The shrubby, deciduous understory includes mugwort (*Artemisia douglasiana)* and the exotic species Himalayan blackberry (*Rubus discolor*), and periwinkle (*Vinca major*).

Montane Riparian Forest: This vegetation type is reported to occur in the vicinity of Big Creek Nos. 2A, 8 & Eastwood, and Mammoth Pool. Montane riparian forests are found along streamsides between 4,000 and 8,500 feet msl. These forests are dominated by aspen (*P. tremuloides*), although white alder, willows, and Oregon ash may also be present. The understory is likely to include California wild grape (*Vitis californica*).

Montane Riparian Scrub: Montane riparian scrub is reported to occur in the vicinity of Big Creek Nos. 1 & 2 and Big Creek Nos. 2A, 8 & Eastwood. Montane riparian scrub is found at widely scattered locations along snowmelt-fed streams or around montane meadows between 5,000 and 7,000 feet msl. These thickets are dominated by a variety of broad-leaved, deciduous shrubs, including Scouler's willow (Salix scouleri), other willows, mountain alder (*Alnus incana* ssp. *tenuifolia*), and dogwood (*Cornus* spp.).

SPECIAL-STATUS PLANT SPECIES AND COMMUNITIES

This discussion of special-status species includes those species that are listed in accordance with the state and federal Endangered Species Acts, as threatened, endangered, rare, or candidates proposed for listing. In addition, this discussion includes other special-status species that are generally recognized as species of concern to many natural resource agencies; these include species that are designated by the USFS and the California Native Plant Society (CNPS).

Twenty-six special-status plant species are known to exist or have the potential to exist in the vicinity of project facilities, based upon the habitat types present (Table G-1 in Appendix G). Seven of these species are recognized by federal and/or state agencies as threatened, endangered or rare. The remaining 19 species are noted as other species of special concern. Eight special-status species are known to occur in the vicinity of the projects. These include: 1) tree-anemone (*Carpenteria californica*) occurring in the vicinity of the Big Creek No. 3 and Big Creek No. 4 projects; 2) Mono Hot Springs evening primrose (*Camissonia sierrae ssp. alticola*) occurring in the vicinity of the Vermilion Valley project; 3) subalpine fireweed (*Epilobium howellii*) occurring in the vicinity of the Portal project; 4) Yosemite ivesia (*Ivesia unguiculata*) occurring in the vicinity of the Portal, Vermilion Valley, Big Creek Nos. 2A, 8, and Eastwood, and Big Creek Nos. 1 and 2 projects; 5) Hall's wyethia (*Wyethia elata*) occurring in the vicinity of the Big Creek No. 4 project; 6) prairie wedge grass (Sphenopholis obtusata) occurring in the vicinity of the Big Creek Nos. 2A, 8, and Eastwood projects; 7) flaming trumpet (Collomia rawsoniana) occurring in the vicinity of the Mammoth Pool project; and 8) Madera linanthus (Linanthus serrulatus) occurring in the vicinity of the Big Creek Nos. 1 and 2 projects. Other species may potentially occur based on habitat conditions, but have not been found in the vicinity of the projects.

The known occurrences of special-status species in the vicinity of the project facilities are noted in Figure 4.5-1. The figure indicates the locations of these plants within a one-half mile radius, as reported by the California Natural Diversity Database (CNDDB).

Tree-anemone (*Carpenteria californica*) is listed as threatened by the State of California, and is known to occur in the vicinity of the Big Creek No. 3 and Big Creek No. 4 projects. Several reserves exist in the area in an effort to protect part of the population of this species. The Sierra National Forest manages the 500-acre Carpinteria Botanical Area (located about 10 miles southwest of Shaver Lake along Highway 168), and the 430-acre Backbone Creek Research Natural Area (located south of Horseshoe Bend the San Joaquin River in the vicinity of the Big Creek No. 4 Project) for protection and study of the sensitive plant (USFS 1991).

Noxious Weeds

Invasive plant species, often non-native, may occupy areas disturbed by natural events or by human activities. Although these species rarely invade closed forests, especially at higher elevations, they may displace natural vegetation at disturbed sites. Roads are often media for the distribution of weeds.

The State of California has a formal process for designating species as noxious weeds, and land-owners are legally obligated to control species so designated. While the U.S. Forest Service is exempt from this legal requirement, the agency has a policy to actively control noxious weeds on lands under its management. Specifically, the Forest Service Manual direction on noxious weeds was updated in 1995 to address this issue. The revised direction establishes Integrated Weed Management as the overarching objective, links weed management to the goals and objectives of the Forest Land and Resource Management Plan, and sets the policy that, for every proposed ground disturbing project or activity, the risk of introducing or spreading noxious weeds must be determined (USFS 1995).

Table 4.5-1 lists the species of noxious weeds believed by Forest Service staff to pose a threat to ecosystems within the Sierra National Forest as of 1999 (SCE 1999). Twenty-one species of noxious weeds are known to occur in the Forest, three of which are A-rated by the California Department of Agriculture as weeds of known economic significance. Diffuse knapweed (*Centaurea diffusa*) is estimated to occur on less than five acres within the Forest. Spotted knapweed (*Centaurea maculosa*) and rush skeletonweed (*Chondrilla juncea*) are reported to occur near the Forest, and are expected in the Forest within the next five years. Seven of the 21 species of noxious weeds are also categorized by the California Exotic Pest Plant Council as the most invasive wildland pest plants. Of these, cheatgrass (*Bromus tectorum*) and yellow star-thistle (*Centaurea solstitialis*) are currently the most widespread, and are reported to infest approximately 10,000 and 3,000 acres of Forest, respectively.

4.5.3 Wildlife Resources

The wildlife resources associated with the Big Creek System Basin include habitat, locally important wildlife species, and special-status wildlife populations that may occur in the vicinity of the project facilities. A total of eighteen wildlife habitat types occur in the area, including nine forest or woodland types, three shrub types, three grassland and wetland types, and three riparian types, contributing to a diversity of wildlife species. The Basin supports several groups of wildlife species considered locally important, including game, raptors, and special-status species. Mule deer are the most important big game species in the forest. There are also several important game birds in the forest, including band-tailed pigeon, mountain quail, California quail, and wild turkey, as well as a diversity of raptor species, including eagles, owls, vultures, hawks, and falcons. In addition, 51 special-status wildlife species are known to occur or have a high probability of occurring in the project region. These special status species include invertebrates, reptiles, amphibians, birds and mammals.

This section describes the Basin habitat types, the locally important wildlife groups, and the special-status species occurring in the Basin. Monitoring program results are also presented from the Balsam Meadows Project area which include recent data specific to the project area. The general wildlife resources are described first, by habitat type, in the following.

Table 4.5-1 Noxious Weeds Occurring in the Sierra National Forest

Scientific Name	Common Name (CalEPPC List)[1]	State Pest Rating[2]	Potential Acreage
Ailanthus altissima	Tree of heaven (A-2)		<10
Brassica nigra	Black mustard (B)		500
Bromus tectorum	Cheatgrass (A-1)		10000
Carduus pycnocephalus	Italian thistle (B)	C	500
Centaurea diffusa	Diffuse knapweed	A	<5
Centaurea maculosa	Spotted knapweed	A	N
Centaurea melitensis	Tocalote (B)		1000
Centaurea solstitialis	Yellow star-thistle (A-1)	C	3000
Chondrilla juncea	Rush skeletonweed	A	N
Cirsium arvense	Canada thistle (B)	B	N
Cirsium vulgare	Bull thistle (B)		1000
Cytisus scoparius	Scotch broom (A-1)	C	500
Hypericum perforatum	Klamath weed	C	500
Lythrum salicaria	Purple loosestrife (Red Alert)	B	N
Robinia pseudoacacia	Black locust (B)		<5
Rubus discolor	Himalayan blackberry (A-1)		20
Spartium junceum	Spanish broom (B)		500
Taeniatherum caput-medusae	Medusahead (A-1)	C	<5
Tamarix chinensis	Tamarisk (A-1)		N
Tribulus terrestris	Puncture vine	C	<5
Verbascum thapsus	Woolly mullein (B)		500

[1] CalEPPC (California Exotic Pest Plant Council, 1999, www.caleppc.org)

List A-1: Most Invasive Wildland Pest Plants: Widespread. List A-2: Most Invasive Wildland Pest Plants: Regional. List B: Wildland Pest Plants of Lesser Invasiveness. Red Alert: Species with Potential to spread explosively: Infestations currently restricted in size. NMI: Need more information. AG: Annual grasses that pose significant threats to wildlands. CBNL: considered but not listed

[2] California State Department of Agriculture: Pest Ratings of Noxious Weeds (Hrusa, 1999)

A-rated pests: Weeds of known economic significance, subject to action by CDFA including eradication, quarantine, containment, rejection of shipments, or other holding action at the state-county level. Quarantine interceptions are to be rejected or treated at any point in the state.

B-rated pests: Weeds subject to action by CDFA only when found in a nursery, and otherwise subject to eradication, containment, control, or other holding action at the discretion of the local county agricultural commissioner.

C-rated pests: Not subject to state action except to provide for general pest cleanliness in nurseries; reject by CDFA only when found in a cropseed for planting or at the discretion of the commissioner, action to retard spread outside of nurseries at the discretion of the county agricultural commissioner.

Wildlife Habitat Types

The eighteen wildlife habitats occurring in the Big Creek System Basin are grouped into four major categories: forested types, shrub types, grassland and wetland types, and riparian types. The wildlife species, including resident and migratory animals that are associated with each of these habitat types are described with each of the habitat types in the sections below.

Forested Types

Foothill Pine/Oak Woodland: A diversity of reptiles, mammals, and birds use pine and oak woodland habitats. Oaks provide an important food resource for many resident and over-wintering bird and mammal species. Mammals typically found in this habitat include Botta's pocket gopher (*Thomomys bottae*), California ground squirrel (*Spermophilus beecheyi*), gray fox (*Urocyon cinereoargenteus*), western gray squirrel (*Sciurus griseus*), striped skunk (*Mephitis mephitis*), mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), and mountain lion (*Felis concolor*) (SCE 1997). While some mule deer reside in oak woodland habitat year-round, their numbers increase in winter months as individuals move down from higher elevation summer habitats. Birds that commonly forage and nest in this habitat include the California towhee (*Pipilo crissalis*), mourning dove (*Zenaida macroura*), western kingbird (*Tyrannus verticalis*), western scrub jay (*Aphelocoma californica*), American crow (*Corvus brachyrhynchos*), rufous-crowned sparrow (*Aimophila ruficeps*), ash-throated flycatcher (*Myiarchus cinerascens*), acorn woodpecker (*Melanerpes formicivorus*), red-tailed hawk (*Buteo jamaicensis*), wrentit (*Chamaea fasciata*), California quail (*Callipepla californica*), and plain titmouse (*Parus inornatus*). Amphibians and reptiles characteristic of this habitat include the Pacific chorus frog (*Pseudacris regilla*), western spadefoot toad (*Scaphiopus hammondi*), western fence lizard (*Sceloporus occidentalis*), common garter snake (*Thamnophis sirtalis*), gopher snake (*Pituophis melanoleucus*), and western rattlesnake (*Crotalus viridis*) (SCE 1997).

Canyon Live Oak Forest: Canyon live oak forests provide forage and cover for many wildlife species. Amphibians and reptiles characteristic of this habitat include the Pacific chorus frog, western spadefoot toad, western fence lizard, common garter snake, gopher snake, and western rattlesnake. Mammals typically found in this habitat include the California ground squirrel, western gray squirrel, several species of skunk, mule deer, coyote, bobcat, and mountain lion. While some mule deer reside in valley oak woodland habitat year-round, their numbers increase in winter months as individuals move down from higher elevation summer habitats. Birds that commonly forage and nest in this habitat include the California towhee, European starling (*Sturnus vulgaris*), mourning dove, western kingbird, scrub jay, American crow, rufous-crowned sparrow, rufous-sided towhee (*Pipilo erythrophthalmus*), ash-throated flycatcher, acorn woodpecker, wrentit, bushtit (*Psaltriparus minimus*), California quail, plain titmouse, and red-tailed hawk (SCE 1997).

California Nutmeg Forest: The wildlife found in shady canyons of the California Nutmeg Forest is probably similar to the surrounding forests and woodlands. Common species expected in this habitat type probably include the western fence lizard, Gilbert's skink (*Eumeces giberti*), western rattlesnake, turkey vulture (*Cathartes aura*), mourning dove, Hutton's vireo (*Vireo huttoni*), dusky-footed woodrat (*Neotoma fuscipes*), gray fox (*Urocyon cinereoargenteus*) and mule deer (SCE 2000b).

Interior Live Oak Woodland: Species known to occur in oak woodland habitats include a diversity of birds, mammals, and reptiles. The following birds have been recorded in the project region in the oak woodlands and are expected to nest in this habitat: California towhee, mourning dove, western kingbird, scrub jay, American crow, rufous-crowned sparrow, ash-throated flycatcher, acorn woodpecker, red-tailed hawk, wrentit, California quail, and plain titmouse (SCE 1997). Other species of wildlife detected in oak woodland habitat in the project area include the California ground squirrel, gopher snake, western fence lizard, botta's pocket gopher, and mule deer. (SCE 1997). The oak woodland habitats are also expected to support several predatory wildlife species, including black bear (*Ursus americanus*), bobcat, mountain lion, coyote, red fox (*Vulpes vulpes*), and wild pig (*Sus scrofa*) (SCE 1997).

Westside Ponderosa Pine Forest: Ponderosa pine forests usually occur above oak woodlands, however, jeffrey pine stands can occur interspersed with ponderosa pine on serpentive soils or harsh soils (Mayer and Laudenslayer 1988). As such, ponderosa pine is often a transitional or migratory habitat for deer, often providing important, essential nutrition to deer in holding areas. Other typical wildlife species include western skink (*Eumeces skiltonianus*), northern alligator lizard (*Elgaria coerulea*), western rattlesnake, great horned owl (*Bubo virginianus*), violet-green swallow (*Tachycineta thalassina*), mountain chickadee (*Parus gambeli*), golden-mantled ground squirrel (*Spermophilus lateralis*), dusky-footed woodrat, and bobcat (SCE 2000b).

Sierran White Fir Forest: White fir forests are typically characterized by nearly monotypic, even-aged overstory, creating cool and moist habitats (Mayer and Laudenslayer 1988). As stands mature, they often become infected with fungus, causing breaks to occur, thereby creating excellent habitat for snag and cavity dependent species, such as the red-breasted sapsucker (*Sphyrapicus ruber*), hairy woodpecker (*Picoides villosus*), three-toed woodpecker (*Picoides tridactylus*), and white-headed woodpecker (*Picoides albolarvatus*). The availability of food is drastically reduced in the winter. Thus, the species diversity is limited to only those predatory species that are sustained by prey, for example, the northern goshawk, northern pygmy-owl (*Glaucidium gnoma*), California spotted owls and great gray owl (*Strix nebulosa*). Avian summer visitors include the common nighthawk (*Chordeiles minor*), western wood pewee, violet-green swallow, solitary vireo (*Vireo solitarius*), black-headed grosbeak (*Pheucticus melanocephalus*), and chipping sparrow (*Spizella passerina*) (Verner and Boss 1980). Numerous insect gleening species forage in white firs, such as yellow-rumped warbler (*Dendroica coronata*), western tanager (*Piranga ludoviciana*), chestnut-backed chickadee (*Parus rufescens*), mountain chickadee, and golden-crowned kinglet (*Regulus satrapa*) (Mayer and Laudenslayer 1988). Other characteristic species include northern alligator lizard, western terrestrial garter snake (*Thamnophis elegans*), mountain quail (*Oreortyx pictus*), calliope hummingbird (*Stellula calliope*), American robin (*Turdus migratorius*), northern flying squirrel (*Glaucomys sabrinus*), bushy-tailed woodrat (*Neotoma cinerea*), and long-tailed weasel (*Mustela frenata*) (SCE 2000b).

Sierran Mixed Conifer Forest: Sierran mixed conifer forests are an assemblage of conifer and hardwood species that form a multilayered, closed canopy of nearly 100 percent cover (Mayer and Laudenslayer 1988). Understory is usually only found where openings occur. With this diverse structure, mixed conifer forests have been reported to support 355 wildlife species (Verner and Boss 1980). The plant species composition, including oak acorns, berries, grasses and forbs, provides essential food resources for a broad range of wildlife species. Additionally, special-status species such as the California spotted owl (*Strix occidentalis*), pine martin (*Martes americana*), and Pacific fisher (*Martes pannanti pacificus*), are permanent residents in this habitat type (Mayer and Laudenslayer 1988). Common wildlife species include northern goshawk (*Accipiter gentilis*), golden-mantled ground squirrel, porcupine (*Erethizon dorsatum*), dusky flycatcher (*Empidonax oberholseri*), western wood pewee (*Contopus sordidulus*), olive side flycatcher (*Contopus borealis*), violet-green swallow, and Steller's jay (*Cyanocitta stelleri*) (SCE 2000b; Verner and Boss 1980).

Jeffrey Pine Forest: The wildlife species diversity of jeffrey pine forests is intermediate between the more diverse warmer forests at lower elevations and the depauperate colder forests at higher elevations (Mayer and Laudenslayer 1988). The production of jeffrey pine seeds contains a high food habitat value for a variety of species. The bark and foliage also provide food resources for western gray squirrels and mule deer (Mayer and Laudenslayer 1988; Verner and Boss 1980). Jeffrey pines also create essential cavity nesting habitat for red-breasted nuthatches (*Sitta canadensis*), brown creepers (*Certhia americana*), hairy woodpeckers, white-headed woodpeckers, and northern flying squirrels (Mayer and Laudenslayer 1988; Verner and Boss 1980). Other characteristic species include western toad (*Bufo boreas*), sagebrush lizard (*Sceloporus graciosus*), sharp-shinned hawk (*Accipitier striatus*), western wood pewee, yellow-rumped warbler, golden-mantled ground squirrel, long-tailed weasel, and bobcat (SCE 2000b).

White-fir Lodgepole Pine Forest: Lodgepole pine forest typically forms even stands of similarly sized trees, with a sparse understory (Mayer and Laudenslayer 1988). Many lodgepole stands are associated with meadow edges, with an understory of grasses, forbes, and sedges. Due to this limited structural diversity, the wildlife species richness is low. Those species associated with lodgepole pines are usually concentrated around the edges of meadows (Mayer and Laudenslayer 1988). Lodgepole pines have been documented to provide suitable habitat for six species of amphibians and reptiles, 49 species of birds, and 35 species of mammals (Verner and Boss

1980). Many of the wildlife species in this habitat are similar to those described for white fir forests.

Shrub Types

Valley and Foothill Willow Scrub: Many wildlife species inhabit or utilize willow riparian habitats because of the proximity of the associated water course, and because of the structural complexity of the habitat created by the multi-layer composition of trees, shrubs, and herbaceous plants (Mayer and Laudenslayer 1988). These areas provide refuge, food, water, resting, and nesting areas for a variety of amphibian, reptilian, avian, and mammalian species. For example, tree branches provide nesting and roosting features for many of the species of birds, such as the plain titmouse (*Parus inornatuus*), house wren (*Troglodytes aedon*), downy woodpecker (*Picoides pubescens*), Nuttall's woodpecker (*Picoides nuttallii*), and northern flicker *(Colaptes auratus*). Song sparrow (*Melospiza melodia*), Bewick's wren, and spotted towhee (*Pipilo caculatus),* prefer the dense thickets for nesting and feeding. A variety of lizards, snakes, and rodents often inhabit the leaf litter at the base of riparian vegetation (Verner and Boss 1980).

Lower Montane Chaparral: Lower montane chaparral provides habitat for a variety of resident and over-wintering wildlife species. Amphibians and reptiles characteristic of this habitat include the western fence lizard, horned lizard (*Phrynosoma coronatum*), common garter snake, gopher snake, and western rattlesnake (SCE 1997). Resident mammals typically associated with chaparral habitat include Botta's pocket gopher (*Thomomys bottae*), California ground squirrel (*Spermophilus beecheyi*), western harvest mouse (*Reithrodontomys megalotis*), deer mouse (*Peromyscus maniculatus*), California vole (*Microtus californicus*), black-tailed jackrabbit (*Lepus californicus*), bobcat, and coyote. Mule deer often over-winter in this habitat. Bird species that commonly nest or forage in chaparral habitat include several species of sparrow, California towhee, California quail (*Callipepla californicus*), rock wren, barn owl (*Tyto alba*), golden eagle (*Aquila chrysaetos*), white-tailed kite (*Elanus caeruleus*), and red-tailed hawk (SCE 1997).

Mixed Montane Chaparral: Montane chaparral adjoins a variety of other wildlife habitats, such as mixed chaparral, montane riparian and grasslands (Mayer and Laudenslayer 1988). As such, montane chaparral provides habitat for a broad range of wildlife species. Montane chaparral provides forage areas for mule deer and other herbivores. In particular, mule deer utilize chaparral as summer range foraging areas, escape cover and fawning habitat (Mayer and Laudenslayer 1988). Smaller herbivores, such as rabbits and jackrabbits, frequently forage in chaparral in the fall and winter when grasses are not abundant. During this time, they usually forage on leaves, twigs and bark (Mayer and Laudenslayer 1988). Additionally, the shrub structure provides shade for mammals during summer, and temperature and winter protection during winter. Montane chaparral also provides food resources such as seeds, fruits, and insects for avian species. The structural configuration creates singing, roosting and nesting sites, as well as protection from predators (Mayer and Laudenslayer 1988). Typical birds found in chaparral include the ash-throated flycatcher, Say's phoebe (*Sayornis saya*) dusky flycatcher, barn swallow (*Hirundo rustica*), wrentit, Bewick's wren (*Thryonames bewickii*), and California thrasher (*Toxostoma redivium*). Reptiles include western fence lizard, western whiptail (*Cnemidophorus tigris*), racer (*Coluber constrictor*), and common kingsnake (*Lampropeltis getlus*) (Verner and Boss 1980).

Grassland and Wetland Types

Non-Native Grassland: Many wildlife species use this habitat for foraging and rely on adjacent habitats for breeding, resting, and escape cover (Mayer and Laudenslayer 1988). Amphibians and reptiles characteristic of grassland habitat include the Pacific chorus frog, California tiger salamander (*Ambystoma tigrinum californiense*), western spadefoot toad, western fence lizard, common garter snake, gopher snake, and western rattlesnake. Mammals typically found in this habitat include Botta's pocket gopher, California ground squirrel, western harvest mouse, California vole, black-tailed jackrabbit, badger (*Taxidea* taxus), and coyote. Bird species that commonly breed or forage in grassland habitat include the western meadowlark (*Sturnella neglecta*), horned lark (*Eremophila alpestris*), several species of blackbird, burrowing owl (*Athene cunicularia*), short-eared owl (*Asio flammeus*), red-tailed hawk, northern harrier (*Circus cyaneus*), white-tailed kite, prairie falcon (*Falco mexicanus*), American kestrel (*Falco sparverius*), and turkey vulture (Verner and Boss 1980).

Montane Meadow, Freshwater Marsh/Swales and Fens: The structure of these types of marshes is fairly simple, consisting primarily of herbaceous vegetation (Mayer and Laudenslayer 1988). Mule deer and elk often feed in lush marshy areas, where they forage on lush forbs and grasses. Open areas in meadows can attract a variety of waterfowl, especially mallards and American coots. The emergent vegetation can often camouflage more secretive birds such as the Virginia rail (*Rallus limicola*) and common snipe (*Gallinago gallinago*) (Verner and Boss 1980). If there is a nectar source, Calliope and rufous hummingbirds (*Selasphorus rufus*) can be seen foraging in these habitat types (Verner and Boss 1980). Yellow-headed (*Xanthocephalus xanthocephalus*) and red-winged blackbirds (*Agelaius phoeniceus*) are known to occasionally nest in tall emergent vegetation protected by open water (Mayer and Laudenslayer 1988). Amphibians and reptiles occurring in montane meadows include Californian mountain kingsnake (*Lampropeltis zonata*), western terrestrial garter snake, rubber boa (*Charina bottae*), western toad, and Pacific chorus frog (Verner and Boss 1980).

Open Water: Open water habitat at the various reservoirs enhances the wildlife habitats in the area by providing resting and foraging habitat for several waterbirds, including the American coot (*Fulica americana*), common merganser (*Mergus merganser*), and great blue heron (*Ardea herodias*). In addition, open water habitat provides hunting habitat for the osprey (*Pandion haliaetus*) and peregrine falcon (*Falco peregrinus*). Boulders surrounding reservoirs provide limited basking sites for western pond turtles; however, other sites in the vicinity also are used by the turtles. Other characteristic species include the eared grebe (*Podiceps nigricollis*), pied-billed grebe (*Podilymbus podiceps*), common goldeneye (*Bucephala clangula*), cliff swallow, tree-swallow (*Tachycineta bicolor*), beaver (*Castor canadensis*), and several species of bat (Mayer and Laudenslayer 1988).

Riparian Types

White Alder Riparian Forest: Birds observed in the riparian forest habitat in the project region include the cliff swallow (*Hirundo pyrrhonota*), black phoebe (*Sayornis nigricans*), rock wren (*Salpinctes obsoletus*), and Anna's hummingbird (*Calypte anna*) (SCE 1997). These species are also expected to nest in this habitat. The Audubon's cottontail (S*ylvilagus audubonii)* and Pacific chorus frog were also observed in the riparian forest. Other species that would be expected to occur in riparian habitats include the ringtail (*Bassariscus astutus*), mink (*Mustela vison*), raccoon (*Procyon lotor*), and opossum (*Didelphis virginiana*) (SCE 1997).

Montane Riparian Forest: Montane riparian forest habitat provides essential resources for both resident wildlife species and those living in adjacent habitats. Riparian habitats provide water, forage, breeding areas, migration and dispersal corridors, and thermal cover on a year-round and seasonal basis for an abundance of wildlife (Mayer and Laudenslayer 1988). Amphibians and reptiles that typically use this habitat include the Pacific chorus frog, foothill yellow-legged frog (*Rana boylii*), western pond turtle (*Clemmys marmorata*), and several species of garter snake. Mesic areas with shallow pools may support the California newt (*Taricha torosa*), ensatina (*Ensatina eschsholtizi*), black-bellied salamander (*Batrachoseps nigriventris*), and Pacific salamander (*Batrachoseps pacificus*) (SCE 1997). Mammals that use this habitat for foraging and cover include Audubon's cottontail (*Sylbilagus audubonii*), ringtail (*Bassariscus astutus*), mink (*Mustela vison*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), several species of skunk, mule deer, coyote, bobcat, and mountain lion. Birds that typically use this habitat include the cliff swallow (*Hirundo pyrrhonota*), black phoebe (*Sayornis nigricans*), rock wren (*Salpinctes obsoletus*), yellow-breasted chat (*Icteria virens*), Anna's hummingbird (*Calypte anna*), killdeer (*Charadrius vociferus*), American dipper (*Cinclus mexicanus*), and several species of sparrow (SCE 1997).

Montane Riparian Scrub: Montane riparian scrub is often an abrupt transition between adjacent non-riparian areas, such as montane chaparral, mountain hardwood, lodgepole pine, red fir and montane meadows (Mayer and Laudenslayer 1988). As with most riparian habitats, the structural complexity provides water, food, breeding sites, thermal cover, and migration corridors. Wildlife species that frequently occur in or adjacent to montane riparian scrub include western toad, Pacific chorus frog, spotted sandpiper (*Actitis macularia*), Anna's hummingbird, downy woodpecker, black phoebe, house wren, broad-footed mole (*Scapanus latimanus*), western jumping mouse (*Zapus princeps*) and mule deer (SCE 2000b).

GAME SPECIES

The Big Creek System Basin supports a variety of local game species throughout the year, including mule deer, game birds, and small mammals. The Forest Land and Resource Management Plan (Forest Plan) for the Sierra National Forest identifies hunting and trapping as popular activities within the Forest. Hunted species in the Forest include mule deer, black bear, California (valley) and mountain quail (*Oreortyx pictus*), band-tailed pigeon (*Columba fasciata*), wild turkey (*Melegris gallopavo*) and western gray squirrel. Species that are trapped in the forest include bobcat, coyote, and other furbearers (USFS 1991). Mule deer and upland game birds, some of the most important game species in the Basin, are discussed below in further detail.

<u>Mule Deer</u>

Mule deer are the most important big game species in the Sierra National Forest (USFS 1991). The Forest Plan notes that deer hunting is the primary consumptive use of wildlife within the Forest. The Forest Plan identifies a number of mule deer herds, including the Soldier Meadow/Green Mountain population winter range, San Joaquin Hero and Huntington deer herds, Beasore and 77 Corrala/Iron Mountain population holding area and deer migration route, and the Kaiser Wilderness population center and deer migration route (USFS 1991). The majority of the deer are transitory, although some deer occupy the winter range throughout the year. The San Joaquin herd disperses widely over the Forest to six population centers. The Huntington herd moves north-eastward to population centers north of Huntington Lake. Deer population centers and their migration ranges are depicted in Figure 4.5-3**.**

<u>Upland Game Birds</u>

The Forest Plan identifies several important game birds in the Forest, including band-tailed pigeon, mountain quail, California (valley) quail, and wild turkey. Favorable habitat conditions in the Basin for these birds include abundant cover, forage, and water.

Within the Sierra National Forest, upland game bird hunting is an important recreational activity. Mourning doves and several species of waterfowl are occasional Forest visitors, but their occurrence is far too limited to provide a significant hunting resource. Recently, wild turkeys have been transplanted to several locations in the Forest. These small populations have multiplied and now provide a limited hunting resource. Band-tailed pigeon, mountain quail, and California quail are the most abundant of the upland game birds (USFS 1991).

The general upland game bird hunting season is from late summer to the end of winter.

RAPTORS

The Basin supports a diversity of raptor species, including eagles, owls, vultures, hawks, and falcons. The habitat conditions in the project region include an abundance of structures for nesting and perching, a variety of hunting and foraging areas, plentiful water surrounding reservoirs, and low levels of human disturbance. Several raptors have been recorded in the project region, including: peregrine falcon (*Falco peregrinus anatum)*, osprey (*Pandion haliaetus)*, red-tailed hawk, turkey vulture, Swainson's hawk (*Buteo swainsoni)*, golden eagle (*Aquila chrysaetos)*, Cooper's hawk (*Accipiter cooperii*), and California spotted owl (*Strix occidentalis occidnetalis)*. Other potentially occurring raptor species include short-eared owl (*Asio flammeus)*, great-horned owl, western screech-owl (*Otus kennicottii*), sharp-shinned hawk (*Accipiter striatus)*, merlin (*Falco columbarius*), bald eagle (*Haliaeetus leucocephalus*), white-tailed kite (*Elanus caeruleus)*, and northern goshawk (*Accipiter gentilis)*. A number of these raptor species are special-status species, and their occurrence in the project region is summarized in Table G-2 (in Appendix G).

SPECIAL-STATUS WILDLIFE SPECIES

The following discussion addresses species of wildlife within the Basin that have been designated with a special-status by the CDFG, the USFWS, and/or the USFS. The designations include federal and state threatened and endangered status; candidates for federal listing as threatened or endangered; California fully

Placeholder for Figure 4.5-3
Wildlife Within the Big Creek Basin

<u>Non-Internet Public Information</u>

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

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protected; California species of special concern; federal species of concern; and Forest Service sensitive.

Fifty-one special-status wildlife species are known to occur or have a high probability of occurring in the Big Creek System Basin. Table G-2 in Appendix G contains a comprehensive list of special-status species, including their scientific and common names, state and/or federal status, habitat usage, range, and potential for occurrence in the areas surrounding project facilities. Twenty-two of these species are reported to occur in the vicinity of the projects as shown in Figure 4.5-3. The special-status invertebrates, reptiles, amphibians, birds, and mammals that are known to occur or have potential to occur in the vicinity of the projects are described below.

<u>Invertebrates</u>

Based on available literature and agency consultation, there are no special status invertebrate species in the vicinity of the projects, however, the valley elderberry longhorn beetle (VELB) a federal threatened species was reported in May 1995, just west of Highway 168, approximately 2.5 miles southeast of Auberry, and about five miles south of Big Creek No. 4.

<u>Reptile and Amphibian Species</u>

A search of the CNDDB (2000), augmented by agency consultation, indicated that 11 special-status reptile and amphibian species occur in the Sierra National Forest and the Sierra Nevada foothills. Only five species of special concern are reported to occur in the vicinity of the projects: foothill yellow-legged frog, mountain yellow-legged frog (*Rana muscosa*), western pond turtle, Mount Lyell salamander, and Yosemite toad (*Bufo canorus*).

<u>Avian Species</u>

A search of the CNDDB (2000), augmented by agency consultation, indicated that 28 special-status avian species occur in the Sierra National Forest and the Sierra Nevada foothills. Thirteen of these 28 species have been recorded in the vicinity of the projects, including several listed as threatened or endangered. The bald eagle *(Haliaeetus leucocephalus)* is listed as threatened, and the Swainson's hawk (*Buteo swainsoni)* is listed by the state as threatened. The American peregrine falcon *(Falco peregrinus anatum*) and the willow flycatcher *(Empidonax traillii brewsteri)* are listed by the state as endangered. The other species of special concern recorded in the area include the double-crested cormorant *(Phalacrocorax auritis),* Cooper's hawk *(Accipiter cooperi),* northern goshawk *(Accipiter gentilis),* golden eagle *(Aquila chrysaetos),* osprey *(Pandion haliaetus),* prairie falcon *(Falco mexicanus),* long-eared owl (*Asio otus*), great gray owl *(Strix nebulosa),* and California spotted owl *(Strix occidentalis occidentalis).*

Mammal Species

Agency consultation and searches of the CNDDB (2000) were conducted to determine which special-status mammals may occur in the vicinity of the projects. This effort identified ten special-status mammals from the Sierra National Forest and the Sierra Nevada foothills. There is potential habitat located throughout the Basin for these species, but no recorded occurrences were identified in the vicinity of the projects for seven of them. These seven include the Mt. Lyell shrew *(Sorex lyelli),* pallid bat (*Antrozous pallidus*), spotted bat (*Euderma maculatum*), pale big-eared bat (*Plecotus townsendii pallescens*), California mastiff bat (*Eumops perotis californicus*), snowshoe hare *(Lepus americanus),* and California wolverine *(Gulo gulo luteus)*. The three special-status mammals that are known to occur in the vicinity of the projects are the Sierra Nevada red fox *(Vulpes vulpes necator),* pine marten *(Martes americana),* and Pacific fisher *(Martes pennanti pacifica)*.

BALSAM MEADOW HYDROELECTRIC PROJECT MONITORING PROGRAM

Avifauna, deer, and small mammal populations were monitored in the vicinity of the Balsam Meadow Hydroelectric Project to determine specific levels of wildlife use. The avifauna and deer populations in three large meadows, five small meadows and timber/shrub enhancement sites were monitored from 1988 to 1992 (ASI 1993). Small mammal populations were monitored for three years from 1988 to 1990. The results of these monitoring efforts are presented below.

Large Meadows

Birds

During the five-year study, a total of 76, 86, and 59 bird species were observed at Stevenson, Burr, and Ely meadows, respectively. The number of species observed ranged from a low of 31 in 1988, to a high of 55 in 1988. The lowest number recorded in a year was 44 in 1990. Fifteen bird species were present during all five years at all three large meadows. The number of individuals observed each year ranged from a low of 202 in 1989 and 1992, to a high of 740 in 1988.

Six species consistently contributed the highest number of individuals for at least four of the five study years. These species were the American robin, chipping sparrow, and brewer's blackbird in the spring; and the white-crowned sparrow, yellow-rumped warbler, and western blackbird in the fall. It is likely that species recorded during all five years in the three large meadows represent the most common of the more than 200 bird species occurring in the western Sierra Nevada. The number of individuals observed at all three large meadows followed similar trends over the five year period, suggesting that regional conditions such as weather were responsible for the high numbers in 1988.

Mule Deer

Annual deer use in the three large meadows was highest in 1989 with 14.3 days/acre at the edge transect of Ely Meadow, and the lowest in 1992 with 0.5 days/acre at the Burr mid-meadow transect. Seasonal deer use ranged from a low of 0.0 days/acre at the middle of Burr Meadow in the fall of 1992, to a high of 10.3 days/acre at the edge of Stevenson Meadow in the fall of 1992. In general, Stevenson Meadow total annual deer use was comparable to the range of typical annual deer use in the North Kings deer herd. Deer use days per acre during the five year study in Ely and Burr meadows was higher in the edge transects than in the mid-meadow transects.

Small Mammals

For large meadows, the range of small mammal individuals per trap night was 0.065, to 0.073. There were four dominant species captured over the five-year monitoring period, including: deer mouse, montane vole, California ground squirrel, and lodgepole chipmunk.

Small Meadows

Birds

Five small meadows were surveyed over a three year period from 1988 to 1990. The number of species observed ranged from a low of 30 in 1988, to a high of 47 in 1988. Fourteen species were recorded as present during all three years at all five meadows. The number of individuals observed each year ranged from a low of 172 in 1990, to a high of 422 in 1988. Three species consistently contributed the highest number of individuals for at least two of the three study years. They were the dark-eyed junco, white-crowned sparrow, and the yellow-rumped warbler. Also, the fox sparrow, mountain quail, and orange-crowned warbler had moderate representation for at least two of the three study years.

Mule Deer

Annual deer use at the Lower East Balsam Meadow was generally the highest of all meadows for all three study years. Annual deer use ranged from a low of 0.0 days/acre for all three years at the mid upper east Balsam Meadow, to a high of 29.3 days/acre at the edge of lower east Balsam Meadow. Seasonal deer use in all five small meadows appeared consistent with highs in the spring of 1989, except for West Balsam Meadow 2A/B, which fluctuate throughout all three study years. Deer use in the five small meadows generally is high in the spring.

Small Mammals

For small meadows, the number of individuals generally increased over the three-year monitoring period. Species composition was dominated mostly by the deer mouse, long-tailed vole, montane vole, and the lodgepole chipmunk. Also represented were the western jumping mouse, trowbridge's shrew, California ground squirrel, and one Botta's pocket gopher.

Timber/Shrub Enhancement Sites

Birds

The number of species observed ranged from a low of 19 in 1989, to a high of 40 in 1989. Five bird species (the dark-eyed junco, golden-crowned kinglet, mountain chickadee, stellar's jay, and the yellow-rumped warbler) were recorded inall five years at all six study sites. The number of individuals ranged from a low of 52 in 1991, to a high of 200 in 1988. Six species consistently contributed the highest number of individuals. They were the dark-eyed junco and fox sparrow in the spring, and the dark-eyed junco, golden-crowned kinglet, mountain quail, purple finch, and yellow-rumped warbler in the fall.

Mule Deer

Annual deer use in the timber/shrub sites was highest in 1989 with 13.4 days/acre. The seasonal deer use generally ranged between 3.2 days/acre and 5.7 days/acre, with the lowest record of 1.8 days/acre occurring in the fall of 1992. Deer use in the timber/shrub sites was generally lower than typical use for San Joaquin and North Kings deer herds. Deer use data for all six timber shrub sites was too variable to determine trends over the five monitoring years.

Small Mammals

The timber/shrub sites were dominated by deer mouse, followed by the lodgepole chipmunk and California ground squirrel. Also represented were merriam's chipmunk, Bottas's pocket gopher, California pocket mouse, douglas' squirrel, western gray squirrel, and an unknown vole species.

4.6 Historic and Archaeological Resources

4.6.1 General Overview

Cultural resources include physical resources and intangible cultural values pertaining to archaeology, ethnography (Native Americans), history, and paleontology. Provided below is a brief, regional overview of cultural resource values and concerns within the Big Creek System Basin.

4.6.2 Archaeology

The upland reaches (about 3,000 feet msl and above) of the southern Sierra Nevada mountain range, including most of the Basin, were sporadically utilized by prehistoric peoples from at least the middle Holocene (ca. 7,000 years before present) until relatively late prehistoric times. This sporadic usage was probably due to the rugged terrain and extreme winter climate of the Basin.

The data supporting this chronology are derived primarily from projectile point typologies based on Great Basin sequences and radio-carbon age determinations. Obsidian hydration, while of limited usefulness as an absolute dating tool, has been helpful in demonstrating relative age sequences and age distributions of obsidian artifacts. Archaeological data derived from these analytical technologies appear to show a rise in upland Sierra Nevada use around 3,000 years before present (YBP) by peoples utilizing dart-point weapons, and then a decline over the next 1,000 to 2,000 years.

By about 1,000 YBP another rapid rise in upland Sierra Nevada use is thought to coincide with the spread of Numic-speaking peoples across the Sierra Nevada from the Owens Valley area, the establishment of the late prehistoric trans-Sierra Nevada trade networks, and the distribution of aboriginal peoples into the patterns encountered by the invading Europeans in the late 18th Century. It was during this time that the Western Mono are thought to have settled into a previously unoccupied territory upland from the Foothill Yokuts. Archaeological assemblages dating to this latter period are typified by small triangular or side-notched projectile points indicative of bow and arrow technology, bedrock mortars (implying exploitation of acorns), ceramic and steatite vessels, and beads. Also seen at this time are permanent, below snowline, upland settlements in the western Sierra Nevada, and a much more intensive seasonal use of above snowline areas.

The distribution of prehistoric archaeological sites corresponds to settlement areas, transportation corridors, and the availability of important commodities. Jackson (TCR/ACRS 1984) identified an archaeological site distribution model based on the “k” or key site around which ancillary or associated residential, foraging, collecting, or ceremonial sites radiated. The k-site is defined as those sites which, as part of their observed cultural attribute assemblage, have 14 or more bedrock milling implements, with associated flaked lithic scatters or middens (TCR/ACRS 1984).

The evidence examined by Jackson (TCR/ACRS 1984) suggested a clear difference between the below snowline and above snowline k-site distribution models: below the snowline, k-sites tend to occur in clusters; above the snowline, k-sites never occur in clusters.

4.6.3 Ethnographic Resources

In the late 18th Century, around the time of the first European contact, several aboriginal groups occupied the southern Sierra Nevada mountain range in the area of the Basin. The eastern Sierra Nevada was occupied by the Northern Paiute and Owens Valley Paiute who together made up the two-fold division of the Western Numic segment of the Numic branch of the Uto-Axtecan linguistic family (Liljeblad and Fowler 1986). The Northern Paiute group, residing in the Mono Basin, were known as the *Kutsavidökadö,* which translates to "brine fly pupae eaters" (Liljeblad and Fowler 1986). The Owens Valley Paiute resided principally along the Owens River in the vicinity of Bishop Creek.

On the west side of the Sierra Nevada, Penutian speaking Foothill Yokuts occupied lands in the western Sierra Nevada foothills from the San Joaquin Valley edge up to an elevation of about 3,000 feet msl (Spier 1978). Monache or Western Mono peoples lived above the Yokuts primarily in the areas between 3,000 and about 7,000 feet msl (Spier 1978). They were linguistically linked to their Owens Valley Paiute cousins, speaking a similar Western Numic language (Lamb 1958). The Monache and Owens Valley Paiute regularly engaged in trans-Sierra Nevada trade, and in doing so, along with exploiting the resources native to their mountain home range, established and made frequent use of an elaborate network of mountain trails (Hindes 1959).

Traditional and cultural values of importance to contemporary descendants of these Native peoples include: archaeological sites; prehistoric trails; natural features such as hot springs and other places of religious or social importance; and native plants and animals used for food-stuffs, building or craft materials, medicines, or that figure prominently in Native American myths or legends.

4.6.4 Historic Resources

With few exceptions, activities of the Spanish and Mexican periods in historic California (ca. 1769-1848) were centered along the narrow coastal strip. The few forays into the interior, or across it, were for the purpose of tracking down runaway Native American neophytes, brief exploratory expeditions, or to establish overland routes between the California Missions and Sonora, Mexico. It wasn't until the Anglo period, specifically the major non-Native invasion precipitated by the discovery of gold on the American River in 1848, that the interior mountains of the state were overrun by non-Native peoples who left an indelible imprint of their passing.

Specific to the Basin, gold discoveries were made in 1850 along the lower San Joaquin River in the areas of Temperance Flat and Rootsville (later renamed Millerton) (Clough 1968). The North Fork Mining District, located along the San

Joaquin River south of the North Fork confluence, opened in 1878 and included the Kaiser Creek diggings which had been worked since the mid-1860s (TCR/ACRS 1984). The center of the district was the town of Chiquita, located in Logan Meadow near Mammoth Pool Reservoir. Although never reaching the proportions of mining in the northern Sierra Nevada, the San Joaquin River and its tributaries (Jackass, Mill, and Kaiser Creeks) were worked for gold into the 1880s and for other minerals as late as 1892 (Hurt 1941; California State Mining Bureau 1919).

William Brewer, working as part of the Whitney Survey in 1864, noted (1966) Anglo farmers living in the western Sierra Nevada foothill region, some with Native American wives. In the 1860s and 1870s, the mountains were filled with aspiring farmers such as Joseph Kinsman who "homesteaded" the area he called Chiquita ridge (TCR/ACRS 1984), but came to be called Kinsman Flat, located just north of the San Joaquin River near the present site of Redinger Lake.

Because of the arid nature of the environment, the lower foothills of the western Sierra Nevada and San Joaquin Valley region were used by the Anglo settlers only for animal grazing until the late 19th Century. The Anglos that settled this region turned to stock raising as a way of life. The primary stock was sheep, although some cattle were also raised (Brewer 1966). According to Winchell (1933) the western Sierra Nevada mountain range was initially opened to non-Indian use primarily by stockmen. The seasonal pattern was to graze the valley in the winter and early spring, moving progressively higher into the mountains as the lower elevations dried out, and returning to the foothills and valley with the first snow of fall. According to a 1915 article, the early Anglo sheepmen got along by dividing the range by gentlemen's agreement. Later, Basque sheepmen and non-local grazing corporations came along, resulting in bloody conflicts (Sierra Ranger 1915:11; Vandor 1919).

Eventually, overgrazing by sheep (John Muir called them "hooved locusts") contributed to the formation of the Forest Reserves in 1893 (the predecessor of the Forest Service). By 1905, sheep were excluded from the public forests, but not from private land such as the holdings of logging companies (Theodoratus *et al*. 1978). The stockraisers that stayed in business switched from sheep to cattle, which were considered less destructive.

The timber industry began in the southern Sierra Nevada in Madera County in 1852 when James Harms built a small, water-powered sawmill on Redwood Creek and sold the lumber to miners and settlers around Coarsegold and Fresno Flats near Bass Lake (Hurt 1941). By 1854, a steam-powered sawmill was operating at Corlew Meadows near Shaver Lake (Winchell 1933 and Hurt 1941).

In the early days of the timber industry, the lumbermen established their mills and logged virtually wherever they wished, usually on the unsurveyed and unpatrolled public lands. After 1881, the General Land Office initiated surveys of forest lands, and by 1893 the Forest Reserve was established, thus extending government control to timber harvests on federal land (TCR/ACRS 1984).

Despite these controls, the late 19th Century and early 20th Century became the "golden age" of the timber industry in the Sierra National Forest. In 1891, the Fresno Flume and Irrigation Company was founded by C. B. Shaver and L. P. Swift. They hired John S. Eastwood, who would later come to fame for his hydroelectric work, to design a dam on Stevenson Creek (producing the original Shaver Lake), and a flume to carry lumber 47 miles from the Shaver Lake mill to Clovis (TCR/ACRS 1984). By 1912 the peak of the industry had passed, and in 1914 the Fresno Flume and Lumber Company (the name was changed in 1908) was forced to close down operations at Shaver Lake (TCR/ACRS 1984; Redinger 1949). The Shaver Lake assets of the Fresno Flume and Lumber Company were purchased by Southern California Edison in 1919 (Redinger 1949).

Hydroelectric development of the San Joaquin River watershed began in 1895 with the incorporation of the San Joaquin Electrical Company and the construction of a powerhouse in 1896 at the site of PG&E's Kerckhoff Powerhouse, which utilized the flow of Willow Creek (Shoup *et al*. 1988). Although technically a success, various problems led to failure of the San Joaquin Electrical Company by 1899. It was acquired by A. C. Balch and W. G. Kerckhoff in 1902, who reorganized it as the San Joaquin Power Company (Shoup *et al*. 1988). The San Joaquin Power Company eventually became part of PG&E.

In 1911, the Pacific Light and Power Corporation, controlled by H. E. Huntington, began construction of the initial development of the Big Creek System. This initial development consisted of Big Creek Powerhouses Nos. 1 and 2, Dams 1, 2, and 3 creating Huntington Lake, Dam 4 at Powerhouse No. 1, and tunnels to feed the system. The assets of Pacific Light and Power Corporation were acquired by Southern California Edison in 1917 in a merger. Southern California Edison continued expansion of the Big Creek System during the 1920s, adding Dam 5 and Powerhouse No. 8 (1921), Dam 6 and Powerhouse No. 3 (1923), Ward Tunnel (1925), Florence Lake Dam (1926), Shaver Lake Dam (1926), Mono/Bear diversion (1927), and Powerhouse 2A (an extension of Powerhouse 2 fed by water from Shaver Lake) (1928). Eventually the Big Creek System came to comprise nine powerhouses, six reservoirs, and a system of water tunnels connecting the powerhouses and the reservoirs.

The National Register of Historic Places eligibility of the Big Creek System was assessed by Shoup *et al*. (1988); Shoup (1997) and Hill (1993). It was found that various components of the System and associated support buildings and worker housing dating to the 1911-1929 Period of Significance are National Register eligible under Criteria A, B, and C. These components are shown below in Table 4.6-1 (Shoup *et al*. 1988 and Shoup 1997).

TABLE 4.6-1. Contributing Elements of the Big Creek Hydroelectric Project's District Eligibility for the National Register of Historic Places

Facility Type	Description
Dams	Huntington Lake Dam Nos. 1, 2, and 3 (1911-1920) Florence Lake Dam (1926) Big Creek/San Joaquin River Dams Nos. 4 (1911-1920), 5 (1921), and 6 (1923) Shaver Lake Dam (1926)
Tunnels	Ward Tunnel (1925) Tunnel Nos. 2, 3, 7, and 8 (1911-1920) Mono/Bear Diversion (1927)
Powerhouses	Powerhouse Nos. 1 (1911-1920), 2/2A (1911-1920/1928), 3 (1923), and 8 (1921)
Penstocks, Incline Railroads, & Surge Chambers	Facilities associated with Powerhouse Nos. 1, 2/2A, 3, and 8 (1911-1929)

Four principal worker/operator communities were built in the Basin. These were Big Creek Townsite (originally called Cascada), located at Powerhouse No. 1, and smaller communities at Powerhouse No. 2/2A, Powerhouse No. 8, and Powerhouse No. 3. Each of these communities was equipped with a commissary, hospital, clubhouse/recreation hall, and cookhouse/dormitory, in addition to small single family homes for the married employees. By the late 1960s to early 1970s, these worker communities had become less important and were on the decline as a result of improved highway access to Big Creek coupled with affordable non-company housing in the surrounding area, and changes in the nature of company/employee relationship stemming from early 1950s unionization. Employee housing and the commissary, hospital, clubhouse/recreation hall, and cookhouse/dormitory support structures have all been removed from Big Creek Nos. 2/2A and 8, and most of the employee housing has been removed from Big Creek No. 3.

4.6.5 Paleontological Resources

Paleontological resources, the fossil remains of plants and animals, are of marginal consideration in the Basin because this area is characterized geologically by lithic units comprised of igneous and metamorphic rock, with some sedimentary rock and recent unconsolidated alluvium. Of these lithic types, only selected metamorphic and sedimentary formations have any potential for the development and preservation of fossil specimens.

The Basin is underlain mainly by Mesozoic granitic rocks formed into the massive plutons of the Sierra Nevada batholith (Strand 1967). Prominent moraine and till deposits from Pleistocene glaciation are found upstream along the South Fork San Joaquin River and its tributaries (Strand 1967). Pre-

Cretaceous metasedimentary rocks of possible Permian or Triassic age, comprised of quartzite, quartz-mica schist, calc-silicate hornfels, and tactite that once covered the granitic rock form remnant capstones in various places (Strand 1967). Intrusive formations of basalt, andesite, and trachy basalt of Pliocene to Pleistocene age are also found in places (Strand 1967). Recent alluvium derived from these sources form the river bottoms. None of these formations are considered conducive to the development or preservation of fossil specimens.

4.7 RECREATIONAL RESOURCES

4.7.1 GENERAL OVERVIEW

The Big Creek System Basin provides a wide range of activities for outdoor enthusiasts (Figure 4.7-1). The Basin is located in the Sierra National Forest and reflects the diversity and wealth of recreational opportunities found throughout the region. Popular activities in the Basin include scenic motor vehicle and bicycle rides, foot and horseback trail activities, camping, winter sports, flatwater sports, whitewater recreation, angling, hunting, off-highway vehicle drives, rock climbing and resort use

4.7.2 REGIONAL PERSPECTIVE

The Basin is located within the 1.3 million acre Sierra National Forest, which extends from the north, bordering the Merced River, Yosemite National Park and Inyo National Forest to the south near the Kings River. The Forest's terrain ranges from the snow-capped peaks in the Sierra Nevada crest to gently rolling, oak and chaparral covered foothills along the San Joaquin Valley. The Sierra National Forest provides year-round recreation opportunities, including land and water-based recreation. The Forest is ranked among the top 15 national forests for recreation use (USFS 1991a). Popular recreation opportunities within the Sierra National Forest include the following:

- 528,000 acres of designated Wilderness areas;
- State highways and paved roads that provide scenic rides for motor vehicles and bicyclists;
- 1,100 miles of hiking trails for hiking, backpacking and horse travel;
- 60 family campgrounds with around 1,000 campsites that are usually open from early summer through fall;
- Snow recreation areas for snowmobilers (180 miles of designated routes), downhill skiers, snowboarders, cross-country skiers, snowshoers and snow campers;
- 11 major reservoirs and over 470 smaller lakes offering many flatwater sport opportunities;
- 1,800 miles of streams and rivers, including two wild and scenic rivers (Merced and Kings) that are popular for canoeing, kayaking and rafting;
- About 31 species of freshwater fish and 315 species of wildlife for fishing, hunting and wildlife observation;
- 13 designated off-highway vehicle routes ranging in length from two to 30 miles; and,

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Placeholder for Figure 4.7-1
Recreation Within the Big Creek Basin

<u>Non-Internet Public Information</u>

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- resort areas in Oakhurst, Bass Lake, Fish Camp, Mariposa and near Huntington Lake, Shaver Lake, Lake Thomas A. Edison, Mammoth Pool and Florence Lake.

The Sierra National Forest and the surrounding foothill and mountainous region of central California embody the popularity and diversity of recreation resources for which the state of California is known. Because of the central California location, visitors from both southern and northern California use this region as a vacation destination. The recreational resources of the region are also a target destination for out-of-state and out-of-country visitors. Within a fifty mile radius of the Basin are numerous State Parks, National Parks, National Forests, and Wilderness areas, including:

- Yosemite National Park;
- Kings Canyon National Park;
- Sequoia National Park;
- Ansel Adams Wilderness Area;
- John Muir Wilderness Area;
- Kaiser Wilderness Area;
- Dinky Lakes Wilderness Area;
- Sierra National Forest;
- Inyo National Forest;
- Millerton Lake State Recreation Area;
- Mammoth Lakes; and
- Pine Flat Reservoir.

4.7.3 Wilderness Areas

Four Wilderness areas are located within or partially within the Basin: Ansel Adams, John Muir, Kaiser, and Dinkey Lakes. Wilderness areas comprise a large percent of the Basin (Figure 4.7-1). Wilderness areas offer abundant opportunities for “primitive and semi-primitive dispersed recreation, such as hiking, horseback riding, camping, fishing, hunting, sightseeing and photography” (USFS 1991b).

Ansel Adams Wilderness

A portion of the Ansel Adams Wilderness is located in the northern section of the Basin, surrounding Lake Thomas A. Edison and bordering the northern tip of

Mammoth Pool Reservoir. The Wilderness encompasses 228,500 acres in the high country east of the Sierra Nevada crest, where elevations range from 7,000 to 13,157 feet msl. The Ansel Adams Wilderness was originally designated in 1979 as Minarets Wilderness and was renamed in 1984 to honor the famous photographer and environmentalist.

The North Fork, Middle Fork and lower South Fork San Joaquin River run through the Ansel Adams Wilderness, showcasing spectacular alpine scenery and deep granite-walled gorges. At lower elevations, the area has small plateaus, perennial streams, and several lakes. The popular Pacific Crest National Scenic Trail crosses the area, from Donahue Pass past the Devil's Postpile National Monument.

Visitor permits are required for entry into the Wilderness and reservations are advisable (USFS 1997). Wood fires are prohibited in some parts of the Wilderness area and portable stoves are recommended. A quota system is in effect the last Friday in June through September 15 (GORP 2000).

JOHN MUIR WILDERNESS

John Muir Wilderness, surrounding Florence Lake and extending southeast, is the largest Wilderness in California totaling 581,000 acres. Elevations within the Wilderness range from 4,000 feet msl to more than 14,000 feet msl. The John Muir Wilderness was originally designated in 1964 and was named after the prominent naturalist and environmentalist.

The John Muir Wilderness is characterized by snow-capped mountains, jagged peaks, carved basins, alpine meadows and hundreds of alpine lakes and streams. The South and Middle Forks of the San Joaquin River and the North Fork Kings River originate in the John Muir Wilderness. Mt. Whitney, the highest mountain in the contiguous United States (at 14,495 feet msl), is located within the area. The popular Pacific Crest National Scenic Trail crosses the area, and a portion of the trail within the Wilderness is named John Muir Trail.

Visitor permits are required to visit the area and a quota system is in effect from the last Friday in June through September 15th. Reservations are recommended (USFS 1997).

DINKEY LAKES WILDERNESS

Dinkey Lakes Wilderness is located between Florence and Shaver Lakes, and southeast of Huntington Lake. The area consists of approximately 30,000 acres and varies in elevation from about 8,000 feet msl to the highest point, Three Sisters Peak, at 10,619 feet msl. The area was originally designated Wilderness in 1984 and was named after 16 lakes in the west central region.

Characterized by its moderately sloped terrain and high peaks near the 16 Dinkey Lakes, this Wilderness is separated from the John Muir Wilderness by the Ershim/Dusy Off-Highway Vehicle Route. Interspersed mountain meadows and barren rocky slopes add to the scenic beauty of the Wilderness.

Visitor permits are required for overnight stays in the area, but a quota system is generally not in effect. The Wilderness is generally accessible from mid-June to late October (USFS 1997).

KAISER WILDERNESS

Kaiser Wilderness, located immediately north of Huntington Lake, is approximately 22,700 acres in size. Named after Kaiser Ridge, the area is divided into two distinctly different regions: the southern and northern portions. Elevations range from 7,000 feet msl to more than 10,000 feet msl.

The southern portion of the area is adjacent to the north shore of Huntington Lake. The terrain rises gradually from red fir and jeffrey pine forests to the alpine zone along Kaiser Ridge. The northern part of the Wilderness descends steeply from Kaiser Ridge and is much more open than the southern portion. Eighteen small lakes, including Upper and Lower Twin Lakes, are located in the northern portion.

Visitor permits are required for overnight stay within the area and a quota system is in effect from the last Friday in June through mid September (USFS 1997).

4.7.4 SCENIC DRIVES AND BICYCLE RIDES

As evidence of the aesthetic value of the area, recreationalists enjoy scenic motor vehicle and bicycle rides on many of the highways and roads within and near the Basin. The Sierra Vista Scenic Byway traverses through the western portion of the Basin and affords travelers with an opportunity to enjoy the scenic quality of the area. The Byway, paved for 76 of its 90 miles, begins on the USFS Highway 81/Minarets Road near the North Fork San Joaquin River and climbs through the heart of the Sierra Nevada, passing the Big Creek System's Mammoth Pool Reservoir, several impressive geological features (including Arch Rock), and Nedler Grove's Shadow of the Giants. State Highway 168, traveled by passenger vehicles and bicyclists, traverses through picturesque foothills and climbs the steep Tollhouse Grade. Highway 168 also provides principal access to Shaver Lake, Huntington Lake, and through Kaiser Pass to the backcountry areas that include Lake Thomas A. Edison and Florence Lake. Off State Highway 168, Auberry and Powerhouse Roads traverse the rolling Sierra Nevada foothills and lead to Redinger Reservoir and other foothill lakes. Dinkey Creek Road, off Highway 168, starts near the town of Shaver Lake and leads to many of the area's recreation opportunities. Figure 4.7-1 depicts the major transportation routes in the Basin.

Mountain bikers can take advantage of several scenic USFS, SCE, railroad and mining roads. For example, old railroad grades in the Whiskey Falls area east of

Huntington Lake and north of Redinger Reservoir are a popular mountain biking attraction.

4.7.5 Trails

The Basin offers a variety of trail recreation experiences (Figure 4.7-1). The area's trails traverse through gentle meadows, by hundreds of pristine lakes and streams, over rugged passes, and into secluded Wilderness areas.

The most famous trail in the Basin is the Pacific Crest National Scenic/John Muir Trail. The Pacific Crest crosses the John Muir Wilderness (where a portion is named John Muir Trail) and the Ansel Adams Wilderness. This trail is used by hikers and horseback/burro riders. Access points to the trail are near Florence Lake, Bear Diversion and Lake Thomas A. Edison. The trail is generally accessible from July through October.

The San Joaquin River Trail System also traverses through the Basin. The San Joaquin River Trail System is comprised of old and newly constructed trails for hiking and equestrian use. With the cooperation of environmental groups, the government and many of volunteers, this trail system is pieced together across both public and private lands. The trail system is planned to run from near sea level at the Millerton Lake State Recreation Area to the Pacific Crest Trail in the high Sierra Nevada mountain range near Devil's Postpile National Monument. The trail will traverse the French Trail's 57 mile stretch along the contour of the San Joaquin River within the Ansel Adams Wilderness. When finished, the trail will extend approximately 73 miles.

The area offers several other notable hiking trails, including: Black Point Trail, located northwest of Huntington Lake, climbing a short ½ mile to views of the Kaiser Crest, San Joaquin Canyon, and Huntington and Shaver lakes; and Rancheria Falls Trail, a one-mile trail located east of Huntington Lake, gently climbing through shady firs to the year-round Rancheria Falls. Almost every major lake and reservoir within the Basin has its own system of trails. In addition, numerous trails are accessible from the area's primary roads.

A wheelchair accessible trail is located at Florence Lake. Stables and horseback riding opportunities are available near Shaver Lake, Florence Lake has two pack stations, and the High Sierra Pack Station at Lake Thomas A. Edison offers services and rentals for a variety of pack trips. The Basin also offers commercial guide services for tours into Wilderness areas.

4.7.6 Camping and Day-Use Facilities

The Basin offers several camping and day-use facilities that are usually open from early summer through fall. Public camping and day-use facilities within the Basin offer a variety of services, as is presented in Table 4.7-1. Table 4.7-1 includes USFS camping and day-use facilities, which are operated by California

Land Management under an USFS permit, and facilities owned and operated by SCE.

The Big Creek System reservoirs serve as the base for several of these camping and day-use facilities. Developed camping facilities, equipped with running water and flush toilets, are located at the Big Creek System's Huntington Lake and Shaver Lake. Semi-primitive camping facilities providing tables, fire rings, vault toilets, and in some cases piped water, are located near the Big Creek System's Mammoth Pool Reservoir, Lake Thomas A. Edison, and Florence Lake.

SCE built and maintains Camp Edison, located along the western shore of Shaver Lake, for public use. Facilities at Camp Edison include 252 campsites and 75 picnic sites at Camp Edison and 100 picnic sites on the north shore. The camp is equipped with hot and cold running water, showers, toilet and laundry facilities, disposal stations and electricity. In addition, the camp provides boat launching facilities. SCE also provides a camp information center, which includes displays on Native Americans, native fish and wildlife, and timber programs in the Basin.

Approximately 15 percent of the family campgrounds in the Basin (including Camp Edison) are wheelchair accessible. Overnight stay outside of a campground is permitted in most parts of the Basin, although a permit is required for overnight stay in Wilderness areas.

Table 4.7-1 SCE and USFS Public Camping and Day-use Facilities within the Basin

Site Name	Family Camp-sites	Group camping capacity	Picnic Sites	Trailer spaces	Drink-ing Water	Toilets-Vault or Flush	Swimm-ing	Elevation (ft)
LAKE THOMAS A. EDISON								
Mono Creek (Camping)	14	0	No	14	Yes	Vault	Yes	7400
Mono Creek (Picnic)	No	0	5	No	No	Vault	No	7400
Vermilion	31	0	No	20	Yes	Vault	Yes	7700
FLORENCE LAKE								
Jackass Meadow	44	0	No	44	Yes	Vault	Yes	7200
Florence Lake (Camping)	14	0	No	No	No	Vault	Yes	7400
Florence Lake	No	0	17	No	Yes	Vault	Yes	7400

Table 4.7-1 SCE and USFS Public Camping and Day-use Facilities within the Basin (continued)

Table 4.7-1 SCE and USFS Public Camping and Day-use Facilities within the Basin (continued)

Site Name	Family Camp-sites	Group camping capacity	Picnic Sites	Trailer spaces	Drink-ing Water	Toilets-Vault or Flush	Swimm-ing	Elevation (ft)
(Picnic)								
HUNTINGTON LAKE								
Billy Creek	44	0	7	15	Yes	Both	Yes	7000
Billy Creek, Lower	13	0	No	5	Yes	Vault	Yes	7000
Catavee	31	0	No	9	Yes	Vault	Yes	7000
College	11	0	No	2	Yes	Both	Yes	7000
Deer Creek	28	0	5	16	Yes	Both	Yes	7000
Kinnikinnick	35	0	No	13	Yes	Both	Yes	7000
Rancheria	150	0	No	67	Yes	Both	Yes	7000
HUNTINGTON LAKE (continued)								
Midge Creek	No	100	No	No	No	Portable	No	7400
Bear Cove	No	0	17	No	Yes	Vault	Yes	7000
Dowville	No	0	5	No	Yes	Vault	Yes	7000
SHAVER LAKE								
Camp Edison (SCE)	252	0	75	No	Yes	Flush	Yes	5400
Edison Day-use Area (SCE)	No	0	100	No	--	--	Yes	5400
Dorabelle	68	0	No	34	Yes	Vault	Yes	5400
Dorabelle	No	0	20	No	Yes	Vault	Yes	5200
MAMMOTH POOL RESERVOIR								
China Bar	6	0	No	No	No	Vault	Yes	3300
Mammoth Pool	47	0	No	30	Yes	Vault	Yes	3500
Windy Point	No	0	Yes	No	--	--	Yes	--
OTHER								
Badger Flat	15	100	No	5	No	Vault	No	8200
Big Sandy	14	0	No	4	No	Vault	No	5800
Black Rock	7	0	No	1	Yes	Vault	No	7400
Bolsillo	3	0	No	3	Yes	Vault	No	7400
Bowler	No	150	No	No	No	Vault	No	7000
Buck Meadow	10	0	No	5	No	Vault	No	6800
Chilcoot	12	0	No	No	No	Vault	No	4600
Clover Meadow	7	0	No	7	Yes	Vault	No	7000
Crane Valley	No	156	No	No	No	Vault	No	3400
Denver Church	No	0	38	No	Yes	Flush	Yes	3400
Dinkey	No	50	No	No	Yes	Vault	No	5700
Dinkey Creek	158	0	No	47	Yes	Both	Yes	5700

Dinkey Fisherman	No	0	8	No	No	Vault	Yes	5600
Fish Creek	7	0	No	No	No	Vault	No	4600
Forks	31	0	No	4	Yes	Flush	Yes	3400
Fresno Dome	9	0	No	6	No	Vault	No	6400
Gaggs Camp	9	0	No	No	No	Vault	No	5700
Gigantea	7	0	No	5	No	Vault	No	6500
Granite Creek	20	0	No	5	No	Vault	Yes	7000
Grey's Mountain	8	0	No	No	No	Vault	No	5200
Helms	No	0	5	No	No	Vault	Yes	6500
Indian Flat	14	0	No	3	Yes	Vault	Yes	1500
Jerseydale	10	0	No	2	Yes	Vault	No	3600
Kelty Meadow	10	0	No	No	No	Vault	No	5800
Kirch	No	50	6	No	No	Vault	Yes	1100
Kirch Flat	17	0	No	12	No	Vault	Yes	1100
Lakeside	No	0	5	No	Yes	Flush	Yes	3400
Lakeview	No	0	16	No	No	Vault	No	1300
Lily Pad	16	0	No	10	Yes	Vault	Yes	6500
Little Jackass	5	0	No	5	No	Vault	No	4800
Little Sandy	8	0	No	2	No	Vault	No	6100
Lower Chiquito	7	0	No	1	No	Vault	Yes	4900
Lupine/Cedar	113	0	No	85	Yes	Flush	Yes	3400
Marmot Rock	10	0	No	No	Yes	Vault	Yes	8200
McKinley Grove	No	0	10	No	No	Vault	No	6200
Mile High Vista	No	0	3	No	No	Vault	No	5300
Mono Hot Spring	26	0	No	22	Yes	Vault	Yes	6500
Nelder Grove	10	0	No	3	No	Vault	No	5300
Pine Point	No	0	12	No	Yes	Flush	Yes	3400
Pine Slope	No	0	8	No	Yes	Flush	Yes	3400
Placer	7	0	No	No	Yes	Vault	No	4100
Portal Forebay	11	0	No	6	No	Vault	Yes	7200

Table 4.7-1 SCE and USFS Public Camping and Day-use Facilities within the Basin (continued)

Site Name	Family Camp-sites	Group camping capacity	Picnic Sites	Trailer spaces	Drink-ing Water	Toilets-Vault or Flush	Swimm-ing	Elevation (ft)
Recreation Point (Youth)	No	155	No	No	Yes	Flush	Yes	3400
Recreation Point (Picnic)	No	200	Yes	No	Yes	Flush	Yes	3400
Redbud	No	0	5	No	No	Vault	Yes	1600
Rock Creek	19	0	No	13	Yes	Vault	Yes	4300
Rocky Point	No	0	6	No	Yes	Flush	Yes	3400
Sample Meadow	16	0	No	16	No	Vault	No	7800
Sawmill Flat	15	0	No	10	No	Vault	No	6700

Soda Springs	16	0	No	7	No	Vault	Yes	4300
Soquel	14	0	No	No	No	Vault	No	5400
Spring Cove	63	0	No	10	Yes	Flush	Yes	3400
Summerdale	30	0	No	9	Yes	Vault	Yes	5000
Summit Camp	10	0	No	No	Yes	Vault	No	5800
Swanson Meadow	12	0	No	8	No	Vault	No	5600
Sweet Water	10	0	No	7	No	Vault	Yes	3800
Texas Flat	No	105	No	No	No	Vault	No	5500
The Falls	No	0	6	No	Yes	Flush	Yes	3400
Trapper Springs	45	0	No	45	Yes	Vault	Yes	8200
Upper Chiquito	20	0	No	10	No	Vault	Yes	6800
Upper Kings	No	50	No	No	Yes	Vault	No	6300
Voyager Rock	14	0	No	No	No	Vault	Yes	8200
Ward Lake	17	0	No	6	No	Vault	Yes	7300
We-Me-Ku-Te	No	0	8	No	No	Vault	No	8300
Westfall	No	0	5	No	Yes	Vault	No	4700
Whiskers	8	0	No	3	No	Vault	No	5300
Whiskey Falls	14	0	No	10	No	Vault	No	5800
Wishon Point	47	0	No	24	Yes	Vault	Yes	3400

Source: USFS 1991c.

4.7.7 Winter Sports

The Basin offers a variety of winter sport resources. In addition to spring through fall trail use, there is considerable winter trail use within the Basin. Trails are used for winter sports such as cross-country skiing, snowshoeing, and snowmobiling.

Scenic and high, the Huntington Lake area draws many winter sport recreationalists. The Sierra Summit Ski Area and other nearby winter sport facilities provide a variety of services, including the Basin's only downhill ski area. Recreation also includes snowboarding, cross-country skiing, snowshoeing, snowmobiling and snow camping.

There are five "Sno-Parks" in the area that support winter recreation activities. Sno-Parks are parking areas that are plowed to provide parking and staging areas for winter snow play and trail use. Day or season permits are required for all cars parked at a Sno-Park site. One Sno-Park is located off Hwy 168 at Balsam Meadows (offering snowplay), two Sno-Parks are located off Hwy 168 near Tamarack Mountain (offering snowmobile, cross-country, sled slopes, and snow play), and two Sno-Parks are located near Huntington Lake (offering snowmobile trails, cross-country skiing, and limited snow play). In addition, the Sierra Marina parking lot at Shaver Lake is plowed to accommodate 25 recreational vehicles for winter snow-play activities.

Cross-country skiing can occur anywhere on USFS land and is not necessarily confined to specific trail routes. Trail difficulty levels are designated by the USFS and are classified as easiest, more difficult or most difficult (USFS 1995). Cross-country skiing trails within the Basin include those listed below.

- Eagle Lake Trail - 5.0 miles (easiest)
- Marmot Loop Trail - 2.2 miles (more difficult)
- Coyote Loop Trail - 6.0 miles (most difficult)
- Grizzly Loop Trail - 5.7 miles (most difficult)
- Chipmunk Trail to Coyote Trailhead - 3.0 miles (easiest)
- Porcupine Loop Trail - 4.0 miles (more difficult)
- Raccoon Loop Trail - 4.0 miles (more difficult)
- Raven Loop Trail - 4.4 miles (most difficult)
- Rancheria Loop Trail - 1.5 miles (easiest)
- Camp Edison Trails – 12 miles total (varying difficulty levels)

In addition to cross-country skiing trails, the Basin offers numerous snowmobile routes. Cross-county skiers also can use these routes but often choose to avoid them for safety and quality of experience considerations. The snowmobile trails are routed to avoid Wilderness areas, which prohibit the use of motorized vehicles. Trail difficulty levels are designated by the USFS and are classified as easiest, more difficult or most difficult (USFS 1995). Snowmobile routes within the Basin include those listed below.

- Huntington Lake Trail - 10.0 miles (easiest)
- Willow Hill Trail - 3.0 miles (easiest)
- Mushroom Rock Trail - 7.0 miles (easiest)
- Grouse Creek Trail - 18.0 miles (more difficult)
- Kaiser Pass Trail - 16.0 miles (more difficult)
- Rancheria Trail - 8.0 miles (more difficult)
- China Peak Trail - 3.0 miles (more difficult)
- Edison Lake Trail - 7.0 miles (more difficult)
- Florence Lake Trail - 7.0 miles (more difficult)
- White Bark Trail - 2.0 miles (more difficult)
- Deer Creek Trail - 5.0 miles (most difficult)
- Stump Springs Trail - 30 miles (more difficult)
- Mount Tom Trail - 5.0 miles (most difficult)
- Coyote Lake Trail - 12 miles (most difficult)
- Red Mountain Trail - 5.0 miles (most difficult)
- Strawberry Lake Tail - 3.0 miles (most difficult)
- Tamarack Trail - 10 miles (more difficult)
- Chipmunk Trail - 3.0 miles (easiest)
- Sunset Trail - 1.0 mile (easiest)
- Meadow Trail - 2.0 miles (easiest)
- Red Fir Trail - 4.0 miles (easiest)

- Snowslide Trail - 4.0 miles (more difficult)
- Bald Mountain Trail - 18 miles (more difficult)

4.7.8 Flatwater Sports

The Basin's lakes and reservoirs are located throughout a broad elevation range (from about 1,000 to 9,000 feet msl) and support a variety of recreational activities (see Table 4.7-2). The six major reservoirs directly associated with the Big Creek System (Lake Thomas A. Edison, Florence Lake, Huntington Lake, Shaver Lake, Mammoth Pool Reservoir, and Redinger Lake) are the focal points for many visitors to the area. These lakes provide visitors with a variety of flatwater and other recreational opportunities and a diversity of physical settings.

Lake Thomas A. Edison

Situated at an elevation of 7,651 feet msl, Lake Thomas A. Edison provides visitors with a high alpine recreational experience. The lake, when filled to the spillway, has a surface area of approximately 1,853 acres.

The lake offers excellent flatwater boating and angling opportunities. Other popular activities at the lake include camping, picnicking, hiking and horseback riding. The lake offers a boat-in campground and a public boat launch (located on the south shore). In addition, privately-held enterprises operating under USFS permits support recreational activities on the lake, including the Vermilion Valley Resort (providing lodging, groceries, a restaurant, boat rentals, and a ferry service). The High Sierra Pack Station at Lake Thomas A. Edison offers services and rentals for a variety of pack trips.

Table 4.7-2 Recreation at Big Creek System Reservoirs

Recreation Opportunity	Lake Thomas A. Edison	Florence Lake	Huntington Lake	Shaver Lake	Mammoth Pool Reservoir	Redinger Lake
Camping	•	•	•	•	•	•
Picnicking	•	•	•	•	•	•
Hiking	•	•	•	•	•	•
Water Skiing			•	•	•	•
Sailing		•	•	•		
Swimming	•	•	•	•	•	•
Fishing	•	•	•	•	•	•
Mountain Biking	•	•	•	•		
Hiking	•	•	•	•	•	•
OHV		•	•	•		
Snowmobile		•	•	•		

Cross County Skiing		•	•	•		
Snowshoeing		•	•	•		
Horseback Riding	•	•	•	•		•
Hunting	•	•	•	•	•	•
Boat Ramps	•	•	•	•	•	•

Access to the lake by large trailers is difficult due to the winding and narrow Kaiser Pass Road approach. The area is generally not accessible in the winter due to snow conditions.

Florence Lake

Located at an elevation of 7,329 feet msl, Florence Lake is considered an alpine recreational resource. When filled to the spillway, the lake has a surface area of 962 acres.

Florence Lake offers excellent flatwater boating and angling opportunities. Hiking is also popular in this area. A boat launch ramp and a boat-camp facility are available at the lake. Visitors can access the headwaters of the South Fork of the San Joaquin River and the John Muir Wilderness from the lake.

Access to the lake by large trailers is difficult due to the winding and narrow Kaiser Pass Road approach. Florence Lake is generally accessible to the public from May to October.

Huntington Lake

Located at an elevation of 7,000 feet msl, the Huntington Lake Recreation Area is a regionally significant recreational resource. The lake, when filled to the spillway, has a surface area of 1,435 acres.

Huntington Lake provides a variety of flatwater recreational activities, including sailing, canoeing, windsurfing, swimming and angling. The lake is very popular with sailing enthusiasts and hosts several sailing regattas each year. Other popular activities at the lake include camping, picnicking, hiking, horseback riding and winter season recreation. The lake offers one public boat ramp and several private marinas, including Rancheria Marina and Huntington Lake Marina.

In general, the lake's facilities and services are open from Memorial Day through Labor Day. Some facilities and services stay open year-round. A permit system for all boats is used to regulate boating in the lake.

SHAVER LAKE

Shaver Lake is located at an elevation of 5,370 feet msl and is the only lake in the Basin that is not located on USFS land. The lake has a surface area of 2,184 acres when full.

The town of Shaver Lake is the largest community in the Basin and its economy is closely tied to recreation at Shaver Lake. Popular flatwater recreational opportunities include powerboating, fishing, houseboating and swimming. The lake is a very popular resource for water skiers and jetskiers. A wide variety of other activities take place at Shaver Lake, including camping, picnicking, hiking, cross-country skiing, mountain biking, horseback riding, motor biking, and off-highway vehicle use. The beaches at various locations around Shaver Lake are enjoyed by sunbathers and picnickers, and provide access for swimmers and anglers. Shaver Lake also serves as a vacation community for downhill skiers who use the Sierra Summit ski resort and other winter recreation facilities located near Huntington Lake.

Public recreation facilities at Shaver Lake are provided by SCE and USFS. These facilities include boat ramps located at the Sierra Marina and at Camp Edison. Large public camping facilities are available at SCE's Camp Edison and USFS's Dorabelle Campground. In addition to the public facilities, private recreation support facilities provided around the lake include boat docks, winter boat storage, gas pumps and concession stands. Gold Arrow Island operates a summer water skiing camp. Sierra Marina, Shaver Lake Marina, Dorabelle Campground and Fresno Fishing Club offer additional recreation facilities.

MAMMOTH POOL RESERVOIR

At an elevation of 3,330 feet msl, Mammoth Pool Reservoir is about 5 miles long and up to ½ mile wide. The lake, when filled to the spillway elevation, has a surface area of 1,095 acres.

The lake was named after a large, natural pool in the river just above the dam. The mountains that surround the reservoir form a steep narrow valley and rise 2,000 feet above the lake's surface. The reservoir provides flatwater recreational activities such as boating, angling and swimming. Other activities popular at the lake include camping and picnicking. Though the lake offers swimming near flat shorelines, there are no designated swimming beaches. There is a boat launch at the reservoir.

Mammoth Pool is closed to the public from May 1st to June 15th to avoid interference with the annual deer migration through the area. The main road generally closes in late fall through winter due to snow conditions.

REDINGER LAKE

Redinger Lake, approximately three miles long and a quarter of a mile wide, is located almost in the exact geographic center of California. The reservoir is located at an elevation of 1,414 feet msl and has a surface area of 464 acres when the water surface reaches the spillway elevation.

The hills that surround the lake form a steep narrow valley and rise 1,000 feet above the lake's surface. The steep and narrow topography of the area limits the level of access and recreation facility development at the lake. The most popular flatwater activities on the lake are boating, water skiing, jet skiing, and paddling. Due to the relatively small width of the reservoir and the predominance of motorized boating, conditions for non-motorized boating are diminished. There is one public boat launch ramp located at the west end of the lake.

Redinger Lake is open and is used all year, even in extremely hot summer weather. Spring and fall are considered the best seasons to visit the site, and during these seasons the lake is usually at or near capacity on holidays and weekends. Drawdown of the lake after Labor Day may limit use of the boat launching ramp during the fall and winter.

4.7.9 WHITEWATER

Running the length of the Basin, the San Joaquin River (and its forks) supports a variety of whitewater boating runs that differ in nature and difficulty. Whitewater boating activities take place on various sections of the San Joaquin River flowing into, or between, the Big Creek System reservoirs.

The Basin offers eight documented whitewater runs (Martzen 2000). The primary whitewater activity on these runs is kayaking, although there is some rafting activity, especially in the lower elevation Horseshoe Bend Run. Currently, there is no accurate estimate of the extent of whitewater boating use in the Basin.

Whitewater runs are rated by the American Whitewater Affiliation on a difficulty scale from Class I (easiest) to Class VI (extremely long, difficult and hazardous). The Basin's whitewater resources range in difficulty from Class III to Class V+, depending on the whitewater run and time of year.

Most of the Basin's documented and undocumented runs are for expert boaters. The changing physical conditions of the riverbed and the area's flow conditions require boaters to have expert skills in recognizing and avoiding life-threatening circumstances. In addition to the Basin's river-specific concerns, there are no access roads along the majority of the runs, making trip logistics, rescue and evacuation difficult.

The Basin's eight documented runs include the following (Holbeck and Stanley 1998):

- Devil’s Postpile Run: A 32.5 mile, Class V+ run starting at Devil’s Postpile National Monument on the Middle Fork San Joaquin River and ending at Mammoth Pool Reservoir.

- Paiute Creek Run: A 14 mile, Class IV-V run accessible from the ferry ride across Florence Lake and/or a pack into the John Muir Wilderness area. This run is on the South Fork San Joaquin River and travels from the confluence of Paiute Creek into Florence Lake.

- Florence Lake Run: A 7 mile, Class IV-V run, starting at Florence Lake on the South Fork San Joaquin River extending to Mono Hot Springs. In comparison to other runs in the vicinity, the Florence Lake Run has a steadier gradient and a more open river channel.

- Mono Hot Springs Run: A 11.3 mile, Class V very rough run from Mono Hot Springs to Mount Tom on the South Fork San Joaquin River.

- Miller’s Crossing Run: An approximately 8 mile, Class V+ run extending from Miller’s Crossing on the Middle Fork San Joaquin River to the Mammoth Pool Reservoir. This kayak run is only occasionally boated, and is characterized by a deep narrow river channel with a high gradient and many boulder piles making for tough conditions.

- Tied-For-First Run: A 7 mile, Class V run on the San Joaquin River extending between Mammoth Pool Reservoir and Mammoth Powerhouse. Large boulders and a high gradient characterize this run. The closure of Mammoth Pool Reservoir for deer migration makes the put-in to this run inaccessible from May 1 to June 15.

- Chawanakee Gorge: An 8.3 mile, Class V+ run between Big Creek Powerhouse No. 8 and Redinger Reservoir on the San Joaquin River. The deep, narrow, rock-filled channel makes access extremely difficult and has limited the use of this run.

- Horseshoe Bend Run: A 6 mile, Class III-IV run that is generally the most accessible whitewater resource in the Basin. The put-in is at the confluence with Willow Creek and the take-out is on Kerckhoff Reservoir. Though suitable for moderately skilled boaters, Horseshoe Bend is not considered a beginner’s run.

4.7.10 ANGLING AND HUNTING

ANGLING

Almost all waters in the Basin, natural or man-made, support some type of fishing opportunity. These water bodies offer a variety of warm and cold-water angling resources.

In the upper elevations, the Basin's lakes, streams and rivers provide cold-water angling opportunities. The transition area to lower elevation fisheries provides mixed cold-water and warm-water angling resources. Depending on the specific angling location, target species within the Basin may include those listed below.

- Rainbow trout (cold-water)
- Brown trout (cold-water)
- Brook trout (cold-water)
- Golden trout (cold-water)
- Kokanee salmon (cold-water)
- Largemouth bass (warm-water)
- Smallmouth bass (warm-water)
- Catfish (warm-water)
- Variety of sunfish (warm-water)

A variety of fishing tackle and techniques are used for angling in the various lakes and streams throughout the Basin, ranging from lightweight fly setups for the small streams and lakes in the upper elevations, to trolling and bait rigs on the larger lakes. Fishing in the Basin's lakes is dependent on seasonal accessibility. The area's rivers and streams are currently closed to fishing from November 15 through the last Saturday in April, although this is subject to change by the California Department of Fish and Game. Additional closures occur to protect spawning fish for specific areas and waterbodies.

In the upper elevations of the Basin, Lake Thomas A. Edison (7,651 feet msl), Florence Lake (7,329 feet msl), the South Fork San Joaquin River, and its tributaries such as Mono Creek and Bear Creek support cold-water fisheries. The high elevation lakes and Mono Creek, which flows into and out of Lake Thomas A. Edison, provide excellent angling opportunities. The target species in these upper elevations are rainbow, brown, brook and golden trout. The California Department of Fish and Game has stocked streams adjacent to roadways and campgrounds with catchable rainbow trout and other trout species during the recreation season to enhance angler success.

At an elevation of 6,950 feet msl, Huntington Lake is considered a cold-water angling resource. The lake is popular with anglers. Target species at Huntington Lake are rainbow trout, brown trout and kokanee salmon.

Shaver Lake, at an elevation of 5,370 feet msl, provides anglers with both cold-water and warm-water angling opportunities. The cold-water target species are similar to those at Huntington Lake (rainbow trout, brown trout and kokanee salmon). Warm-water target species are largemouth bass, smallmouth bass, and various sunfish. This lake has a statewide reputation for its excellent angling opportunities.

Mammoth Pool Reservoir, at an elevation of 3,330 feet msl, is considered a good mid-elevation angling resource. The water temperatures in Mammoth Pool are cold enough to support a variety of trout species, including and brook, brown, and rainbow trout. The reservoir is stocked with catchable trout during the recreation season. Mammoth Pool Reservoir is closed from May 1st through June 15th due to deer migration. The fishing season extends from mid-June to late fall, when the access road is closed due to winter road conditions.

From Mammoth Pool downstream to Redinger Reservoir, the San Joaquin River transitions from a coldwater trout fishery to a community characterized by native minnows including hardhead and Sacramento pikeminnow. Angling for trout occurs in the San Joaquin River downstream of Mammoth Pool Reservoir, near Rock Creek and near Dam No. 6.

Redinger Lake is characterized as a low-elevation reservoir and is dominated by the Transition Zone fish community (see Section 4.4). Limited angling occurs in the reservoir.

The San Joaquin River between Redinger Lake and Kerckhoff Reservoir is characterized by the native minnows and suckers (see Section 4.4). Though rainbow and brown trout have been documented in this section of stream, little angling activity occurs in this reach as temperatures are often hot and access to the river is long and difficult except at the confluence with Willow Creek, from the bridge on Powerhouse Road and between Big Creek No. 4 Powerhouse and Kerckhoff Reservoir.

HUNTING

Legal hunting and trapping occurs throughout the Basin. All hunting and trapping activity is managed by the California Department of Fish and Game through the State of California hunting and trapping regulations. Popular species for hunters in the Basin include those listed below.

- Deer
- Black bear
- Valley and mountain quail
- Band-tailed pigeon
- Wild turkey
- Western grey squirrel
- Bobcat

- Coyote

4.7.11 Off-Highway Vehicle Routes

The Basin offers several off-highway vehicle (OHV) routes for four-wheel drive enthusiasts. These routes are located in forested areas and on barren mountain sides. They provide access to remote high-country lakes, mountains, and trailheads. The routes range in length from two to over 30 miles and are located at elevations throughout the Basin. All OHV routes are closed after deer hunting season through the winter for erosion protection. Vehicles traveling the routes must have an approved spark arrestor and exhaust system (USFS 1994).

OHV routes are classified by the USFS based on their degree of difficulty. Class A is the easiest route and is designed for beginners, intermediates and those testing out new vehicles. Class B routes are for advanced OHV users with long wheelbases. Class C routes are only for experts with short wheelbases. There are no facilities on any OHV routes within the Basin (USFS 1994).

Designated off-highway vehicle routes located within the Basin include the following:

- Bald Mountain Route: A 3.0 mile, Class A route located off Rock Creek Road east of Shaver Lake leading to the abandoned Bald Mountain Lookout Station at 7,832 feet msl.
- Bear Route: A 3.0 mile, Class A route off Forest Route 80 to Lake Thomas A. Edison between Florence Lake and Lake Thomas A. Edison.
- Brewer Route: A 3.5 mile, Class A route located off Rock Creek Road through a diversity of dense fir and barren open spaces.
- Red Lake/Coyote Lake Route: A 3.5 mile, Class B route located off Forest Service Road 8S10 south of State Hwy 168 and southeast of Huntington Lake.
- Dusy/Ershim Route: A 33 mile, Class C route that traverses between the Dinkey Creek and John Muir Wilderness areas from Courtright Reservoir to Kaiser Pass Road.
- Hooper Route: A 1.5 mile, Class A route located immediately north of Florence Lake off Kaiser Pass Road.
- Onion Springs Route: A 5.0 mile, Class A route located immediately west of Lake Thomas A. Edison.

- West Lake/Strawberry Lake Route: A 2.0 mile, Class A route located off Forest Service Road 8S10 south of State Hwy 168 and southeast of Huntington Lake.

- Swamp Lake Route: A 13.5 mile, Class C route located south of Huntington Lake and east of Shaver Lake and accessible from the south by Exchequer Meadow and from the north by Willow Meadow.

4.7.12 Rock Climbing

The Sierra Nevada is world renowned for rock climbing. Within the Basin, recreationalists can enjoy bouldering, high mountain trail routes and big wall climbing. Balloon Dome, located in the Ansel Adams Wilderness just south of the San Joaquin River, and Kerckhoff Dome, near Big Creek, are popular sites for rock climbers. Entry points for rock climbers are also located near Shaver Lake, Bear Creek Diversion and Mono Creek Diversion. Guides and courses are available throughout the area for climbers of varying experience levels.

4.7.13 Resorts

In addition to the public and private camping facilities within the Basin, visitors may enjoy overnight stays at private resorts at various locations. Near Huntington and Shaver lakes are several resorts, lodges and numerous rental units. Less than one mile from Mammoth Pool Reservoir, at Logan Meadow, is Mammoth Pool Resort. This privately owned and operated area contains approximately 100 campsites. The Vermilion Valley Resort is located on Lake Thomas A. Edison. The Mono Hot Springs area also contains a rustic resort.

4.8 LAND MANAGEMENT, SOCIOECONOMICS AND AESTHETICS

4.8.1 GENERAL OVERVIEW

The USFS and the Counties of Fresno and Madera have administrative responsibility over lands within the Basin. Existing uses of the land within the Basin are primarily rural, including: communities and private residences, hydroelectric power generation, range land, timber production, mining, research areas, floodplains, Wilderness areas, recreation and transportation systems. Planned land uses within the Basin are jurisdictionally intended uses, and therefore they must comply with the USFS's *Sierra National Forest Land and Resource Management Plan*, the *Fresno County General Plan* and the *Madera County General Plan*.

The diversity and uniqueness of the Basin's scenery gives the area its high aesthetic appeal. The USFS's Visual Management System is the basis for evaluating the aesthetic resources in the Basin. This system establishes Visual Quality Objectives (goals of how the landscape should appear in the future) by evaluating visual indicators. The primary Visual Quality Objectives in the Basin, as depicted in the USFS's Forest Plan, are Preservation, Retention and Partial Retention.

4.8.2 LAND MANAGEMENT

LAND JURISDICTIONS

Most of the existing Big Creek System facilities are located entirely within northeastern Fresno County, with the exception of Mammoth Pool, Big Creek No. 3, and Big Creek No. 4, which are located on or near the county line between southern Madera County and northern Fresno County. The Basin includes Sierra National Forest federal lands and private parcels under jurisdiction of the USFS and the Counties of Fresno and Madera. Figure 4.8-1 depicts the federal and private lands within the Basin boundaries.

<u>Federal Lands</u>

A large portion of the Big Creek System Basin is federally owned Sierra National Forest land (see Figure 4.8-1). This area is under the jurisdiction of the USFS and its regional and local districts.

The Basin is situated within both the Minarets and Pineridge Ranger Districts of the Forest. The Minarets Ranger District headquarters are located northwest of Redinger Lake in the community of North Fork. The Pineridge Ranger District headquarters are located southwest of Redinger Lake in the community of Prather. The Forest Plan (adopted in 1991) is the current USFS federal planning document for the Forest.

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Placeholder for Figure 4.8-1
Land Management Within the Big Creek Basin

<u>Non-Internet Public Information</u>

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

This Figure 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.

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Private land uses on federal lands are allowed under various laws and policies (including the Timber and Stone Act, Homestead Act, 1872 Mining Act, Organic Act, and the Forest Service Manual). Special Use permits, leases, Grants of Easements, Memoranda of Understanding, licenses, and Operating Plans provide for private occupancy and use of resources including: hydroelectric power development, timber production, private residential developments and summer homes, roads, water transmission, utility corridors, mineral extraction, and recreation developments (USFS 1991a).

Private Land Holdings

Some of the lands within the Basin are private land holdings surrounded by the Forest (see Figure 4.8-1). Most private parcels within the Basin are concentrated around Shaver Lake/Highway 168, Huntington Lake, Auberry, Meadow Lakes and North Fork.

EXISTING LAND USES

Developed Land Use

The closest major urban areas to the Basin include the City of Fresno with an approximate population of 415,100 (about 25 miles southwest) and the City of Madera with an approximate population of 36,650 (about 35 miles west) (DOF 1999a). The Basin provides for predominantly rural land uses, as is congruent with federal planning and county zoning.

Communities and Private Residences

Most communities and rural residences are concentrated in the western portion of the Basin near Shaver Lake and the adjoining portion of Highway 168, Huntington Lake, Meadow Lakes and North Fork. Communities in the Basin include Auberry, New Auberry, Prather, North Fork, South Fork, Alder Springs, Shaver Lake, Meadow Lakes, Pine Ridge, Camp Sierra, Big Creek, Cedar Crest, Lakeshore and Huntington Lake. Section 4.8.3, Socioeconomics, discusses the population and economics of communities within the Basin.Hydroelectric Use

The Basin, with its large elevation drops in short distances and available water supply, is ideal for developing hydroelectric resources. Construction of the first Big Creek facilities began in 1911 and the Big Creek System represents a long-established land use in the area. Reservoirs, diversions, roads, tunnels, penstocks and conduits, and employee facilities are the primary land-based facilities of the Big Creek System. A complete description of the Big Creek System components is provided in Section 3.0.

Range

Suitable land below 4,000 feet msl with annual grass and forage is used as rangeland for cattle and recreation livestock. Suitable grazing areas are defined by the USFS as "areas: 1) accessible to livestock; 2) have inherent forage-producing capabilities; and 3) can be grazed on a sustained yield basis in harmony with other resource uses and values under reasonable management goals" (USFS 1991b). These areas are generally intermingled with extensive, unsuitable areas. Specific rangeland sites are managed through individual USFS interdisciplinary Allotment Management Plans, which incorporate management measures to improve livestock distribution and minimize impacts on riparian areas (USFS 1991a). Grazing is a long-established land use in the Basin.

Timber

The USFS regulates timber production in the Basin through four regulation classes, varying in allowable production: Class I; managed for full-timber production; Class II; managed for modified-timber production; Class III; managed for limited production; and Class IV; managed to provide custodial protection with no planned timber harvest. Timber land occurs in the Basin (excluding Wilderness areas) in four major forest types of varying elevation and production: ponderosa pine, mixed conifer, red fir and subalpine (see Table 4.8-1).

Table 4.8-1 Timber Lands Within the Basin

Forest Type	Elevation Range (feet)	Production Range (cubic feet/acre/year)	Average Class Designation
Ponderosa Pine	2,500 to 3,500	85 to 119	Class II
Mixed Conifer	3,000 to 6,000	85 to 119	Class II
Red Fir	6,000 to 8,500	85 to 120	Class III
Subalpine*	above 8,500	N/A	Class IV

Source: USFS 1991b
N/A: Not available.
*Subalpine is the least productive category.

The total timber harvested in the Sierra National Forest in fiscal year 1998 (October 1, 1997 to September 30, 1998) was 22,388 thousand board feet. This production was the ninth largest and accounted for 5% of the total timber harvested in California's 18 National Forests (USFS 1999). The 1998 harvest was nearly 75% less than the harvest in 1991, estimated to be 88,000 thousand board feet (USFS 1991a).

Mining

Most of the land in the Basin is classified as having low mineral potential, and only a few mineral deposits are being explored. Mineral potential classifications within the Sierra National Forest are compiled in the Forest Plan and are based on the area's mining history, geology, current activity and density. At a national level, the Sierra National Forest is not considered a major source for these minerals, excepting tungsten. There are no known oil and gas resources in the Forest, although a few hot springs, including Mono Hot Springs within the Basin, are considered valuable. Much of the Basin is withdrawn from mineral entry (primarily by legislature withdrawing Wilderness areas) (USFS 1991b). Seventeen mined minerals occur in the vicinity of the Basin, including: barite, sanbornite, chromium, feldspar, gold, iron, lead, zinc, copper, silver, limestone, manganese, quartz, tungsten, uranium, sand and gravel, and decomposed granite (Gould and Moulton 1969).

Research and Special Interest Areas

The USFS's 430-acre Backbone Creek Research Natural Area is located within the Basin. This area was developed for protection and study of the sensitive plant *Carpenteria californica* (tree-anemone) and is located along the Horseshoe Bend Reach of the San Joaquin River about 2 miles south of the Big Creek No. 4 Powerhouse. Other research and special interest areas occur outside and near the Basin, including: the 500 acre Carpenteria Botanical Area established for the protection and study of *Carpenteria californica*, located less than ten miles southwest of Shaver Lake along Highway 168; the 520 acre McKinley Grove Botanical Area established for the preservation of giant Sequoias located 12 miles southeast of Shaver Lake; and the 640 acre Dinkey Creek Roof Pendant Geological Area revealing remnant sedimentary rocks, located about 8 miles east of Shaver Lake.

Floodplains

Portions of the Basin are seasonally inundated by the San Joaquin River and its tributaries. Steep, erosion resistant river channel walls generally confine the San Joaquin River floodplain to the existing bankfull river channel, although the floodplain morphology varies throughout the Basin.

Wilderness Areas

Wilderness areas comprise a substantial portion of USFS lands within the Basin (see Figure 4.8-1). These areas are managed by the USFS in accordance with the Wilderness Act of 1964 and/or terms established in the legislative act. The areas have no roads, no planned timber production, limited pest management, and livestock grazing is permitted only with an approved Allotment Management Plan. According to the Forest Plan, Wilderness areas offer abundant opportunities for "primitive and semi-primitive dispersed recreation, such as hiking, horseback riding, camping, fishing, hunting, sightseeing and photography" (USFS 1991b). Four Wilderness areas are located within, or partially within, the Basin: Ansel Adams Wilderness is located in the northern portion of the Basin, surrounding Lake Thomas A. Edison and bordering the northern tip of Mammoth Pool Reservoir; John Muir Wilderness surrounds Florence Lake and extends southeast; Kaiser Wilderness is centrally located to the Big Creek System reservoirs; and Dinkey Lakes Wilderness is located between Florence and Shaver Lakes, and southeast of Huntington Lake. The four Wilderness areas that occur in the Basin, their size and original date of designation are presented in Table 4.8-2. Section 4.7.3 in this IIP discusses Wilderness areas in further detail.

Table 4.8-2 Wilderness Areas Within the Basin

Name	Total Size (acres)	Originally Designated
Ansel Adams Wilderness	228,500	1979
John Muir Wilderness	581,000	1964
Kaiser Wilderness	22,700	1977
Dinkey Lakes Wilderness	30,000	1984

Source: USFS 1991b, GORP 2000

Recreation

The Big Creek System facilities are located on the San Joaquin River and its tributaries and within the Sierra National Forest, an area offering many recreational opportunities. Recreation use in the Forest ranks among the top in all National Forests. Demand for dispersed recreation areas and developed facilities is expected to increase in upcoming years (USFS 1991a). Section 4.7 in this IIP describes recreation opportunities in the Basin in further detail.

Transportation System

Access within the Basin is provided by a system of paved and unpaved roads and highways (Figure 4.8-1). This transportation system, although suitable for activities common within the Basin, is limited due to the area's rugged terrain and rural landscape.

The major arteries within the Basin are state and USFS maintained roads, including: State Highway 168 (traversing from Fresno northeast to Huntington Lake), Forest Service Highway 80 or Kaiser Pass Road (from Huntington Lake to Lake Thomas A. Edison), Forest Service Highway 5 or Stump Springs Road (traversing around Kaiser Wilderness), and Forest Service Highway 81 or Minarets Road (traversing along the northwest side of the San Joaquin River). County roads are generally concentrated within the western portion of the Basin. Fresno County's Powerhouse, Smalley, Jose Basin, Auberry and Dinkey Creek Roads are located west of Shaver Lake. Madera County's Italian Bar and Redinger Lake Roads are located northwest of Redinger Lake, and Mammoth Pool Road is located north of Mammoth Pool.

SCE built and maintains small access roads in the Basin to provide entry to transmission lines and other Big Creek System facilities and to serve as fuel breaks, fire roads and recreation entry. Some roads are gated to prevent unauthorized access and minimize impacts on wildlife and cultural resources.

Many of the highways and roads within and near the Basin provide scenic rides for motor vehicles and bicycles. The Sierra Vista Scenic Byway, begins on the USFS Highway 81/Minarets Road near the North Fork of the San Joaquin River and climbs through the heart of the Sierra Nevada, passing the Big Creek System's Mammoth Pool Reservoir. State Highway 168, traveled by passenger cars and bicyclists, traverses through picturesque foothills and climbs the steep Tollhouse Grade. Off State Highway 168, Auberry and Powerhouse Roads traverse the rolling Sierra Nevada foothills and lead to Redinger and other foothill lakes. Dinkey Creek Road, off of Highway 168, starts near the town of Shaver Lake and leads to many of the area's recreation opportunities.

PLANNED LAND USES

Land uses in the Basin must coincide with federal, state and local land use plans for the area. One federal and two county planning documents address land use in the Basin: the USFS's Forest Plan (1991), the *Fresno County General Plan* (2000), and the *Madera County General Plan* (1995).

Federal Planning

The Forest Plan provides the long-term management goals, policies, standards and guidelines for Sierra National Forest lands. This document guides long-term management of Forest lands and depicts a management program involving multiple uses and the protection of forest resources. The document is congruent with the USFS's National Resource Planning Act and the USFS's Pacific Southwest Regional Plan, and it provides the basis for local environmental analyses. The Forest Plan designates most lands within the Basin as Dispersed Recreation, Wilderness, General Forest and Front Country (USFS 1991b), and defines these designations as follows:

- Developed Recreation: Land and water areas where developed recreation opportunities, such as public campgrounds, picnic areas, visitor information centers, vistas, resorts, organization camps, and recreation residents are emphasized.

- Wilderness: All National Forest Lands congressionally designated as Wilderness. The areas are free of roads and motorized vehicles. Opportunities for primitive and semi-primitive dispersed recreation are abundant. No timber harvest is planned.
- General Forest: Lands generally available, capable and suitable for timber production. Included in this area are lands with limited, modified, and full timber yield prescriptions. Resource considerations, such as watershed, wildlife, visuals, and cultural activities, often place constraints on timber management activities.
- Front Country: Land areas where wildlife and range management activities with adequate protection of watershed values are emphasized.

The plan also identifies sixteen general management prescriptions, or strategies for managing resources within the Forest, to address issues and obtain desired goals and objectives (USFS 1991a). These prescriptions are presented below:

1. maintain and protect wilderness values;
2. preserve free flowing conditions of selected rivers having various characteristics that could permit eventual inclusion in the National Wild and Scenic River System;
3. protect existing forest resources by monitoring and mitigating conditions that might adversely affect resources;
4. protect sensitive soils and maintain aesthetic quality by permitting limited-timber harvest in areas;
5. allow consideration for wildlife and aesthetic quality by permitting modified-timber yield in areas;
6. provide intensive management of selected resources by providing full-timber yield in areas;
7. maintain recreation opportunities at levels of development and intensities expressed by management direction and standards and guidelines;
8. provide sites necessary for administration of the Forest;
9. protect and manage unique geological, historical, archaeological, botanical and memorial features and make educational opportunities available through Special Interest Areas;
10. protect natural archaeological and scenic resources, provide dispersed recreation and manage fish and wildlife in the Kings River Special Management Area;

11. provide research and development of silvicultural, wildlife, watershed and other applied forest management practices through Experimental Forest areas;

12. provide range and wildlife research in non forested areas through Experimental Range areas;

13. protect and manage natural areas as potential components of the Forest Service Research Natural Area System;

14. improve National Forest land ownership patterns through land exchange;

15. provide dispersed recreation opportunities (semi-primitive, roaded natural and rural recreation); and,

16. emphasize wildlife and range management activities, with adequate protection of watershed values through Front Country areas.

County Planning

The current *Fresno County General Plan*, adopted in 2000, is intended to maintain compact urban boundaries, obtain a high level of urban services, and minimize impacts of urban development on productive agricultural land. Prepared within the policy framework of the *Fresno County General Plan*, focused plans also address planned uses for land within the Basin. These plans include the *Sierra-North Regional Plan,* the *Shaver Lake Community Plan*, the *Shaver Lake Forest Specific Plan*, the *Bretz Mountain Village Specific Plan*, and the *Wildflower Village Specific Plan*. The *Sierra-North Regional Plan* discusses constraints to development, rural residential development, public facilities and services, and population forecasts within the portion of Fresno County east of Friant-Kern Canal and north of Kings River. The *Shaver Lake Community Plan*, most recently updated in 1986, discusses land use, circulation, housing, public services, and other issues within the community of Shaver Lake. The *Shaver Lake Forest Specific Plan*, adopted in 1973, accommodates limited residential, commercial, recreation and public land uses within about 2.6 square miles adjacent to Shaver Lake. The *Bretz Mountain Village Specific Plan*, adopted in 1982, plans for a recreation residential area south of Shaver Lake just east of Highway 168. The *Wildflower Village Specific Plan*, adopted in 1982, plans for primarily seasonal residential and recreational land uses in the Wildflower Village located about two miles southwest of Shaver Lake. The General Plan and its focused plans designate three primary land zones to Basin lands within Fresno County: Eastside Rangeland, Foothill Rural Residential and Public Lands and Open Space (Fresno 2000). The General Plan defines these designations as follows:

- Eastside Rangeland: Land designated for grazing and other agricultural operations, wildlife habitats, various non-intensive recreational activities, and other appropriate open space functions in eastern Fresno County east of the Friant-Kern Canal. The minimum parcel size is 40 acres.

- Foothill Rural Residential: Land designated for rural home sites in various locations east of the Friant-Kern Canal at a net density not to exceed one dwelling unit per two acres.

- Public Lands and Open Space: Land and/or water areas, which are essentially unimproved and planned to remain open in character. These areas are devoted to such activities as the preservation of natural resources, managed production of resources, and parks and recreation, or are subject to flood, fire or geologic hazards.

The current *Madera County General Plan* was adopted October 24, 1995 and instructs land use in a small portion of the Basin northeast of the county line that bisects Redinger and Mammoth Pool Reservoirs and the intervening portion of the San Joaquin River. The plan provides an overall framework for development in the county and describes the county's approach to land use, protection of natural and cultural resources, and environmental quality. The plan designates most of the Basin lands within Madera County as Open Space and scattered smaller parcels are designated as Agricultural Exclusive (Madera 1995). The General Plan defines these designations as follows:

- Open Space: This designation provides for low-intensity agricultural uses, grazing, forestry, golf courses, recreational and equestrian uses, major electrical and trunk communication transmission lines, habitat protection, irrigation canals, reservoirs, refuse disposal sites, airports and airstrips, watershed management, public and quasi-public uses, mining, and areas typically unsuitable for human occupation due to public health and safety hazards such as earthquake faults, floodways, unstable soils, or areas containing wildlife habitat and other environmentally-sensitive features. Limited residential uses may not exceed 0.05 units per gross acre. The floor-area ratio (FAR) or ratio of the gross building square footage to the net square footage of the lot for nonresidential uses shall not exceed 0.10. This designation assumes an average of 3.2 persons per dwelling unit.

- Agricultural Exclusive: This designation provides for agricultural uses, limited agricultural support service uses (e.g., barns, animal feed facilities, silos, stables, fruit stands, and feed stores), agriculturally-oriented services (e.g., wineries, cotton gins), timber production, mineral extraction, airstrips, public and commercial refuse disposal sites, recreational uses, public and quasi public uses, and similar and compatible uses. The minimum parcel size shall be 36 to 640 acres. Allowable residential development in areas designated Agriculture Exclusive includes one to two single family homes per parcel, secondary residential units, caretaker/employee housing, and farmworker housing. The FAR for nonresidential uses shall not exceed 0.10 with the following exceptions: the FAR for agriculturally oriented services shall not exceed 0.25 and the FAR for poultry ranches, greenhouses, and similar uses shall not exceed 0.50. This designation assumes an average of 3.2 persons per dwelling unit.

4.8.3 SOCIOECONOMICS

PEOPLE AND POPULATION

The closest major urban areas to the Basin are the City of Fresno and the City of Madera. The City of Fresno, with an estimated January 1999 population of 415,100, is located approximately 25 miles southwest of the Basin. The City of Madera, with an estimated January 1999 population of 36,650, is located approximately 35 miles west of the Basin (DOF 1999a). With the exception of these centralized urban areas, Fresno and Madera counties are fairly rural (see Table 4.8-3). Fresno and Madera counties contributed a combined 2.7% to California's total population in 1999. The population density in Fresno County was an estimated 61% of that in California. Madera County's population density was 26% of that in California. Despite relatively low population densities, recent population growth in these counties has been rapid, exceeding the state's growth rate by 5 percentage points in Fresno County and by over 22 percentage points in Madera County (see Table 4.8-3). The Department of Finance forecasts that the population in Fresno County will grow by nearly 40% and the population in Madera County will grow by nearly 85% in the next twenty years (DOF 1998). This growth, as well as that occurring nearby in the San Joaquin Valley and in southern California suburban areas, creates a high demand for public use of the Sierra National Forest.

Table 4.8-3 Population Estimates for California, Fresno County and Madera County

Location	1990 Population	1999 Population Estimate	1999 Estimate Population Density (per mi^2)	2020 Population Estimate
California	29,942,397	34,072,478	219	45,448,627
Fresno County	673,608	800,121	134	1,114,403
Madera County	89,349	121,779	57	224,567

Source: Department of Finance 1998

Communities within the Basin are concentrated in the western portion of the Basin near Huntington Lake, Meadow Lakes, North Fork, and Shaver Lake and the adjoining portion of Highway 168. Communities in the Basin include Fresno County's Auberry, New Auberry, Prather, Alder Springs, Shaver Lake, Meadow Lakes, Pine Ridge, Camp Sierra, Big Creek, Cedar Crest, Lakeshore and Huntington Lake; and Madera County's North Fork and South Fork. The last population count of the unincorporated areas in the vicinity of the Basin in Fresno County (a tract including Auberry, Shaver Lake and smaller communities in the area) was 4,090 individuals (New United Way 1997). The last population count of the unincorporated areas in the vicinity of the Basin in Madera County (a tract from Millerton Lake northeast to Bass Lake) was 3,768 individuals (Census 1990). The communities of North Fork and South Fork contribute the majority of this population.

The Forest Plan identifies five major social groups within the Sierra National Forest: long-time residents, new arrivals, regional recreationalists, second-home residents and Native Americans (1991b). These social groups are consistent with the major population groups identifiable within the Basin. These groups are discussed below:

- Long-time residents in the area include residents who are employed in Forest resource-related industries, including: timber, hydropower, ranching, mining, and trades and services. These residents value the area for its resource commodities and recreational opportunities, and often are involved with the local communities.

- New arrivals are generally less involved in Forest resource-related industries and express more interest in the area's environmental setting and recreational opportunities.

- Regional recreationalists also are less involved in Forest resource-related industries and are more interested in the area's recreation opportunities, both developed and dispersed. Most regional recreationalists reside in the metropolitan areas of California.

- Second home residents are interested in recreational opportunities and the natural setting. The majority of this social group has primary residence in various areas of the San Joaquin Valley.

- Local Native American groups (including the Western Mono, Owens Valley Paiute, and Foothill Yokuts) have historically been associated with the area. The area also provides resources that are integral to many Native American cultural traditions. Native American communities near the Big Creek System facilities occur primarily in the North Fork, Auberry, and Sycamore Creek (Cold Springs) areas.

ECONOMIC FACTORS AND EMPLOYMENT

Products and amenities generated from resources within the Basin include timber, fisheries, recreation, hydroelectric energy, and livestock. These commodities are consumed in local and regional markets. Timber sales average nearly 90 percent of the Sierra National Forest's revenues, with recreation fees accounting for most of the remaining 10 percent. Economic relationships occur among various resources within the area. For example, reservoirs created for generation of hydroelectric power attract recreationalists from San Francisco, Los Angeles, San Diego, and many other areas.

The major employer sectors in the region (Fresno and Madera Counties) are services, trade, and state and local government. Employment by state and local government is higher, and for trade and services less, than the average for all of California (see Table 4.8-4). Local employment is, to some extent, dependent on development of Sierra National Forest resources. SCE currently employs about 89 full time, 6 part time and 4 seasonal employees within the Basin.

Fresno and Madera counties together contributed an estimated 2.6% to California's total labor force in 1999. The 1999 estimated unemployment rates in both counties were significantly higher and the per capita incomes were well below those in California (See Table 4.8-4).

Table 4.8-4 Socioeconomics in California, Fresno County and Madera County

Location	Civilian Labor Force (1999)	Unemployment Rate (1999)	Per Capita Income, Dollars (1997)	Major Industries and % of Labor Force Employed* (1999)
California	16,585,900	5.2%	26,314	Services 31% Trade 23% State/local Govt. 14%
Fresno County	379,500	13,4%	19,179	Services 26% Trade 24% State/local Govt. 20%
Madera County	52,720	11.6%	17,483	

Source: Department of Finance 1999b
* Non-agricultural wage and salary; Fresno and Madera County are included together.

4.8.4 AESTHETIC RESOURCES

A variety of landscapes occur within the Basin, from chaparral-covered foothills to snow-topped mountain crests. The diversity and uniqueness of the scenery gives the Basin its aesthetic appeal. The high aesthetic value of the area and the demand for aesthetic quality are evident in the popularity of the area for recreation associated with scenic quality, including hiking, biking, photography, and scenic drives.

The USFS's Visual Management System is the basis for evaluating the aesthetic resources in the Basin. This system provides a framework for systematically evaluating scenic resources and the effects of land management activities on those resources. The system establishes Visual Quality Objectives (goals of how the landscape should appear in the future) by evaluating Sensitivity Level, Variety Class, and Distance Zone. These indicators are described below:

- Sensitivity Level: Sensitivity levels assess people's concern for aesthetic value. Sensitive viewers are those traveling through, permanently residing in or temporarily occupying an area. Sensitive areas are travel routes (roads, trails, or waterways), water bodies, and use areas. Viewer sensitivity is divided into three classes: High Sensitivity, Moderate Sensitivity, and Low Sensitivity. These classes differ by how many people see the area and the concern they display for its scenic quality.

- Variety Class: Variety classes measure an area's scenic quality by classifying the variety of the physical features in a landscape. There are three variety classes: distinctive landscapes where features of landform, vegetative patterns, water forms and rock formations are of unusual or outstanding visual quality; common landscapes that are pleasing in the variety of form, line, color and texture, but tend to be common throughout a region and are not outstanding in visual quality; and minimal landscapes where features have little change in form, line, color or texture.

- Distance Zone: Distance zones figure prominently in the determination of scenic quality, as distance from view is a major influence in the relative importance of a landscape. Distance zones are divided into three viewing distances that are determined on a case-by-case basis but generally fall within the following parameters: foreground views, 0.25 to 0.5 mile from the observer; middle ground views, from the foreground up to about 3 to 5 miles from the observer; background views, extending from middle ground to beyond the range of view.

VISUAL QUALITY OBJECTIVES

The Forest Plan evaluates visual quality objectives for the Forest and identifies the primary objectives in the Basin as Preservation, Retention and Partial Retention (USFS 1991b). These objectives are described below:

- Preservation: The landscape appears totally natural.

- Retention: The effects of past or on-going management activities blend with the landscape and are not readily apparent.

- Partial Retention: The effects of past or on-going management activities may not fully blend with the landscape; in the foreground, changes would be subordinate to an area's natural character; in the middleground, changes would be detected, but would not be a focal point; in the background, changes would not be noticeable.

SCENIC LOCATIONS

The Basin offers many spectacular views and beautiful areas. Some of these scenic locations are described below.

- Arch Rock: Arch Rock is located off the Sierra Vista Scenic Highway (on Minarets Road) at an elevation of approximately 6,500 feet msl. This granite arch was formed by erosion and is a scenic geological feature in the Basin. Mount Tom and Kaiser Ridge are also visible from this location.

- Mile High Vista: Located along the Sierra Vista Scenic Highway (on Minarets Road) at an elevation of approximately 5,300 feet msl, the Mile High Vista offers scenic views of the Sierra Crest, Mammoth Pool Reservoir, the San Joaquin River, Fuller Buttes, Balloon Dome, and the Ansel Adams, Kaiser and John Muir Wilderness areas.

- Redinger Overlook: Redinger Overlook, located at an elevation of 3,700 feet msl off the Sierra Vista Scenic Highway (on Minarets Road), offers views of Redinger Lake, the San Joaquin River, and the surrounding rugged Sierra Nevada front country.

- White Bark Vista: Located off Forest Service Highway 80 (Kaiser Pass Road), the White Bark Vista offers views of the crest of the Sierra Nevada, Florence Lake and Lake Thomas A. Edison.

- Mono Hot Springs: The Mono Hot Springs are located southeast of Lake Thomas A. Edison and off Forest Service Highway 80. The location offers a scenic view of steaming hot mineral water springs settled in the Basin's rugged high country and the prominent Devil's Table.

- Pacific Crest Trail: The Pacific Crest Trail passes through the John Muir Wilderness, and traverses the Basin east of Florence Lake and Lake Thomas A. Edison. The trail offers scenic views of deep canyons, meadows, lakes and streams.

SECTION 2.0

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SECTION 3.0

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SECTION 4.1

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APPENDIX A

ALTERNATIVE LICENSING REQUEST AND COMMUNICATION PROTOCOLS

SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL Company

December 9, 1999

Wesley C. Moody
General Manager
Power Production

OFFICE OF THE SECRETARY
99 DEC 10 PM 2:43
FEDERAL ENERGY
REGULATORY COMMISSION

ORIGINAL

Mr. David E. Boergers, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D. C. 20426

Subject: **Big Creek Hydroelectric System – FERC License Project Nos. 167, 120, 2085, 2175 Request To Use an Alternative Licensing Process**

Dear Mr. Boergers:

This letter is a formal request by Southern California Edison (SCE), Northern Hydro Region, to use, as authorized by the Energy Policy Act of 1992, and described in the Federal Energy Regulatory Commission (FERC) Order 596, an Alternative Licensing Process (ALP) to relicense FERC Project Nos. 067, 120, 2085, and 2175 collectively called, along with FERC Project Nos. 2017, 2086, and 2174, the Big Creek System.

The Alternative Licensing Process (ALP) will include a basin-wide planning process focused on collaboratively identifying and addressing the issues related to relicensing the Big Creek System. The goal is to develop a negotiated settlement agreement by December 2004 supported by SCE, resource agencies, Indian tribes, non-governmental organizations, individuals and organizations from local and regional communities. SCE intends to incorporate the collaborative agreement in the Applicant Prepared Environmental Assessment and license applications in lieu of Exhibits E.

The specific goals of the Big Creek System ALP are to:

1. Combine into a single process the pre-filing consultation process, the environmental review process under the National Environmental Policy Act and administrative processes.
2. Facilitate greater participation by, and improve communication among, SCE, resource agencies, local and regional authorities and private interests, Indian tribes, the public and Commission staff in a flexible pre-filing consultation process.
3. Allow for the preparation of an Applicant Prepared Environmental Assessment (APEA) by SCE with input by stakeholders.
4. Promote cooperative efforts between SCE and the stakeholders to share information about resource impacts and mitigation and enhancement proposals and to narrow any areas of disagreement and reach a comprehensive settlement.
5. Facilitate an orderly and expeditious review of an agreement or offer of a settlement for use as a basis for protection, mitigation and enhancement measures for the hydropower licenses.

SCE, the licensee, and Big Creek stakeholders believe the common ownership by SCE and the location of the above referenced projects within one watershed basin presents a unique opportunity to address multiple licenses within a single collaborative licensing process.

Although Big Creek No. 4 (FERC Project No. 2017), Vermilion Valley (FERC Project No. 2086), and Portal (FERC Project No. 2174) are being relicensed independently, given their earlier expiration dates, SCE and the stakeholders contacted plan to discuss all licenses as part of the watershed planning process. The settlement agreement and subsequent FERC DOCKETED

DEC 1 0 1999

300 N. Lone Hill Ave.
San Dimas, CA 91773

9912150063

recommend protection, mitigation and enhancement measures for these early licenses to take advantage of the trade-off opportunities in the basin. Based on a successfully negotiated settlement agreement, SCE will request FERC to reopen these early licenses, if necessary, to amend the protection, mitigation and enhancement terms and conditions.

On March 9th, 1999, representatives of SCE met with Mark Robinson, Ann Miles and other FERC staff to discuss these ALP plans. Since that time, we have been in contact with approximately 50 key Big Creek stakeholders including representatives of national, state and local authorities and local and regional private interests (see attachment 2) to solicit their views and gauge their support for, and interest in, an ALP collaborative approach to relicensing.

In addition, SCE managers, or their representatives, met with the following key stakeholders to seek specific input into the design of an ALP collaborative process and an associated communications protocol:

J. Gangemi, Conservation Director, American Whitewater
D. Mitchell, Environmental Specialist Supervisor, CA Department of Fish & Game
R. Baiocchi, Consultant, CA Sportfishing Protection Alliance (CALSPA)
J. Canaday, Environmental Specialist for Wildlife/Riparian Ecology, CA State Water Resources Control Board
J. Edmondson, Conservation Director, Cal Trout
B. Ferguson, Fresno County Home Rule Advisory
J. Quaschnick, Presiding Judge, Fresno County
R. Moss, General Manager, Friant Water Users Authority
J. Carville, Policy Advocate, Friends of the River and CA Hydro Reform Coalition
R. Penny, Development Director, Friends of the River
R. Roos-Collins, Attorney, Natural Heritage Institute and Hydro Reform Coalition (HRC)
E. Roberts, Rancheria Enterprises
J. Paul Martzen, San Joaquin Paddlers Association
J. Good, Shaver Lake Fishing Club
G. Powell, Shaver Lake Marina
J. Sandstrom, Sierra Marina
J. Boynton, Forest Supervisor, Sierra National Forest, USFS
C. Efird, Acting, Recreation/Lands/Wilderness, Sierra National Forest, USFS
T. Horst, Sierra Resource Conservation District.
Dr. Witzansky, Superintendent of Schools
A. Buelna, Operations Division Chief, US Bureau of Reclamation
D. Heagy, USDA Forest Service, Sequoia National Forest
T. Baxter, Team Leader, Regional Hydropower Assistance Team, USFS
L. Baty, Tribal Chair, Big Sandy Rancheria
D. Roberts, Tribal Chair, North Fork Mono Rancheria

There is great support for an ALP approach from stakeholders contacted, and we received valuable input from many on the design of the attached Communications Protocol. Signature pages from key stakeholders (Attachment 1) indicates their support for an ALP and their approval of the Communications Protocol. CA State Water Resources Control Board staff and CA Department of Fish and Game staff support, in concept, the ALP. The State Water Resources Control Board and Department of Fish and Game intend to send a letter supporting the ALP in the near future.

Enclosed are the signatures of stakeholders (attachment 1), a list of all stakeholders contacted, (attachment 2), a list of the projects (attachment 3), a project schedule (attachment 4), the Communications Protocol (attachment 5) and a Big Creek Relicensing Contact form (attachment 6).

We are attaching, in accordance with 18 CFR Section 4.34(i), a copy of the Communications Protocol produced with the help and approval of key Big Creek stakeholders. The attached Communication Protocol addresses the Commission's *ex parte* rule during pre-filing consultation by describing how SCE and FERC will document communications and provide public access to information relevant to relicensing. In addition, the Protocols reflect the up-front input and approval of key stakeholders by describing and setting forth some basic guidelines for the ALP collaborative process. We would emphasize, however, that a provision of the Protocol enables the ALP participants, based on consensus, to revise and add to this document. We expect detail to be added to this Protocol framework.

We anticipate an initial stakeholder meeting in February 2000, with an initial information package distributed soon after. We also foresee cooperative scoping of environmental issues, analysis of completed studies, and further scoping, if necessary.

SCE looks forward to working with FERC staff and the stakeholders during the preparation of the APEA. If you have any questions on this matter, please call Geoff Rabone, the Big Creek Relicensing Project Manager, at 909-394-8721.

Sincerely,

Wes Moody

Attachments

cc: Service List
G. L. Rabone
T. J. McPheeters
N. J. Mascolo

Attachment 1

Big Creek Alternative Licensing Process Request and Communications Protocol
Signature Pages

I, John Good, support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the Communications Protocol for the Big Creek ALP.

Signature: [signature]
Title: TREASURER
For Organization: SHAVER LAKE FISHING CLUB

Attachment 1

I, JERRY SANDSTROM, support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the draft Communications Protocol for the Big Creek ALP. I understand that details of the ALP and Communications Protocol will be revised collaboratively when group meetings commence in 2000.

Signature: Jerry Sandstrom
Title: PRESIDENT
For Organization: SIERRA MARINA INC.

Attachment 1

I, Bob Baiocchi, support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the Communications Protocol for the Big Creek ALP.

Signature: Bob Baiocchi
Title: Consultant & Agent
For Organization: California Sportfishing Protection Alliance (CSPA)

Attachment 1

I, James L. Boynton, support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the draft Communications Protocol for the Big Creek ALP. I understand that details of the ALP and Communications Protocol will be revised collaboratively when group meetings commence in 2000.

Signature: [signature]

Title: JAMES L. BOYNTON, Forest Supervisor

For Organization: Sierra National Forest

Attachment 1

I, Paul Martzen support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the Communications Protocol for the Big Creek ALP.

Signature: Paul Martzen
Title: Conservation & Access Chair
For Organization: San Joaquin Paddlers

Attachment 1

I, Jen Carville, support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the draft Communications Protocol for the Big Creek ALP. I understand that details of the ALP and Communications Protocol will be revised collaboratively when group meetings commence in 2000.

Signature: [signature]
Title: Policy Advocate
For Organization: Friends of the River

I, Richard Roos-Collins, support Southern California Edison's use of a watershed-based Alternative Licensing Process (ALP) for relicensing their Big Creek hydroelectric system. I have reviewed and approve the draft Communications Protocol for the Big Creek ALP. I understand that details of the ALP and Communications Protocol will be revised collaboratively when group meetings commence in 2000.

Signature: Richard Roos-Collins

Title: Senior Staff Attorney

For Organization: Natural Heritage Institute

State of California - The Resources Agency
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
San Joaquin Valley-Southern Sierra Region
1234 East Shaw Avenue
Fresno, CA 93710
(209) 243-4014

GRAY DAVIS, Governor

December 9, 1999

Mr. Geoffrey Rabone
Hydro Generation
Southern California Edison Company
2nd Floor
300 N. Lone Hill Avenue
San Dimas, CA 91773

Dear Mr. Rabone:

Use of Alternative Licensing Procedure for the Big Creek Projects

The Department of Fish and Game supports Southern California Edison Company using a watershed-based Alternative Licensing Process (ALP) for relicensing the Big Creek series of projects. We have participated in the development of the Communication Protocol as proposed by Edison, and we concur that the proposed Protocol will satisfy our needs in consulting on the projects. We understand that the detailed application of the Alternative Licensing Procedure and the Communication Protocol will be considered collaboratively and possibly revised in response to the needs of the various participating parties, after the group commences meetings during the year 2000.

If you have any questions about this letter or about the Departments ability and commitment to participate in the ALP. Please do not hesitate to contact me at your convenience.

Sincerely,

Dale Mitchell

Dale Mitchell
Senior Environmental Specialist Supervisor

Conserving California's Wildlife Since 1870.

Big Creek Pre-Relicensing Stakeholder Consultation

Attachment 2

Big Creek Stakeholders	Organization	Contacted
Witzansky	Supt. Of Schools	Yes
Jones	Supt. Of Sierra Highschool	Yes
Saude	Sierra Unified School District	Yes
Bigelow	Madera County	Ongoing Effort
Krogen	High Sierra Volunteer Trail Crew	Yes
Smith	Muir Ranch, Blaney Meadows	Yes
McAllister	Fresno Yacht Club	Ongoing Effort
Ferguson	Fresno County Home Rule Adv. Committee	Yes
Horst	Sierra Resource Conservation District/ SAMS	Yes
TBD	RCRC	Ongoing Effort
Oken	Fresno County Board of Supervisors	Yes
	NGOs	
Martzen	San Joaquin Paddlers Association	Yes
Redmond	San Joaquin River Trail Council	Yes
Wald	CA HRC	Yes
Edmondson	CA Trout	Yes
Bowers	American Whitewater	Yes
Evans	Friends of the River	Yes
Penny	Friends of the River	Yes
Carville	Friends of the River	Yes
Fahlund	Hydropower Reform Coalition	Yes
Gangemi	American Whitewater	Yes
Baiocchi	CALSPA	Yes
Merrill	Planning Conservation League	Ongoing Effort
Trafton	Trout Unlimited of CA	Yes
Kuntsman	EDF	Ongoing Effort
Candee	NRDC	Ongoing Effort
Roos-Collins	Natural Heritage Institute	Yes
	DOWNSTREAM/ SUPPLY	
Moss	Friant Water Users Authority	Yes
Brogan	Delano-Earlimart Irrigation District	Yes
	TRIBES	
Baty	Big Sandy Rancheria	Yes
Roberts	North Fork Mono Rancheria	Yes
Hunter	Tule River Indian Reservation	Yes

Big Creek Pre-Relicensing Stakeholder Consultation

Attachment 2

Big Creek Stakeholders	Category & Organization	Contacted
	AGENCY	
Payne	EPA Region IX	Ongoing Effort
Borges	USF&WS	Ongoing Effort
Risling	BIA	Yes
Boynton	USDA FS	Yes
Efird	USDA FS	Yes
Porter	USDA FS	Yes
Heagy	USDA FS	Yes
Baxter	USDA FS	Yes
Ammon	CA Dept. of Boating & Waterways	Yes
Sepe	CA Dept. of Boating & Waterways	Yes
Canaday	SWRCB –Division of Water Rights	Yes
Buelna	US Bureau of Reclamation – Millerton Dam	Yes
Mitchell	CA Dept. of Fish & Game	Yes
Morse	USF&WS – Energy & Power Branch	Yes
Taylor	USF&WS – Energy & Power Branch	Ongoing Effort
Waste	NMFS	Yes
Abeda	State Historic Preservation Office	Yes
	LOCAL/REGIONAL	
Bray	Madera Chamber of Commerce	Yes
Roberts	Rancheria Enterprises	Yes
Young	Young's Sporting Goods	Yes
Cunningham	Cunningham Packaging	Yes
Kudrow	Lakeview Cottages	Yes
Wiggs	Vermilion Valley Resort	Yes
Elliot	Shaver Lake Chamber of Commerce	Yes
Smith	Shaver Lake Real Estate/ S.L. Lions	Yes
Beard	Dinkey Creek Campground	Ongoing Effort
Sherry	Lakeshore Resort	Yes
Winslow	Mono Hot Springs	Yes
Good	Shaver Lake Fishing Club	Yes
Powell, D.	Shaver Lake Marina	Yes
Powell, S.	Shaver Lake Marina	Yes
Powell, G.	Shaver Lake Marina	Yes
Sandstrom, J.	Sierra Marina/ S.L. Advisory Council	Yes
Sandstrom, Ja.	Sierra Marina	Yes
Hurley, T.	Muir Trail Ranch	Yes
Hurley, C.	Muir Trail Ranch	Yes
Escalante	PG&E	Ongoing Effort
Scaparo	Sierra Summit Mountain Resort	Ongoing Effort
Westman	C. Sierra History Club	Yes

Project List

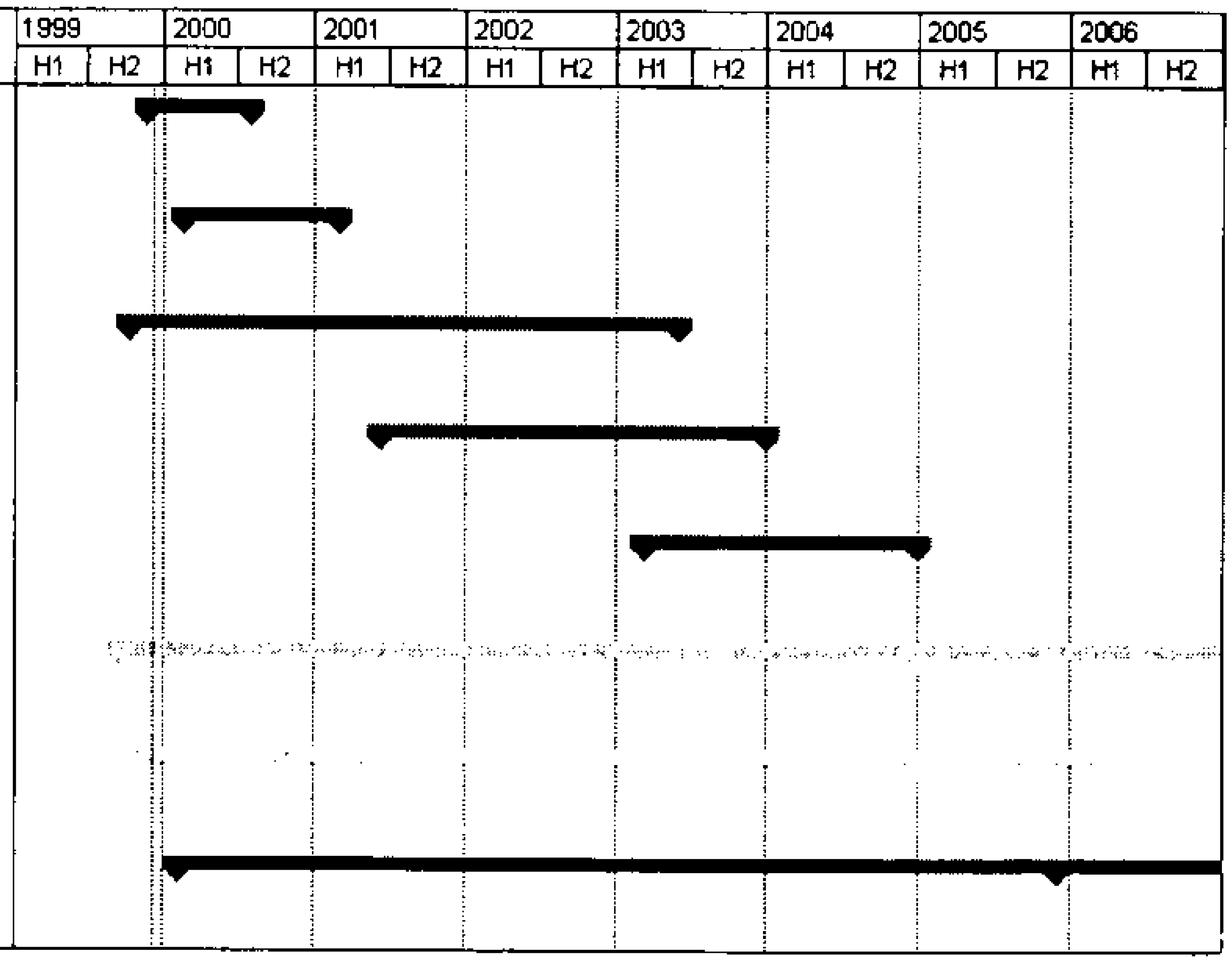
Attachment 3

Northern Hydro Region	FERC No.	Expiration	Dependable Operation Capacity (MW)
Big Creek Nos. 1&2	2175	02/28/09	150.00
Big Creek Nos. 2A, 8 & John Eastwood	67	02/28/09	370.00
Big Creek No. 3	120	02/28/09	181.90
Big Creek No. 4	2017	02/28/99	100.20
Portal	2174	03/31/05	10.50
Mammoth Pool	2085	11/30/07	187.00
Vermilion Valley	2086	08/31/03	0.00

ALP Summary Schedule

Big Creek System

ID	Task Name
2	Formalize ALP Process
23	INITIATE BASIN PLANNING PROCESS
56	CONDUCT NEW TECHNICAL STUDIES
106	Development of Enhancement/Mitigation Measures
142	Negotiate Comprehensive Resource Settlement Agreement
176	Public Outreach
189	Information Management Framework
198	LICENSE APPLICATIONS APEA/COLLABORATIVE PROCESS



Big Creek Alternative Relicensing Process

Communications Protocol

Southern California Edison Big Creek System
(FERC Project Nos. 067, 120, 2085, and 2175)

INTRODUCTION

As authorized by the Energy Policy Act of 1992 and described in the Federal Energy Regulatory Commission (FERC) Order 596, SCE will use an Alternative Licensing Process (ALP) to relicense four projects in its Big Creek System. These projects are Big Creek Nos. 2A, 8, and Eastwood Power Station (FERC Project No. 067); Big Creek No. 3 (FERC Project No. 120); Mammoth Pool (FERC Project No. 2085); and, Big Creek Nos. 1 and 2 (FERC Project No. 2175) (Table 1).

SCE and Big Creek stakeholders believe the common ownership by SCE and the location of the above referenced projects within one watershed basin presents a unique opportunity to address multiple licenses within a single collaborative licensing process. SCE will prepare an Applicant Prepared Environmental Assessment (APEA) in collaboration with stakeholders. The goal of the ALP is to reach a final settlement agreement by December, 2004 between the parties which will serve as the basis for SCE's APEA to be filed with its license applications in lieu of Exhibits E.

Although Big Creek No. 4 (FERC Project No. 2017), Vermilion Valley (FERC Project No. 2086) and Portal (FERC Project No. 2174) are being relicensed independently given their earlier expiration dates, SCE and the stakeholders contacted plan to discuss all licenses as part of the watershed planning process. The settlement agreement and subsequent APEA may recommend protection, mitigation and enhancement measures for these early licenses to take advantage of the trade-off opportunities in the basin. Based on a successful negotiated settlement agreement, SCE will request FERC to reopen these early licenses, if necessary, to amend the protection, mitigation and enhancement terms and conditions.

The Communications Protocol addresses the Commission's *ex parte* rule during pre-filing consultation by describing how SCE and FERC will document communications and provide public access to information relevant to relicensing. In addition, this Protocol, reflecting the up-front input and support of key stakeholders, describes and sets forth some basic guidelines for the ALP collaborative process.

COMMUNICATIONS MECHANISMS AND GUIDELINES

Stakeholder Service List

SCE will maintain a service list of interested parties to the Big Creek Relicensing proceedings which will include name, organization, address, telephone and e-mail address, if applicable. Stakeholders on the service list will include those agencies, organizations or individuals or groups identified through SCE's ongoing outreach efforts, (these include those already listed on Big Creek Project Relicensing service lists, local resource agency service lists or, requesting to be added through written communication with FERC, SCE, and relevant resource agencies or sign-in sheets at public meetings).

Public Meetings And Requests For Comment

Formal public meetings (i.e. initial consultation/scoping meetings and APEA public comment meetings) will be held and formally noticed by SCE in appropriate local and other forums. These notices will also be provided in writing to the stakeholder service list maintained by SCE. Meetings will likely be held in Fresno, California.

Verbal and formal written comments will be solicited from all interested parties to obtain wide public input and to comply with the FERC's regulations regarding consultation. Additional written comments will be solicited for study plans, study reports, and other applicable documents during the consultation process.

Extensive notes will be kept and maintained of these and all other meetings concerned with the Big Creek Relicensing proceedings. Copies of these will be made available to all parties according to the protocols below.

Public Information Files and Sharing Materials

Materials related to relicensing and all pertinent communications between stakeholders including written correspondence, records of verbal communication, stakeholder service lists, meeting notices and summaries, technical data, and documentation developed during the ALP process will be available and/or, when required by FERC regulations, provided to the public via four mechanisms:

- FERC's Public Reference Room, Washington, D.C.
- A Public Information Library established and maintained by SCE at its Northern Hydro Region Administrative offices in Big Creek (this library will also house a collection of relevant reference materials)
- Big Creek Relicensing Web Site established and maintained by SCE.
- E-mail, or hard copy when requested (automatic for formal meeting notices and license proceeding announcements, or to parties notifying Edison of their preference for this format)

Electronic Communication Mechanisms

A significant percentage of the Big Creek stakeholders contacted by SCE have identified the Internet as the mechanism of choice for sharing and accessing information and materials related to Big Creek Relicensing. The collaborative group will emphasize the use of electronic media in managing and disseminating materials and conducting the collaborative process and will select an electronic format for documents that is accessible to all participants.

Because the Federal Power Act requires SCE to serve all legally required documents in hardcopy form to all interested parties, SCE must be informed, in writing, that a hardcopy of materials is <u>not</u> required.

Web Site: SCE will maintain a Web Site designed to support and facilitate the Big Creek relicensing process. This Web Site has several integrated functions:

- Interactive tool to educate stakeholders (descriptions of: Big Creek watershed/basin, SCE project operations, ALP, collaborative process, resource agency management goals, and principles of mutual-gains negotiation).
- Interactive tool to inform stakeholders of licensing proceedings and collaborative activity (meeting notices, status reports, meeting summaries, regulatory milestones, collaborative milestones/schedule)
- Mechanism for the public to provide input to SCE and other participants in the collaborative process.
- Accessible, downloadable repository for technical reports, public correspondence, legal documents, meeting notes, records of verbal communication and stakeholder lists.
- A central location for various "single text" documents where the public can review and provide comment (e-mail) and for use by collaborative participants engaged in working group assignments.

SCE intends that the Web Site will be "user-friendly" and will have the following attributes:

- A thorough table of contents
- Searchable
- Hot Button - home page prompt of new documents or collaborative activity
- Downloadable
- E-mail connection for 2-way communication

SCE requests that, where possible, correspondence and documents be sent via e-mail or disk for posting to the Web Site. Hard copies will, if necessary, be scanned by SCE and then posted to the Web Site. (Copyrighted material will not be posted without written release from the copyright holder.)

E-Mail: E-mail will be used to inform stakeholders of the availability of new documents on the Big Creek Relicensing Web Site. Stakeholders can inform SCE, via return e-mail, that they would like to be mailed a hard-copy or provided with an electronic version as an e-mail attachment.

Meeting notices and license proceeding announcements will also be provided by e-mail. Because Internet access is not universal, however, these notices and announcements will also be sent by mail to the relicensing stakeholder service list, if not waived.

E-mail is considered a legitimate means of written communication between parties in the relicensing. All e-mail related substantively to Big Creek Relicensing (projects or process) will be logged and made available to the public. Participants are to copy SCE for posting on its web site communications between each other related to the relicensing proceedings.

E-mail is considered an efficient method for coordinating and circulating written works-in-progress (technical reports, protocols, guidelines) among stakeholders engaged in Work Group activities. E-mail can also be used to coordinate and circulate draft "single text" components of the developing settlement agreement/APEA amongst collaborative participants.

Communication with FERC Staff

The Commission has determined that its *ex parte* rule (18 CFR 385.2201) applies to all communications in the pre-filing consultation portion of the relicensing process. Open communication and public access to information are essential criteria for this relicensing process and this protocol has been developed to advance these objectives while ensuring that *ex parte* rules are not violated.

Any person may communicate verbally or in writing—by paper or electronic version (e-mail or fax)—with FERC staff during the pre-filing consultation stage of Big Creek Relicensing. These communications can concern the relicensing process, the merits of the project and the preparation of the APEA and may occur without prior notice to other parties.

Any verbal communication with FERC staff involving substantive issues, as opposed to procedural matters, must be summarized in a written Big Creek Relicensing Contact Form (attachment 5) by the FERC staff participating in the communication or by another participant in the communication designated by FERC. This applies to communications from all entities other than the applicant. The applicant will document, in a Contact form, its own communications with FERC staff.

All written correspondence, including fax and e-mail communications, and all records of verbal communications with FERC staff will be placed in the Commission's official file and copies will be available in the Public Reference Room, Room 2-A, 888 First Street NE, Washington DC. A copy of these materials will be provided to SCE (attention: Geoff Rabone, Big Creek Relicensing Project Manager). SCE will also make this information available to the public in its Big Creek Public Information Library and on its dedicated web site.

Any FERC staff may participate in a Big Creek Relicensing meeting – either in person or by telephone conference- or other meeting related to the relicensing without prior notice to other team members provided that a meeting summary is written and placed in the FERC and SCE files.

COLLABORATIVE PROCESS

Participation

Participation in the Big Creek Relicensing collaborative process requires a consistent and long-term commitment of time and energy. Through a sustained public outreach effort between March and November, 1999, SCE has received commitments from stakeholders representing a balance of interests in the relicensing proceeding. This includes the Federal and State natural resource agencies with statutory authority, Indian tribes, a cross-section of environmental and recreational Non-Governmental Organizations (NGOs) and members of the upstream and downstream public.

Additional Participants
Stakeholders not participating during the initial collaborative meetings may join the collaborative at any time upon agreeing to accept the collaborative's written protocols.

Funding

SCE recognizes the importance of broad public participation in the ALP. SCE is committed to providing some form of assistance, where necessary, in funding NGO participation. The extent and detail of any assistance will be determined by SCE and participating stakeholders at the outset of the collaborative process.

Meetings
It is recognized that limited financial, organizational and/or time resources may make it difficult for some key participants to provide the level of availability necessary for a successful collaborative. For this reason, efforts will be made to identify and provide flexible and productive means for participation including participation by teleconferencing.

> ***Plenary Meetings:*** The full collaborative team will convene for one day, on the same day of each month (i.e., the first Wednesday) to be determined by the group. During the first process planning and scoping phase, meetings will be held monthly. During the second study/technical phase of the process, the plenary meetings will be held quarterly. During the first phase the plenary meeting's purpose and focus will be on assigning, reviewing and finalizing outputs from participant work groups. During settlement agreement negotiations plenary meetings will return to one per month status, and most of the collaborative work will take place in the plenary context.
>
> Most meetings will be held in Fresno, California.
>
> ***Work Groups:*** Work groups will be formed by the Plenary Team to address particular issues or accomplish discrete tasks. Much of the collaboration and productivity in the process will occur at this Work Group level.
>
> Work Groups are expected to accomplish much of their work through teleconferencing with the support of e-mail and the web site for document preparation, review, comment and agreement. Work Group teleconference calls will be summarized in writing and distributed by the facilitator or SCE. If the facilitator or SCE is not directly involved in the teleconference, the initiator of the call is responsible for providing a written summary to SCE for inclusion in the public record.

Facilitator
A neutral, third-party facilitator, chosen by the group, will be contracted by SCE to manage the collaborative process. The facilitator will be responsible for:
- Developing draft agendas
- Setting and enforcing deadlines

- Coordinating Work Group sessions and assignments
- Enforcing the collaborative schedule
- Moderating Plenary meetings and Work Group sessions (conference calls and face-to-face sessions)
- Providing counsel and insight to the Team on substance and process
- Enforcing protocols and ground rules
- Working with all participants in the meetings and between meetings to build consensus to meet the goal of the collaborative process
- Preparing meeting summaries
- Assisting with development of visual aids for meetings
- Assisting with locating and circulating background materials and work group products

Representation
All stakeholders can attend collaborative meetings. It is encouraged that a primary spokesperson from each interest or institution be appointed by their colleagues to participate in the collaborative Plenary group meetings. This individual should be able to speak for their organization during collaborative sessions and will be responsible for keeping their organizations informed and supportive.

Each interest or institution should strive to maintain the participation of a consistent representative. Because this is not always possible, however, the representative wishing to substitute another individual should inform the group as early as possible about their chosen alternate.

To make the most of limited meeting time, interests and institutions are encouraged to engage in between meeting caucuses to evaluate and work on issues and solutions.

Ground Rules
Infractions of the ground rules listed below will be assessed by the group and may result in the group's request for a replacement participant.

> ***Respect:*** The personal integrity, values, and legitimacy of the interests of each participant will be respected by the other participants. This includes the avoidance of personal attacks and stereotyping within the collaborative or in public. The motivations and intentions of participants will not be attacked within the collaborative or in public.
>
> ***Preparation:*** Participants agree to read background information provided before each meeting or Work Group session and be prepared to effectively discuss topics on the agenda or engage in Work Group activity.
>
> ***Commitment:*** Commitments will not be made lightly and will be kept. Delay will not be employed as a tactic to avoid an undesired result.
>
> ***Disagreements:*** Disagreements will be regarded as challenges to be solved rather than battles to be won. All participants will seek mutual gain solutions.

Communicating Interests: Every participant is responsible for communicating their interests clearly and early. Voicing these interests is essential to enable meaningful dialogue and full consideration of the subject in the collaborative. For resource agencies, this includes communicating their management objectives up-front. For SCE, this includes informing the participants about the proposed operations and economic needs. For non-governmental organizations it is important that they communicate their goals for the watershed.

Mutual Goal: Participants will all strive to reach a settlement agreement within the necessary timeframe required by the FERC regulations.

Decision-making

The intended product of this Alternative Licensing Process is a settlement agreement by December 2004, which will serve as the basis for the Applicant Prepared Environmental Assessment and license application, and hence the terms and conditions of the new licenses. The goal is to reach consensus among all participating members including federal, state, and local agencies; tribes; non-governmental organizations; individuals and organizations from the local and regional community; and, SCE. The stakeholder group in the collaborative process will early on define decision making and consensus for this process.

In the interests of reaching agreement, participants are expected to make compromises in some areas. This means that those participating will make good faith effort to address the concerns of others so that most participants do not object to the terms and conditions.

Finally, participants agree that the primary basis for sound decision-making will be solid, measurable and objective science. Every effort will be made to incorporate and abide by this principle early and throughout the collaborative effort. This will greatly reduce conflict in developing the settlement agreement.

Participants will determine at the beginning of the collaborative process, further procedures for decision-making. Every effort will be made to address this in the first two to three meetings.

Dispute Settlement

The facilitator and the participants will work to identify, design and use other alternative dispute resolution mechanisms including possible third party mediation in resolving disputes concerning the Alternative Relicensing Process.

While the FERC can be requested to settle a dispute of a required study, reasonable effort should be made by the facilitator and stakeholders to settle the dispute among participants.

Participants will determine at the beginning of the collaborative process, dispute resolution protocols. Every effort will be made to address this in the first two to three meetings.

"Single Text"
Participants in Work Groups will use a "single text" approach for development of decisions, agreements and process guidelines. All comments by the participants on written documents under consideration in or among Work Groups will be made on the actual document in question, so the comments can easily be understood, shared and integrated into a revised (iterative) text. The facilitator will ensure that a cumulative record of the decisions reached on a given document is maintained to serve as back-up and to help participants move forward through the iterative process. The facilitator will also be responsible for providing the latest revised text to participants with each Work Group session summary (meeting record). The final document from the Work Group level will then be provided to the Plenary for further discussion. In this fashion, several individual documents from Working Groups may be merged into a larger "single text" at the Plenary level (i.e. study plan).

This individual "single text" approach will greatly enhance the ability of Work Groups to conduct their efforts by teleconference with an e-mailed version of the "single text" in question.

In developing the final settlement agreement, participants will use one "single text" of the evolving agreement which will provide a detailed cumulative record of all comments, decisions, and agreements. The facilitator is responsible for maintaining this cumulative record in a "single text" and will provide the latest version to participants along with the separate meeting summary.

Ending The Collaborative
The collaborative may be halted upon consensus of the participants or if the facilitator determines that progress toward settlement has halted and key participants are no longer willing to commit to the process. The departure of one or more participants does not halt the collaborative if SCE and the remaining participants choose by consensus to continue.

Amendments To Protocol
This protocol serves as the framework for further collaborative team additions. Additions and changes can be made with the consensus of the team, but must be documented and added to the record of the relicensing proceedings.

Attachment 6

BIG CREEK RELICENSING CONTACT REPORT

Project Name (s):____________________ Date: ____________

Time ____________:

Participants: ____________________ Contact Type ____________

____________________________ Meeting / Telephone Call/ Other

Recorded By:: ____________________ Phone: ____________

Subject(s): ____

Summary:

____

____

____

____

____

____

____

____

____

____

____

____

____

Action Item:____

____Date Due:____________

Documents Referenced:________________________________

Information Requests:________________________________

APPENDIX B

FEDERAL ENERGY REGULATORY COMMISSION ALTERNATIVE LICENSING PROCESS APPROVAL

FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON, D.C. 20426

OFFICE OF ENERGY PROJECTS

Project Nos. 67, 120, 2085, and 2175-
California
Big Creek Nos. 2A, 8, Eastwood; Big
Creek No. 3; Mammoth Pool; and Big
Creek Nos. 1 and 2
Southern California Edison

Mr. Geoff Rabone
Relicensing Project Manager
Southern California Edison
300 N. Lone Hill Ave.
San Dimas, CA 91773

MAR 15 2000

Dear Mr. Rabone:

Thank you for your December 9, 1999, request to use the alternative procedures in relicensing the existing hydroelectric projects - Big Creek Nos. 2A, 8, and Eastwood; (FERC No. 67); Big Creek No. 3 (FERC No. 120); Mammoth Pool (FERC No. 2085); and Big Creek Nos. 1 and 2 (FERC No. 2175) . We've reviewed your request, and the comments filed by the U.S. Department of the Interior (Interior), the U.S. Forest Service (FS) and the California State Water Resources Control Board (SWRCB), in response to our December 23, 1999, notice of your request.

Interior concurred with the use of alternative procedures and with the consolidation of the four interrelated Big Creek relicenses.

The FS initially recommended that all seven projects in the Big Creek system be relicensed at the same time. Under this approach several projects in the system currently undergoing relicensing efforts (e.g. Big Creek No. 4, FERC No. 2017; Vermillion Valley, FERC No. 2174; and Portal, FERC No. 2086) would be delayed. The FS was also concerned about relying on reopener clauses in these three licenses should they be issued ahead of the other projects in the basin. The FS's concern was that they wouldn't have enough data or corresponding analysis to support their submittals of license reopener recommendations under the process being proposed. However, after further consultation with SCE the FS reports that they now agree with SEC's proposal for using the alternative licensing process (personal communication, Carol Efird, Forest Lands Officer, Sierra National Forest, Clovis, California, March 3, 2000).

The SWRCB in their January 21, 2000, comment letter gave general support of your request to use the alternative licensing process, but expressed a few remaining

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concerns with the draft Communications Protocol relating to service requirements of electronic communications and *ex parte* communications, and the frequency and location of meetings. To address these remaining concerns, we recommend that additional consultation be conducted with all of the parties before the Communications Protocol is revised. Once it is revised, please file it with the Secretary of the Commission.

We have one additional recommendation regarding your draft Communications Protocol. Order 607 (Regulations Governing Off-the-Record Communications) issued by the Commission on September 15, 1999, emphasizes that projects in the pre-filing stages are not subject to the *ex parte* rule. Therefore, we recommend that you discuss Order 607 with the parties and at a minimum remove the wording in the section of the draft Communications Protocol entitled **Communication with FERC Staff** that states the *ex parte* rule applies to all FERC communications.

We see as one of the main benefits of the alternative procedures, better communication and collaboration among all people and organizations interested in hydro-licensing. Based on our experience with the process, this enhanced participation can be a challenge for tribes, conservation groups, private citizens, and agencies working with limited budgets. Not all participants may be able to attend every meeting or comment on every piece of information generated during the pre-filing period. We ask you, therefore, to take special care to highlight the key commenting points in the process as it unfolds.

Getting agreement on when there is sufficient information on which to base decisions for these projects will be a difficult issue, regardless of the process used. Nonetheless, we see the alternative procedures as a way of coordinating and enhancing how we meet our individual responsibilities.

The Commission recognized the possibility in the final rule on the alternative procedures, that there might be uncertainty about the process at the outset, but said that in such situations it was worth trying the alternative procedures rather than closing the door on this option. Therefore, I am approving your request to follow the alternative procedures in accordance with the Commission's Regulations for Licensing Hydroelectric Projects at 18 CFR § 4.34 (i). If you have any questions, please call Michael Henry at (503) 944-6762.

Sincerely,

Ann Miles

Ann Miles
Group Leader
Hydro West Group 1

cc: Mailing List, Public File

APPENDIX C

DETAILED PROJECT COMPONENT/FACILITY DESCRIPTIONS

APPENDIX C. DETAILED PROJECT FACILITY/COMPONENT DESCRIPTIONS

The Big Creek System includes seven hydroelectric projects licensed under separate FERC licenses (see Figure 3.2-1). The Big Creek hydroelectric projects within the Basin range in elevation from approximately 1,000 feet msl to over 8,000 feet msl and include: Big Creek Nos. 1 & 2 (FERC No. 2175), Big Creek Nos. 2A, 8, & Eastwood (FERC No. 67), Big Creek No. 3 (FERC No. 120), Big Creek No. 4 (FERC No. 2017), Vermilion Valley (FERC No. 2086), Portal Powerhouse (FERC No. 2174), and Mammoth Pool (FERC No. 2085).

Major components of the hydroelectric project infrastructure are the dams and diversions, reservoirs and forebays, water conveyance systems, and powerhouses. Detailed descriptions of the project facilities/components are provided below.

BIG CREEK NOS. 1 & 2 (FERC PROJECT NO. 2175) MAJOR COMPONENTS

Big Creek Nos. 1 & 2 operate under a FERC license as Project 2175 issued on March 27, 1959, which expires on February 28, 2009. The project consists of Powerhouse No. 1, Powerhouse No. 2, Huntington Lake, five dams (Dams 1, 2, 3, and 3a forming Huntington Lake and Dam 4 at the tailrace of Powerhouse No. 1), three small diversions (Balsam, Ely, and Adit 8) and associated tunnels, and penstocks. Big Creek Powerhouse No. 1 and Powerhouse No. 2 have an Exhibit M Generator Capacity of 154.85 MW. Water for the project is diverted from Huntington Lake to Powerhouse No. 1 and from Big Creek, Pitman Creek, Balsam Creek, and Ely Creek to Powerhouse No. 2.

Huntington Lake - Huntington Lake, with a drainage area of 81 square miles and a surface area of 1,435 acres, was the first reservoir built as part of the "Initial Development" at Big Creek in 1911-13. It is named for Henry Edwards Huntington, the Southern California entrepreneur who financed the earliest work at Big Creek. Originally created by the construction of three dams, Dam Nos. 1, 2, and 3, Huntington Lake was enlarged in 1917-18 by the raising of those dams, and by the construction of an additional dam, No. 3A. With a spillway at 6,950 feet msl, the lake has a storage capacity of 89,166 acre feet of water. Water from this lake can either be sent to Powerhouse No. 1 or to Shaver Lake via Balsam Forebay and Eastwood Power Station. It impounds the waters of Big Creek, several tributaries, and the water diverted through Ward Tunnel.

Dam No. 1 - Dam No. 1 located at Huntington Lake was originally constructed in 1912-1913 as a concrete gravity structure and was raised in 1917 concurrently with Dams Nos. 2 and 3. The dam was extensively modified by supplementing the spillway, placing earth fill against the downstream face and part of the upstream face, and covering a major portion of the upstream face with steel sheathing. The dam is 170 feet high and the crest length is 1,335 feet at elevation 6,953.5 feet.

There are two spillways located at Dam No. 1. The original was constructed as a series of seven siphon sections, each 10 feet wide, that are now operating as overflow weirs since the siphons were opened to air at their high points. The crest of the overflow weirs is at an elevation of 6,950 feet msl.

A second spillway consists of a 110 feet long concrete ogee weir section with the crest at elevation 6,945 feet msl. This section is provided with 15 manually-operated vertical lift slide gates, each 5 feet high by 12 feet wide. The tops of the gates in the closed (up) position are also at elevation 6,950 feet msl. The rated capacity of the gated spillway at water surface elevation 6,950 feet is 7,000 cfs. The rated capacity of the combined spillways at water surface elevation 6,953 feet is 16,500 cfs.

Dam No. 1 has a 9 feet diameter steel outlet pipe with the invert at elevation 6,820 feet leading to Tunnel No. 1 and controlled by a slide gate operated from a tower in the lake near the dam. The dam is also provided with three 42-inch pipes passing through the base at elevation 6,808 feet msl, and a 72-inch pipe through the right abutment at elevation 6,921 feet msl. All four outlets are equipped with slide gates at both the upstream and downstream ends.

Dam No. 2 - Huntington Lake Dam No. 2 was originally constructed in 1913 as a concrete gravity dam and was raised in 1917 concurrently with Dams Nos. 1 and 3. The dam was extensively modified by placing earth fill against both the upstream and downstream face of the concrete structure to improve stability and protect against freezing and covering the upstream face near the outlet tunnel with sheet steel facing. The dam is 120 feet high and has a crest length of 1,862 feet at elevation 6,953.5 feet msl.

Dam No. 2 outlet works consist of a 10 feet diameter steel pipe with the invert at elevation 6,885 feet msl connecting to the Huntington-Pitman-Shaver Conduit. A 10 feet slide gate, protected by a trash rack, controls the inlet and is a guard for a 9 feet duplex valve located in a valve housing buried under the downstream fill.

No spillway has been provided for Dam No. 2. The spill from the lake is discharged over the spillways at Dam No. 1.

Dam No. 3 - Huntington Lake Dam No. 3 was originally constructed in 1913 as a concrete gravity dam, and was raised in 1917 concurrently with Dams Nos. 1 and 2. The dam was extensively modified by placing earth fill against both the upstream and downstream dam faces to increase the stability and protect from freezing. The dam is 640 feet long and approximately 165 feet high with a crest elevation of 6,953.5 feet msl. No spillway has been provided for Dam No. 3. The spill from the lake is discharged over the spillways at Dam No. 1. There are no outlet works in this dam.

Dam No. 3A - Huntington Lake Dam No. 3A was constructed in 1917 as a concrete gravity structure when Dams Nos. 1, 2, and 3 were raised to provide a normal reservoir level at elevation 6,950 feet msl. The dam was extensively modified by placing earth fill against both faces of the dam in 1936-1938 and additional backfill in 1966 to completely cover the upstream face to protect from freezing. The dam is 22.5 feet high with a crest length of 263 feet at elevation 6,953.5 feet msl. No spillway has been provided for Dam No. 3A. The spill from the lake is discharged over the spillways at Dam No. 1. There are no outlet works in the dam.

Dam No. 4 / Powerhouse No. 2 Forebay - Water for Powerhouse No. 2 is diverted from Big Creek and Pitman Creek at the tailrace of Powerhouse No. 1. The Powerhouse No. 2 Forebay is formed by Dam No. 4, built in 1913 immediately downstream of Powerhouse No. 1 at the confluence of Big Creek and Pitman Creek, which impounds the waters of Powerhouse No. 1 discharge. It is a 75 feet high constant-radius concrete arch dam with a crest length of 287 feet at elevation 4,805 feet msl. A walkway, which spans the full length, is above the dam at elevation 4,814 feet msl. The dam has a spillway, which consists of 27 ungated bays, separated by piers with a total length of 187 feet. The spillway crest is provided with flashboards. The crest without the flashboards is at elevation 4,805 feet msl. The reservoir net storage capacity with the flashboards in place at elevation 4,810 feet msl is 60 acre feet. The rated discharge capacity of the spillway is 7,000 cfs. The dam's outlet works, located a short distance upstream from the left abutment, form the entrance to Tunnel No. 2 which leads to Powerhouse No. 2.

Powerhouse No. 1 Water Conveyance System - The water conveyance system for Powerhouse No. 1, built in 1913, begins with Tunnel No. 1, a 12 feet diameter, 3,946 feet long, generally unlined, tunnel through granite. The downstream end of Tunnel No. 1 is lined with a 108-inch diameter, 409 feet long, riveted steel pipe that branches into two riveted steel pipes as it emerges from the tunnel. The first branch, 84-inches in diameter and 6,459 feet long, connects to Units No. 1, 2, and 3 penstocks. Flow through this pipe is controlled by an 84-inch butterfly valve located at the downstream end of the pipe and operated either locally or remotely from Powerhouse No. 1 and Powerhouse No. 3. The second branch, installed in 1924, is 60-inches in diameter and 6,478 feet long and connects to the Unit No. 4 penstock. Flow through this pipe is controlled by a 54-inch gate valve located at the downstream end of the pipe and operated either locally or remotely from Powerhouse No. 1 and Powerhouse No. 3.

Units No. 1 and 2 penstocks were installed in 1913. Each penstock is 4,311 feet long, 44-inch diameter welded steel pipe which reduces to 36-inches in diameter before branching into two 26-inch lines outside the powerhouse. Each of the branches further reduces to 24-inches in diameter and connects to a turbine.

Unit No. 3 penstock was installed in 1923. It is 4,360 feet long, 42-inch diameter welded steel pipe that reduces to 36-inches in diameter before branching into two 26-inch lines outside the powerhouse. Each of the branches further reduces to 24-inches in diameter and connects to a turbine.

Unit No. 4 penstock was installed in 1924. It is 4,301 feet long, 54-inch diameter welded steel pipe that reduces to 36-inches in diameter before branching into two 34-inch lines outside the powerhouse. Each of the branches further reduces to 30-inches in diameter and connects to a turbine.

The upstream end of each penstock is equipped with an electric-motor-operated gate valve, controllable either locally or remotely from Powerhouse Nos. 1 and 3. Each penstock also has an air valve just downstream from each gate valve (a standby air vent, consisting of a vertical, 36-inch diameter steel pipe, approximately 28 feet tall with a top elevation of 6,990 ft.) and a sonic flow device to sense excess flow in the penstock.

The water conduit is designed to carry approximately 700 cfs under optimum conditions.

Powerhouse No. 2 Water Conveyance System - The water conveyance system for Powerhouse No. 2, built in 1913, begins with Tunnel No. 2 which is 12 feet in diameter with the invert at elevation 4,788.5 feet msl. As there is no gate at the tunnel portal, stop-logs are utilized to dewater the deepest section of the channel with the invert at elevation 4,743.2 feet msl. The tunnel passes through the lower portion of the dam and is equipped with a manually-operated slide gate at the upstream end.

The flowline consists of Tunnel No. 2, a 12 feet diameter, 21,759 feet long, generally unlined bore through granite which intersects the base of a surge tank at its downstream end. The surge tank is a mostly underground, concrete-lined tank, 30 feet in diameter and 115 feet high. A 108-inch diameter, 255 feet long, riveted steel pipe exits from the base of the surge tank and divides unsymmetrically into four penstocks. Flow through this pipe is controlled by an electrically operated, 108-inch slide gate on the inside wall of the surge tank. The gate can be operated either locally or remotely from Powerhouse No. 3.

The four penstocks are 44-inch diameter pipes that reduce to 36-inches in diameter before bifurcating to 24-inch legs just outside the powerhouse. Each of the eight legs connects to a turbine in the powerhouse. The first two penstocks were installed in 1913 with a third penstock added in 1921 and a fourth added in 1925.

Each penstock is controlled at its upstream end by an electric-motor-operated, 42-inch gate valve activated either locally or remotely from Powerhouse No. 2 and Powerhouse No. 3. About 24 feet downstream from the gate valve in each penstock is an air vent consisting of a vertical 44-inch diameter steel pipe approximately 107 feet high. A sonic flow device is used to sense excess flow in the penstocks.

The water conduit is designed to carry approximately 620 cfs under optimum conditions.

Powerhouse No. 1 - Powerhouse No. 1, located at an elevation of 4,819 feet msl at the town of Big Creek, was the first on the Big Creek System to be placed into commercial operation. Built in 1913 and expanded in 1925, it contains four turbine/generator units. Unit No. 2 was the first unit placed on line. It began commercial operation on November 8, 1913 followed by Unit No. 1 on November 9. Unit No. 3 went on line July 12, 1923 and the final unit, Unit No. 4 went on line June 8, 1925. All four units operate on a static head of 2,131 feet, provided by water from Huntington Lake Reservoir.

The turbines are Pelton type, horizontal shaft, single jet, double overhung, hydraulic impulse turbines. Unit Nos. 1 & 2 turbines, manufactured by Allis Chalmers, were originally rated at 20,000 HP each. Unit No. 3 turbine, manufactured by Allis Chalmers, was originally rated at 22,500 HP. Unit No. 4 turbine, manufactured by Pelton, was originally rated at 35,000 HP. Unit No. 4 turbine was upgraded in 1986 to 42,100 HP, Unit No. 2 turbine was upgraded in 1989 to 28,060 HP, Unit No. 1 turbine was upgraded in 1993 to 29,025 HP, and Unit No. 3 turbine was upgraded in 1994 to 29,025 HP.

The four main generators are horizontal shaft, partially enclosed units. Unit Nos. 1, 2, and 3 generators, manufactured by General Electric, were originally rated at 14,000 kW. Unit No. 4 generator, manufactured by Westinghouse, was originally rated at 25,000 kW. Unit No. 4 generator was upgraded in 1971 to increase the rated power to 31,200 kW, Unit No. 2 was upgraded in 1989 to 15,750 kW, Unit No. 1 was upgraded in 1993 to 19,800 kW and Unit No. 3 was upgraded in 1994 to 21,600 kW.

Powerhouse No. 2 - Powerhouse No. 2 was built at the same time as Powerhouse No. 1, both being part of the initial development. The generating equipment at the two powerhouses is virtually identical. Located at an elevation of 2,952 feet msl, Powerhouse No. 2 operates on water impounded behind Dam No. 4 at the discharge of Powerhouse No. 1. The powerhouse contains four turbine/generator units numbered three through six. Unit No. 3 went into service December 18, 1913 followed by Unit No. 4 on January 11, 1914, Unit No. 5 on February 1, 1921, and Unit No. 6 on March 31, 1921. All four units operate on a static head of 1,858 feet.

The turbines are Pelton type, horizontal shaft, single jet, double overhung, hydraulic impulse turbines. Unit Nos. 3 and 4 turbines, manufactured by Allis Chalmers, were originally rated at 20,000 HP each. Unit No. 5 turbine, manufactured by Pelton, was originally rated at 21,450 HP. Unit No. 6 turbine, manufactured by Pelton, was originally rated at 25,000 HP. Unit No. 4 was upgraded in 1989 to 27,270 HP, and Unit No. 3 was upgraded in 1991 to 27,270 HP.

The four main generators are horizontal shaft, partially enclosed units. Unit Nos. 3, 4, and 5 generators, manufactured by Westinghouse, were originally rated at 14,000 kW each. Unit No. 6, manufactured by Westinghouse, was originally rated at 25,000 kW. Unit Nos. 5&6 generators were upgraded in 1985 to increase their rated power to 17,500 kW, Unit No. 4 was upgraded in 1989 to 15,750 kW, and Unit No. 3 was upgraded in 1991 to 15,750 kW.

Balsam Creek Diversion - Balsam Creek Diversion, located across Balsam Creek approximately two miles southwest of Big Creek, is a concrete diversion nine feet high with a crest length of 72 feet. Diverted water is conveyed through approximately 400 feet of 12-inch diameter steel pipe to Tunnel No. 2 where it enters through Adit No. 3. Flow through the conduit is controlled by a gate valve located upstream of the diversion structure.

Ely Creek Diversion - Ely Creek Diversion, located across Ely Creek approximately three miles southwest of Big Creek, is a concrete diversion seven feet high with a crest length of 44 feet. Diverted water is conveyed through approximately 300 feet of 12-inch diameter steel pipe to Tunnel No. 2 where it enters through Adit No. 6. Flow through the conduit is controlled by a gate valve located upstream of the diversion structure.

Adit 8 Diversion – The Adit 8 Diversion, located on Adit 8 Creek about 3-1/2 miles southwest of Big Creek is a concrete diversion approximately 30 feet high with a crest length of approximately 44 feet. When used, water is diverted through a vertical borehole that intersects Tunnel No. 2 at Adit 8.

The Adit 8 Diversion was built to divert Tunnel 5 water (from Shaver Lake) into Tunnel 2 (to Powerhouse No. 2). A bulkhead was poured in Tunnel 5 with a pipe leading downhill to a valve and an energy dissipation structure just above the Adit 8 diversion. The bulkhead, piping, valve, and energy dissipation structure are known as the Shoofly.

This was used during the construction of Shaver Lake Dam and Powerhouse 2A to keep water off the dam under construction and increase generation at Powerhouse No. 2 while Powerhouse No. 2A was being constructed. When Powerhouse No. 2A came on line, it was more efficient to run the water through this powerhouse than to use the Shoofly and Adit 8 Diversion. Although not currently in use, It gives SCE the flexibility to divert water from one water system into another if required.

BIG CREEK NOS. 2A, 8, & EASTWOOD (FERC PROJECT NO. 67) MAJOR COMPONENTS

Powerhouse No. 2A, Powerhouse No. 8, and Eastwood Power Station operate under FERC license as Project No. 67 issued on August 9, 1978, which expires on February 28, 2009. The project has an Exhibit M Generator Capacity of 384.80 MW. Project No.67 consists of Powerhouse No. 2A, Powerhouse No. 8, Eastwood Power Station, Shaver Lake Reservoir and Dam, Florence Lake Reservoir and Dam, Balsam Forebay, Dam 5 Forebay, Bear Creek Diversion, Mono Creek Diversion, Hooper Creek Diversion, North & South Slide Creek

Diversions, Tombstone Creek Diversion, Crater Creek Diversion, Bolsillo Creek Diversion, Chinquapin Creek Diversion, Camp 62 Creek Diversion, Pitman Creek Diversion, Ward Tunnel, Mono-Bear Siphon, Huntington-Pitman-Shaver Conduit, Balsam Diversion Tunnel, Eastwood Power & Tailrace Tunnels, Powerhouse No. 2A Water Conveyance System, Powerhouse No. 8 Water Conveyance System, and the Eastwood – Big Creek 1 Transmission Line.

Powerhouse No. 2A - Powerhouse 2A located adjacent to Powerhouse 2 at an elevation of 2,952 feet msl was constructed in 1928. Powerhouse 2A is operated integrally with Powerhouse 2, but utilizes water for power from Shaver Lake. The Powerhouse contains two turbine/generator units operating at a static head of 2,418 feet which for many years was the highest static head in the world. Unit No. 1 went into service on August 6, 1928 followed by Unit No. 2 on December 21,1928.

The turbines are Pelton type, horizontal shaft, single jet, double overhung, hydraulic impulse turbines. Both turbines were manufactured by Allis Chalmers. Unit No. 1 turbine was originally rated at 56,000 HP and Unit No. 2 turbine was originally rated at 68,000 HP. Unit No. 2 was upgraded in 1984 to 69,000 HP and Unit No. 1 was upgraded in 1987 to 74,100 HP.

The two main generators are horizontal shaft, partially enclosed units. They originally had a combined capacity of 96,000 kW and have since been upgraded to a combined capacity of 110,000 kW.

Powerhouse No. 8 - Powerhouse No. 8, located at the junction of Big Creek with the San Joaquin River, was placed in service in 1921. Its out-of-sequence number results from it not having been a part of the original Big Creek System. The powerhouse was built in 1921 to provide additional energy quickly during a power shortage. Unit No. 1 went into operation on August 16, 1921. Unit No. 2 went into operation on June 8, 1929 (this unit was not added until additional water became available from Shaver Lake via Powerhouse No. 2A). The two units operate on water impounded behind Dam No. 5 at the discharge of Powerhouses Nos. 2/2A and operate on a static head of 713 feet.

The turbines are Francis-type, vertical shaft, hydraulic reaction turbines. Unit No. 1, originally rated at 30,000 HP, was upgraded in 1985 to 36,500 HP. Unit No. 2, originally rated at 44,000 HP, was upgraded in 1984 to 52,500 HP.

The generators are vertical shaft, partially enclosed General Electric units. Unit No. 1, originally rated at 22,500 kW, was upgraded in 1986 to 30,000 kW. Unit No. 2, originally rated at 31,500 kW, was upgraded in 1986 to 45,000 kW.

Additionally, the powerhouse contains two Pelton impulse horizontal shaft, station service generators (SSG). The No. 1 station service generator, was manufactured by General Electric, and the No. 2 station service generator, was manufactured by Allis Chalmers. The No. 1 station service generator is out of service.

Eastwood Power Station - Eastwood Power Station (EPS), part of the Balsam Meadow hydroelectric project, was placed in service on December 1, 1987. It is the last addition to the Big Creek System. It is located in an underground cavern 80 feet wide, 188 feet long, and 153 feet high, hollowed from the native Sierra granite near the shore of Shaver Lake, at an elevation of 5,200 feet msl.

It contains one main, Francis-type, vertical shaft, hydraulic reaction turbine/pump rated at 296,247 HP. The turbine is reversible and mechanically suitable for operating as a pump during pumped storage operation.

The main generator/motor is a vertical shaft, direct coupled, totally-enclosed General Electric Canada unit designed for either direction of rotation and is equipped with a voltage regulator, excitation system, thrust and guide bearings, brakes, cooling system and fire protection. The generator/motor is rated at 199,800 kW, 0.9 power factor.

Shaver Lake Dam / Shaver Lake - Shaver Lake is the largest reservoir on the Big Creek System, having an operating capacity of 135,568 acre feet and a surface area of 2,184 acres when full. The lake is named for pioneer lumberman C. B. Shaver who logged in this area around the turn of the century. Shaver Lake was created in 1927 by the construction of the Shaver Lake Dam across Stevenson Creek, a tributary of the San Joaquin River. The drainage area into Shaver Lake is only 29 square miles, so the majority of the water impounded in the reservoir is diverted through the Huntington-Pitman-Shaver Conduit from Huntington Lake.

Shaver Lake Dam, constructed between 1926 and 1927, is a concrete gravity dam, 185 feet high. The crest, formed by a 3 feet high concrete parapet wall at elevation 5,371 feet msl, is 1,760 feet long. In plan, the dam's axis consists of two nearly equal tangents, intersecting at 26 degrees, connected by a 600 feet radius curve. A dike, designed as an earthfill, with a concrete core on bedrock, extends the left end of the dam by 409 feet.

The spillway, an overpour type, consists of a notch, 0.9 feet deep by 250 feet long, in the dam's 3 feet high parapet wall. The spillway is located in the center of the dam at elevation 5,370 feet msl. The spillway rated discharge capacity at elevation 5,371 feet msl is 745 cubic feet per second.

Florence Lake Dam / Florence Lake - Florence Lake , with a drainage area of 171 square miles and a storage capacity of 64,406 acre feet of water, was created by the construction of the Florence Lake Dam across the South Fork of the San Joaquin River. It required 56,000 cubic yards of concrete to build the structure, which was completed in August of 1926 after only two seasons of work. When full, it has a surface area of 962 acres. Inflow to the lake is obtained from natural flows into the South Fork of the San Joaquin River above the lake and from Crater Creek, Tombstone Creek, North Slide Creek, South Slide Creek, and Hooper Creek diversions. Discharge from the reservoir is normally controlled to supply water to Huntington Lake. Part of this discharge, up to 724 cfs, passes through Portal Powerhouse before entering Huntington Lake. As such, Florence Lake acts as a storage reservoir for the Portal Powerhouse.

Florence Lake Dam was built to the unique multiple-arch concrete design pioneered by John Eastwood. The crest, at elevation 7,329 feet msl, is 3,156 feet long, and contains 58 arches. The arches each have a 50 feet span and are inclined 48 degrees to the vertical. The thickness of the uppermost 34 feet of the arches is 18-inches, while the maximum thickness at the lowest point of the tallest arch is approximately 4.5 feet. The buttresses that support the arches have a minimum thickness of 2.25 feet at the top.

The spillway is a concrete gravity structure located near the middle of the dam with a total crest length of 100 feet at elevation 7,315.5 feet msl. The spillway has two 50-by 14 feet drum gates with an effective height of 12 feet. Both gates are manually operated and are positioned by adjusting valves in the drum gate pits. The spillway rated discharge capacity at elevation 7,329 feet msl is 15,800 cubic feet per second.

Two 36-inch-diameter cast iron drain pipes pass through the base of Arch 53 at elevation 7,214 feet msl. Flow through the right side pipe is controlled by a normally-closed 46-by 46-inch slide gate at the dam upstream face. Flow through the left side pipe is controlled by a normally-open 46-by 46-inch slide gate at the dam upstream face and a manually-operated, 36-inch, gate valve at the downstream end of the pipe. An 8-inch-diameter cast iron pipe, for minimum water release, passes through the base of Arch 53 at elevation 7,200 feet msl.

Balsam Meadow Forebay & Dam - Balsam Meadow Forebay, with a spillway elevation of 6,669.9 feet msl, is located on Balsam Creek, a tributary of Big Creek. The forebay is the regulating reservoir that controls the water flow into the John S. Eastwood underground power station. Filled by water carried down the Huntington-Pitman-Shaver Conduit from Huntington Lake or from water pumped back from Shaver Lake via Eastwood Power Station, the forebay forms a lake with a surface area of 60 acres containing 1,547 acre feet of water.

The Balsam Meadow Forebay Dam is a compacted rockfill dam, 123 feet high, with a concrete slab on the upstream face. The crest, at elevation 6,674.5 feet msl, is 1,325 feet long. The top of the dam concrete parapet wall is at elevation 6,677 feet msl. An earthfill/rockfill saddle dike, 12 feet high, is located approximately 500 feet to the east of the main dam. The top of the dike, at elevation 6,677 feet msl, is 264 feet long.

A single 8 feet horizontal duplex slide gate located at Huntington Lake Dam 2 controls inflow to Balsam Meadow Forebay from Huntington Lake. This gate is remotely operated from Eastwood Power Station control room or from the system dispatching center at Big Creek No. 3.

A 48-inch diameter low-level outlet pipe, encased in concrete, extends through the base of the dam at maximum section, at invert elevation 6,575 feet msl. Flow through the pipe is controlled by manually operated 24-inch butterfly valves located at each end of the pipe. Minimum release from the reservoir is provided through a 6-inch bypass line around the downstream butterfly valve. Redundant float and level probes are in service to warn of increasing water level in the forebay. In addition, an alarm system is in operation which will warn downstream inhabitants and alert the control operator at the dispatching center in the event of a dam failure or spill.

The spillway, near the left abutment of the dam, is an open channel excavated in granite. The crest, at elevation 6,669.9 feet msl, is a 280 feet long concrete weir oriented at a skew with the 140 feet wide spillway channel. The spillway channel discharges into West Fork Balsam Creek. This creek flows to the north to join Balsam Creek and discharges into Big Creek near Camp Sierra below Dam No. 4. The spillway channel is used only under extreme emergency conditions.

Dam No. 5 / Powerhouse No. 8 Forebay - Dam No. 5 is a constant-radius concrete arch dam, 60 feet high, built across Big Creek just below Powerhouse Nos. 2/2A. The crest, at elevation 2,950 feet msl, is 224 feet long. It impounds the discharge from both powerhouses to form a regulating reservoir and forebay for Powerhouse No. 8 downstream.

The spillway, which is an overpour type, consists of 19 ungated spans, separated by piers, with a total length of 133 feet at elevation 2,939 feet msl. Four feet high flashboards are customarily installed in the spillway spans to raise maximum reservoir level to an elevation of 2,943 feet msl. The boards are handled by a power-operated trolley hoist and can be withdrawn during extreme runoffs. The spillway rated discharge capacity at zero freeboard and with all flashboards removed is 15,000 cubic feet per second.

The dam creates a reservoir with a net capacity of 49 acre feet (53 af with dam flash boards installed) and a surface area of 3.3 acres when the water surface is at elevation 2,943 feet msl.

Two, 72-inch-diameter steel drain pipes pass through the base of the dam at invert elevation of 2,895 feet. Flow through these pipes, is controlled by locally activated electric-motor-operated, 72-inch-diameter slide gates at the dam upstream face.

Bear Creek Diversion - Bear Creek Diversion, located across Bear Creek approximately two miles south of Lake Thomas A. Edison, is a constant-radius, concrete arch diversion, 55 feet high. The crest, at elevation 7,356.0 feet msl, is 293 feet long. The ungated, overpour spillway has an effective length of 232 feet and a crest at elevation 7,350.0 feet msl. Diverted water is conveyed through a 7-by 7 feet cross section, 7,596 feet long, bore through granite into the Mono-Bear Siphon. Flow through the conduit is controlled by a manually operated 7.5 feet wide by 15 feet high radial gate, located in the outlet works on the right abutment of the diversion.

Mono Creek Diversion - Mono Creek Diversion, located across Mono Creek approximately one mile southwest of Lake Thomas A. Edison, is a constant-radius, concrete arch diversion, 64 feet high. The crest, at elevation 7,360.0 feet msl, is 156 feet long. The ungated, overpour spillway has an effective length of 106 feet and a crest at elevation 7,350.0 feet msl. Diverted water from Mono Creek is conveyed through: 1) a 92-inch-diameter, 4,538 feet long, steel pipe; 2) an eight feet by 9.5 feet cross section, 3,933 feet long, bore through granite; and 3) a 102-inch, 13,806 feet long, steel pipe into Ward Tunnel (Adit No. 1). Flow through the conduit is controlled by a manually operated 6-by 9 feet slide gate, located in the outlet works on the left abutment of the diversion.

Hooper Creek Diversion - Hooper Creek Diversion, located across Hooper Creek approximately three miles north of Florence Lake, is a concrete diversion, 30 feet high. The crest, at elevation 7,507 feet msl, is 158 feet long. The over pour type spillway located on the left side of the diversion, is 75 feet long with a crest elevation at 7,505 feet msl. Diverted water is conveyed through a 34-inch diameter, 13,097 feet long, steel pipe to Florence Lake. Flow through the conduit is controlled by a manually operated 48-inch head gate located on the upstream face of the diversion.

North and South Slide Creek Diversions - North Slide Creek Diversion, located across Slide Creek approximately two miles north of Florence Lake, is a masonry diversion, five feet high. The crest, at elevation 7,501.5 feet msl, is 19 feet long. South Slide Creek Diversion, also across Slide Creek, is a masonry diversion, five feet high. The crest, at elevation 7,501.5 feet msl, is 22 feet long. Diverted water is conveyed through an eight inch-diameter steel pipe and then through 12-inch-diameter steel pipe for 1,028 feet to a point where it discharges into Hooper Creek conduit. Manually operated 14-inch-head gates located on the upstream face of each diversion control flow through the conduits.

Tombstone Creek Diversion - Tombstone Creek Diversion, located across Tombstone Creek approximately one mile northeast of Florence Lake, is a masonry diversion, five feet high. The crest, at elevation 7,673 feet msl, is 26.4 feet long. Diverted water is conveyed through a combination of 14-inch-diameter steel pipe and natural channel 3,299 feet long to Florence Lake. Flow through the conduit is controlled by a manually-operated 24-inch-diameter head gate located on the upstream face of the diversion.

Crater Creek Diversion - Crater Creek Diversion, located across Crater Creek approximately one mile west of Florence Lake, is a concrete diversion, three feet high. The crest, at elevation 8,764.6 feet msl, is 21 feet long. Diverted water is conveyed through a combination of ditch and natural channel, 7,260 feet long, to Florence Lake.

Bolsillo Creek Diversion - Bolsillo Creek Diversion, located across Bolsillo Creek approximately 1-1/2 miles east of Portal Forebay, is a rock and earth diversion, six feet high. The crest, at elevation 7,538.0 feet msl, is 54 feet long. The overpour type spillway located on the right side of the diversion, is eight feet long with a crest elevation at 7,535 feet msl. Water impounded behind the diversion enters an uncontrolled 388 feet deep bore hole in the bottom of the reservoir which intersects the top of Ward Tunnel. The top of the hole is 66-inches-diameter which tapers down to a 12-inch-diameter steel pipe and then a 10-inch-diameter bore through granite. The hole inlet is protected by trash grids.

Chinquapin Creek Diversion - Chinquapin Creek Diversion, located across Chinquapin Creek approximately three miles east of Portal Forebay, is a concrete diversion, eight feet high. The crest, at elevation 7,273.5 feet msl, is 23 feet long. The overpour type spillway located in the center of the diversion, is 8.5 feet long with a crest elevation at 7,273.0 feet msl. Diverted water is conveyed through a 24-inch-diameter, 2,800 feet long, steel pipe into Ward Tunnel Adit No. 1. Flow through the conduit is controlled by a manually operated 36-inch head gate, located on the upstream face of the dam. The diversion structure was damaged during the January 1997 flood and is presently being re-built to a design adapted from the Bolsillo Creek Diversion described above. This description of the diversion will change when the construction project is completed in the summer of 2000.

Camp 62 Diversion - Camp 62 Diversion, located across Camp 62 Creek approximately two miles east of Portal Forebay, is a concrete diversion, seven feet high. The crest, at elevation 7,257.5 feet msl, is 45 feet long. The overpour type located on the right side of the diversion, is 21 feet long with a crest elevation at 7,257.0 feet msl. Diverted water is conveyed through a 24 inch diameter, 1,000 feet long, steel pipe which joins Chinquapin diversion pipe at Ward Tunnel Adit No. 1. Flow through the conduit is controlled by a manually operated 36-inch-head gate, located on the upstream face of the diversion. The diversion structure was damaged during the January 1997 flood and is presently being re-built to a design adapted from the Bolsillo Creek Diversion described above. This description of the diversion will change when the construction project is completed in the summer of 2000.

Pitman Creek Diversion - Pitman Creek Diversion, located across Pitman Creek approximately 1-1/2 miles east of Big Creek, is a concrete diversion, 10 feet high. The crest, at elevation 6,998 feet msl, is 68 feet long. Diverted water is conveyed through a 185 feet deep bore hole, abutting the left side of the dam face, which intersects Tunnel No. 7. The top of the hole, protected by trash grids, has a 17- by 31 feet cross section which tapers down to a 6 feet square bore through granite. Flow into the bore hole is controlled by three manually-operated 4-by 11 feet slide gates at its the upstream end.

Ward Tunnel - The Florence Lake dam outlet works, located behind full-height trash racks 2000 feet from the left abutment on the western shore of Florence Lake, form the entrance to Ward Tunnel which leads to Portal Powerhouse and Huntington Lake. The 15 feet diameter tunnel has an invert at elevation 7,220 feet. Two 110 feet high 72-inch diameter cylindrical gates at the entrance to the intake control flow through the tunnel. Hydraulic cylinders operate the gate stems and are powered by an electric motor with energy from propane-fueled generators,.

Ward Tunnel is a 15-by 15 feet horseshoe-shaped section 67,619 feet long, unlined bore through granite. The tunnel connects to the Florence Lake Dam outlet works at its upstream end, intersects Portal Powerhouse Forebay through Adit No. 2, 32,860 feet downstream of the inlet portal, contains a surge chamber and rock trap at its downstream end, and terminates in the penstock for Portal Powerhouse.

Ward Tunnel surge chamber is a 15 feet diameter, 175 feet high, bore through granite, concrete lined at its upper end, with an overflow crest at elevation 7,180 feet msl. Overflow from the top of the surge chamber runs into a buried 72-inch-diameter reinforced concrete pipe, approximately 556 feet long, which reduces to 48-inch-diameter before connecting to an energy dissipation structure at its downstream end. The energy dissipation structure consists of a compartmented, reinforced concrete box, approximately 25 x 25 x 15 feet high, which discharges into Rancheria Creek near Portal Powerhouse, and then to Huntington Lake.

The water conduit from Florence Lake to Huntington Lake is designed to carry approximately 1,760 cfs under optimum conditions.

Mono-Bear Siphon - The Mono-Bear Conduit, more commonly referred to as the Mono-Bear Siphon carries water from the Mono and Bear Diversions to the Ward Tunnel. A 7,596 feet unlined tunnel begins at Bear Diversion and ends at the intersection with the tunnel outlet from Mono Diversion. A 4,538 feet flow line begins at the Mono Diversion, connecting to a 3,933 feet unlined tunnel that ends at the intersection of the tunnel from Bear Diversion. Lap and butt welded steel pipe connect these two tunnels to a common 13,806 feet long siphon which connects to the Ward Tunnel at a construction adit. The conduit can carry 350 cfs from the Bear Diversion, 530 cfs from the Mono Diversion, and a maximum of 590 cfs in the common siphon.

Huntington-Pitman-Shaver Conduit - Tunnel No. 7 conveys water from Huntington Lake to Balsam Diversion Tunnel and to Shaver Lake via the North Fork of Stevenson Creek. The upstream end of Tunnel No. 7 connects to Huntington Lake Dam No. 2 outlet works, a 10 feet diameter, 80 feet long, riveted steel pipe with the invert at elevation 6,885 feet msl.

The outlet works contain a 36-inch vent stack, 65 feet from its upstream end, with a top at elevation 6,955 feet msl. Flow through the outlet works is controlled by a

10 feet wide by 10 feet high slide gate at the upstream face of the dam, protected by a trash rack, and an 8 feet high horizontal sliding duplex gate located in a valve house buried under the dam downstream fill. The 10 feet gate is locally operated by an electric-motor-operated stem lifting device with a shaft-coupled gearbox, powered by a gasoline engine for backup. The 8 feet high duplex gate has an electric motor-driven operator and it can be operated locally or remotely from Big Creek 3.

Tunnel No. 7 consists of four sections. the first is a 12 feet diameter, 680 feet long, earth-covered riveted steel pipe. The pipe contains a 42-inch vent stack, 421 feet from its upstream end, with a top at elevation 6,957 feet msl. The second is a short tunnel that is a 14-by 14 feet horseshoe-shaped section, 2,642 feet long unlined bore through granite. The tunnel contains a 42-inch vent stack, 130 feet high located at the upstream end, with a top at elevation 6,958 feet msl. The third is a siphon made of riveted steel pipe with diameter varying from 120 inches to 96 inches and back to 120 inches, and 2,425 feet long. The forth is a long tunnel that is a 14 feet by 14 feet horseshoe-shaped section, 22,843 feet long unlined bore through granite.

The Tunnel No. 7 discharge into the North Fork of Stevenson Creek is controlled by a normally-closed 10 feet by 10 feet vertical slide gate located at the "long tunnel" outlet portal. The gate is locally operated by an electric-motor-driven screw hoist.

Balsam Diversion Tunnel – This is a 16 feet by 16 feet horseshoe-shaped tunnel, 5866 feet long unlined bore through granite that intersects Tunnel No. 7 approximately 1,200 feet upstream of its outlet portal. Inflow into the Balsam forebay can be shut off by a single locally controlled, hydraulically operated 12-by 16 feet slide gate located at the downstream end of the diversion tunnel.

Eastwood Power & Tailrace Tunnels - Releases from the Balsam Meadow Forebay are made through a 18-by 18 feet horseshoe-shaped power tunnel leading to Eastwood Power Station. Two 9-by 17 feet vertical slide gates at the upstream end of the tunnel are provided for shut-off. The gates are locally operated by electric-motor-driven, rising-stem screw hoists. These gates are equipped with an emergency remote close feature from Big Creek 3, which is tested monthly. Hydraulic control is provided by the power tunnel intake slide gates and the turbine shutoff valve at Eastwood Power Station. The dam outlet (intake) works, located behind full-height trash racks approximately 1,150 feet southwest of the dam, form the entrance (exit) to the power tunnel. The tunnel has an invert at elevation 6,600.0 feet msl.

The power tunnel consists of three parts. The first is the upper tunnel that is an 18-by 18 feet horseshoe-shaped section, 2,832 feet long bore through granite, with a concrete-lined invert and a rock trap 107 feet from the downstream end. The second is a vertical shaft that is a 1,043 feet long vertical bore through granite which connects the upper and lower tunnels. The upper tunnel section is unlined for 603 feet, with a 13.5 feet diameter. The lower tunnel section is steel lined for 440 feet, with an 11 feet diameter. The third part is the lower tunnel that is a 1,328 feet long, 12 feet diameter, steel-lined bore through granite which reduces to 83 inches in diameter before connecting to the turbine shut-off valve.

A surge chamber connects to the power tunnel. The surge chamber is a 30 feet diameter, 275 feet high, vertical shaft through granite with an eight feet diameter ventilation shaft extending 816 feet from the top of the surge chamber to the ground surface. The surge chamber is connected to the power tunnel by concrete-lined, 15 feet diameter, 33 feet long, shaft containing a 10.25 feet diameter restricting orifice. Two 9-by 17 feet slide gates are located at the downstream end of the tunnel. The gates are locally operated by electric-motor-driven steel cable hoists. Two 12-by 16 feet slide gates are located in the turbine draft tube. These gates allow the turbine to be de-watered without draining the tunnel. The gates are locally operated by hydraulic cylinders.

The power tunnel may be drained, (except for net static submersion head on the pump/turbine) by gravity through the turbine to the tailrace. The remaining water can be pumped out. A single, high total discharge head pump is provided to dewater any portion of the hydraulic system. Four separate sectors which may require dewatering exist: 1) power tunnel upstream of spherical turbine shut-off valve; 2) tailrace tunnel downstream of lower guard valve; 3) piping and equipment between the turbine shut-off valve and the lower guard valve; and 4) turbine pit in the powerhouse.

All four of these sectors are manifolded to the dewatering pump suction so that water may be pumped out of any sector. The pump discharge is manifolded to the power tunnel and the tailrace tunnel so that discharge may be directed to either. The tailrace tunnel may be dewatered for maintenance by closing the discharge portal with stop logs and pumping the tailwater into the power tunnel.

The water conduit is designed to carry approximately 1,522 cfs during pump-back and 2,306 cfs when generating under optimum conditions.

The tailrace tunnel conveys water from (into) the draft tube into (from) Shaver Lake. The tunnel is a 7,543- feet long, bore through granite. The first 35 feet of the tunnel is a concrete-lined draft tube transition. This is followed by a concrete-lined, 15 feet diameter section, 440 feet long. The remainder of the tunnel is an 18- by 18- feet horseshoe-shaped section with a concrete-lined invert. The tunnel intersects the base of a surge chamber and rock trap 175 feet and 475 feet, respectively, downstream from the draft tube.

Powerhouse No. 2A Water Conveyance System - The Shaver Dam outlet works is located behind full-height trash racks approximately 300 feet offshore of the right abutment (facing downstream).and form the entrance to Tunnel No. 5 which leads to Big Creek Powerhouse No. 2A. The tunnel has an invert at elevation 5,225 feet msl. Flow into Tunnel No. 5 is controlled by a 6-by 9 feet slide gate, located beneath a gate house on the right abutment. The gate is locally operated by an electric-motor-driven hoist.

The flowline consists of Tunnel No. 5, an 11-by 11 feet cross section, 13,900 feet long, unlined bore through granite, which intersects the base of a vertical surge chamber, containing a rock trap, at its downstream end. The surge chamber is 150 feet high with a 6 feet diameter shaft, which transitions to 25 feet diameter at its upper end, extending up to the ground surface at an elevation of 5,405 feet msl. The shaft inlet is located 40 feet from the downstream end of the chamber. A 9 feet diameter, 460 feet long, riveted steel pipe, downstream of the surge tank, lines the tunnel and connects to the penstock, as it exits the tunnel portal.

The penstock consists of a 108-to 66-inch-diameter combination of riveted, forged-welded, and forged-seamless steel pipe, 6,218 ft. long, which branches into two 48-inch lines outside the powerhouse. Each of these lines branch a second time, reduce to 34 inch-diameter and connect to a turbine. A 102-inch-diameter electric-motor-operated butterfly valve is located in a valve house at the upstream end of the penstock. This valve can be operated locally or remotely from Powerhouse No. 3. Four pairs of 10-inch air & vacuum relief valves are located just downstream of the butterfly valve.

Powerhouse No. 8 Water Conveyance System - The power tunnel intake, located behind full-height trash racks, approximately 70 feet upstream from the dam on the left abutment, form the entrance to Tunnel No. 8, which leads to Big Creek 8. The tunnel has an invert at elevation 2,921.5 feet msl. The tunnel does not have an intake gate and stoplogs must be installed to de-water the tunnel.

Tunnel No. 8 is a 20 by 20 feet cross section, 5,570 feet long, unlined bore through granite. The tunnel downstream portal is sleeved with an 18 feet diameter, 32 feet long riveted steel pipe which exits the tunnel into a surge tank. The surge tank is a 35 feet diameter, 90 feet high, above-ground, steel tank. Two penstocks exit the downstream base of the surge tank. Each penstock is controlled by a slide gate on the inside wall of the tank. Both gates are operated by stems extending to an operating platform at the top of the tank, where electric-motor-operated gear trains drive the gate stems. There is a gas engine standby gate operator, for use if electric power fails. The gates can be operated locally or remotely from Big Creek No. 3.

Unit No. 1 penstock is a 2,668 feet long, 96-inch-diameter riveted and lap welded steel pipe which reduces to 72 inches in diameter before connecting to the turbine. An 8-by 8 feet slide gate is located at the upstream end of the penstock, inside the surge tank, as described above. Downstream from the slide gate, the penstock is provided with air vent valves.

Unit No. 2 penstock is a 2,698 feet long, 120-inch diameter riveted and lap-welded steel pipe which reduces to 84-inches in diameter before connecting to the turbine. A 10-by 10 feet slide gate is located at the upstream end of the penstock, inside the surge tank, as described above. The penstock is provided with air vent valves downstream from the slide gate.

The water conduit is designed to carry approximately 1,385 cfs under optimum conditions.

Big Creek 1 - Eastwood Power Station Transmission Line - The transmission line extending from the switchyard at Powerhouse No. 1 to the switchyard at Eastwood Power Station is licensed under FERC Project No. 67. This line is 4.7 miles in length and has one 605kcm ACSR conductor per phase supported on single circuit lattice steel towers. In addition, the towers support two overhead stranded steel ground wires for lightning protection as well as containing six optical fibers each for communication, control, and data links between Eastwood Power Station and Big Creek 1. For 3.4 miles from the Eastwood Power Station, the line is centered on its own right-of-way having varying widths of 150 to 220 feet depending upon span lengths. For the remaining 1.3 miles into the Powerhouse 1 switchyard, the line is adjacent to two other 220kV transmission lines separated by 82 feet from the closest other line.

BIG CREEK NO. 3 (FERC PROJECT 120) MAJOR COMPONENTS

Powerhouse No. 3 operates under FERC license as Project No. 120 issued in 1977, which expires on February 28, 2009. The project has a Exhibit M Generator Capacity of 174,450 kW. Project No. 120 consists of Powerhouse No. 3, Dam 6 and Forebay, and the Powerhouse No. 3 Water Conveyance System.

Powerhouse No. 3 - Powerhouse No. 3, located at an elevation of 1,412 feet on the San Joaquin River is the operating headquarters of the Big Creek System, housing the control center for the entire project. When Powerhouse 3 went into service in 1923 it was hailed as “the Electrical Giant of the West” for its then 99,000 kW of rated capacity made it the largest hydroelectric plant in the West. Powerhouse 3 contains five turbine/generator units. Unit No. 1 went into service on October 3, 1923, Unit No. 2 on September 30, 1923, Unit No. 3 on October 5, 1923, Unit No. 4 on April 28, 1948, and Unit 5 on February 24, 1980. The units operate on a static head of 827 feet.

The turbines are Francis-type vertical shaft hydraulic reaction turbines. Unit Nos. 1-3 were originally rated at 42,500 HP each. Unit No. 4 turbine was originally rated at 45,000 HP, and Unit No. 5 turbine is rated at 57,700 HP. Unit Nos. 1-3 turbines were de-rated in 1982-83 to 41,300 HP each. Unit No. 4 turbine was upgraded in 1985 to 49,500 HP.

Unit Nos. 1 - 3 generators are Y-connected, vertical shaft, partially enclosed Westinghouse units with cooling provided by once-through air, drawn from outside of the powerhouse after passing through a humidifier system. Originally rated at 25,032 kW, they were upgraded in 1943-45 to 34,000 kW, unity power factor. Unit No. 4 generator is a Y-connected, vertical shaft, Westinghouse unit cooled by a closed-circuit air system with heat exchangers. Originally rated at 31,500 kW, it was upgraded in 1985 to 36,000 kW. Unit No. 5 generator is a Y-connected, vertical shaft, totally enclosed Allis-Chalmers unit cooled by heat exchangers. It is rated at 36,450 kW.

Dam No. 6 / Powerhouse 3 Forebay - Dam No. 6, completed in 1923, is a constant-radius, concrete arch dam, 155 feet high. It is located across the San Joaquin River a short distance downstream from the confluence with Big Creek. The dam forms a small reservoir with a surface area of 23 acres containing 993 acre feet of water. This reservoir is the forebay for Powerhouse No. 3 several miles downstream. The crest of Dam No. 6, at elevation 2,250 feet msl, is 495 feet long. The dam is eight feet thick at the crest and 39 feet thick at the lowest point of the foundation.

The spillway, which is an overpour type, consists of six ungated spans, separated by piers, with a total length of 389 feet at elevation 2,230 feet msl. A walkway, at elevation 2,250 feet msl, spans the ungated spillway and provides access to the controls for the four drain gates and to the 15 ton revolving crane used for removal of floating debris.

Four 66-inch-diameter steel sluice pipes pass through the base of the dam at elevation 2,142.25 feet. Flow through these pipes is controlled by 100-inch slide gates (installed in 1940) at the upstream face and 72-inch slide gates (installed 1938) at the downstream face of the dam. A 24-inch diameter cast iron minimum flow release pipe and an 8-inch diameter drain line also pass through the dam structure.

Powerhouse No. 3 Water Conveyance System - The dam outlet works, located in a tower with full-height trash racks a short distance upstream from the left abutment, form the entrance to Tunnel No. 3 which leads to Powerhouse No. 3. The tunnel has an invert at elevation 2,171 feet msl. Flow into Tunnel No. 3 is controlled by a 22 feet diameter cylindrical gate at the bottom of the tower.

The flowline consists of Tunnel No. 3, a 21 by 21 feet cross section, 28,191 feet long, unlined bore through granite which intersects the base of a surge tank and rock drop chamber at its downstream end. The surge tank is an underground chamber, 164 feet high, 60-inch diameter at its base, necking to 25 inch diameter at the mid-section and expanding to approximately 75 inch diameter at the top. An 18 feet diameter, 310 feet long, riveted steel pipe, downstream of the base of the surge tank, divides non-symmetrically through two spherical manifolds into five penstocks after exiting the tunnel portal. The rock drop is equipped with both a 24 inch and a 12 inch locally activated electric motor activated valve. These are used to flush rock and sand from the rock drop chamber.

Units No. 1, 2, and 3 penstocks: 1,386 feet, 1,365 feet and 1,324 feet long respectively, are 90 inch diameter forge welded steel pipes which reduce to 54-inch-diameter before connecting to the turbine. Unit No. 4 penstock is a 1,322 feet long, 90-inch diameter butt-welded steel pipe, which reduces to 54-inches in diameter before connecting to the turbine. A 90-inch electric-motor-operated butterfly valve is located at the upstream end of each penstock. This valve can be operated either locally or remotely from Big Creek 3. Standpipe air vents are provided for units No. 1, 2, 3, and 4 penstocks. They consist of vertical 36-inch-diameter steel pipes, over 200 feet tall, with a top elevation of 2,285 feet msl. The vents are located just downstream of each butterfly valve and are combined into a common structure. Four air and vacuum relief valves are located just downstream of the butterfly valves. These standpipes are scheduled to be removed in the spring of the year 2000, and to be replaced by pressure relief devices similar to that associated with the Unit 5 penstock of the Big Creek No. 3 Powerhouse. As three of the standpipes are part of the Big Creek Hydroelectric System Historical District (the fourth pipe was added in 1948), an MOA has been established between SCE, the California State Historic Preservation Office, and the Commission to meet the requirements of Section 106 of the National Historic Preservation Act [16 USC § 470(f)]. This MOA outlines agreed upon measures to mitigate any adverse effects on the Historic District caused by the standpipe replacement and allows for review of the standpipe replacement by the Advisory council on Historic Preservation under 36 CFR Part 800. The Commission has approved this standpipe replacement project.

The water conduit is designed to carry approximately 3,450 cfs under optimum conditions.

BIG CREEK NO. 4 (FERC PROJECT NO. 2017) MAJOR COMPONENTS

Powerhouse No. 4 operates under FERC license as Project No. 2017 issued December 23, 1949, which expired on February 28, 1999. The project currently is operating under annual renewable license. The project has an Exhibit M Generator Capacity of 100.00 MW. Project No. 2017 consists of Powerhouse No. 4, Dam No. 7 and Redinger Lake, and the Powerhouse No. 4 Water Conveyance System.

Powerhouse No. 4 - Powerhouse 4 is the lowest in the chain of plants on the Big Creek System, located on the San Joaquin River at an elevation of 988 feet msl. The powerhouse contains two turbine/generator units, Unit No. 1 which went into service on June 12, 1951, and Unit No. 2 which went into service on July 12, 1951. The units operate on a static head of 416 feet provided by water from Redinger Lake.

The turbines are Francis-type vertical shaft, hydraulic reaction turbines rated at 66,000 HP each. The generators are vertical shaft, totally enclosed units rated at 50,000 kW, 1.0 power factor each. Unit No. 1 generator is an Allis Chalmers unit while Unit No. 2 generator is a General Electric unit.

In addition to the two main generators, the powerhouse contains a "Station Service" generator. The Station Service generator is a horizontal shaft, Elliott unit. The generator is rated at 300 kW, 0.8 power factor. The generator is connected to a horizontal, Francis-type reaction water turbine rated at 450 HP.

Dam No. 7 / Redinger Lake - Dam No. 7, completed in 1951, is located across the San Joaquin River at an elevation of 1165 feet msl. It is a concrete gravity dam, 250 feet high, with a compound downstream slope of 0.75 and 0.83 to 1. The dam crest, at elevation 1,413.5 feet msl, is 875 feet long. Dam No. 7 creates Redinger Lake with a storage capacity of approximately 26,119 acre feet, and a surface area of 464 acres, when the water surface is at Elevation 1,403 feet msl. Redinger Lake is the forebay for Powerhouse No. 4.

The spillway has an ogee crest, formed in five blocks, at Elevation 1,373 feet. It is divided into four openings by three piers, each opening being 40 ft. wide and controlled by a 40- feet wide by 30- feet high radial gate. The gates are raised by electrically operated cable winches. Two gates can be remotely operated from Powerhouse No. 3. All gates can be operated from a panel at the Dam. There are two power sources for the cable winches, the local power system and a propane driven, emergency standby engine-generator set housed on the right abutment. The spillway capacity at zero freeboard is about 165,000 cfs. The downstream end of the spillway consists of a dentated flip bucket formed in the face of the dam about 70 feet above the canyon floor.

A low level outlet conduit, 5 feet x 6.5 feet in cross section, and controlled by two, tandem slide gates with hydraulic operators in a gallery, penetrates the dam at an elevation of 1,307 feet msl near the center of the dam.

In addition to the powerhouse turbines, a 500 HP, design head 222 feet, 1,200 rpm, Francis-type, horizontal shaft, hydraulic reaction turbine is installed in Dam No. 7. This turbine is used to recover the energy of water released for instream purposes from the reservoir through the dam. The turbine intake is a 24-inch pipe at an elevation of 1,318.5 feet msl on the upstream face of the dam and discharge is a 2.4 X 5.0 feet bypass tunnel at an elevation of 1,183.0 ft. on the downstream face of the dam. The turbine is directly connected to a 350 kW, 0.9 power factor, induction generator which feeds into the 12 kV local distribution system. The unit is unattended with supervisory control and remote restart capability at Big Creek No. 3.

Powerhouse No. 4 Water Conveyance System - The power tunnel intake is located on the face of the dam behind full-height trash racks. This intake is divided into two rectangular openings which may be closed by two, cable-suspended, electric-hoist-operated, 8 feet x 17 feet 8 inch, fixed wheel gates. The outlet makes a transition to a 115 feet long, 17 feet diameter, welded steel pipe within and just beyond the dam section and then to the unlined power tunnel.

The power tunnel is divided into three reaches: 1) an upstream leg, 2,200 feet long; 2) a 17 ft. 6 in. diameter, welded steel pipe, 700 feet long, on grade, across and above Willow Creek; and 3) a downstream leg 8,109 feet long. Both tunnels are unlined, except that the inverts are concrete paved and, in places where the rock is not sound or self-supporting, the tunnels are timber or steel supported and gunite lined. Each tunnel has a horseshoe shaped cross section with a nominal dimension of 24 feet, which drops to 23 feet in gunited sections. A rock trap and a restricted orifice type surge chamber are provided in the tunnel section above the penstock connection.

The penstock is a welded steel pipe with two branches at the lower end. The section of the penstock from the lower tunnel portal to the point of branching consists of 573 feet of 15-ft. diameter pipe. Each of the two branches to the butterfly valves at the powerhouse is 185 feet in length and 10 feet 6 inches in diameter. The water conduit is designed to carry approximately 3,450 cfs under optimum conditions.

PORTAL (FERC PROJECT NO. 2174) MAJOR COMPONENTS

Portal powerhouse operates under FERC license as Project No. 2174 issued April 19, 1955, which expires on March 31, 2005. The project has an Exhibit M Generator Capacity of 10.80 MW. Project No. 2174 consists of Portal Powerhouse, Portal Forebay and Dam, and the Portal Water Conveyance System.

Portal Powerhouse - Portal Powerhouse is the highest in the Big Creek chain, located at an elevation of 6,952 feet msl, at the outlet of the Ward Tunnel near Huntington Lake. The powerhouse went into operation December 22, 1956 and was the first powerhouse in the Big Creek System to be operated unmanned, via remote “supervisory control” from another powerhouse.

The powerhouse contains one, Francis-type, vertical shaft, hydraulic reaction turbine originally rated at 14,000 HP and upgraded in 1983 to the current rated horsepower of 14,745. The generator is a vertical shaft, outdoor, enclosed, air-water cooled General Electric unit. The generator was originally rated at 10,000 kW and was upgraded in 1995 to the current rating of 10,800 kW, 0.9 power factor.

Portal Forebay Dam / Portal Forebay - Portal Forebay is a small man-made lake completed in 1956, situated on the eastern slope of Kaiser Ridge astride the Ward Tunnel at Camp 61 Creek, a tributary to the South Fork of the San Joaquin River. It lies about midway between Florence Lake and Huntington Lake, at an elevation of 7,180 feet msl. It has a surface area of 20 acres and a storage capacity of 325 acre feet. It serves as a regulating forebay for the Portal Powerhouse, located at the outlet of Ward Tunnel.

The dam, which forms the forebay, is a compacted earth and rockfill dam, 65 feet high. The top, at an elevation of 7,185 feet msl is 795 feet long. An earthfill saddle dike, 18 feet high, is located about 400 feet east of the main dam. The top of the dike, at an elevation of 7,185 feet msl, is 350 feet long.

The spillway, at the left abutment of the dam, is an open channel excavated in granite. The crest, at an elevation of 7,180 feet msl, is a 100 feet long concrete sill, doweled into the rock. The spillway discharge channel joins Camp 61 Creek a safe distance downstream from the embankment toe.

The dam's outlet works consist of a 24-inch steel pipe extending through the base of the dam with a 24-inch square, manually-operated, slide gate at its intake. The pipe is encased in concrete through the impervious zone of the dam.

Portal Forebay is normally operated at an elevation of 7,177 feet msl, 3 feet below spillway level, with automatic control to restrict the reservoir level to 2 feet below spillway level.

Portal Powerhouse Water Conveyance System - Portal Powerhouse Forebay, with a capacity of 325 acre feet, impounds water received through the vertical shaft of Adit No. 2, an uncontrolled Adit to Ward Tunnel. (Ward Tunnel, FERC Project No. 67, is aligned under the forebay on the way to Rancheria Creek, a tributary of Huntington Lake.) The adit allows water from Florence Lake, Lake Thomas A. Edison, Mono and Bear Diversions, and several minor creeks flowing into Ward tunnel to fill Portal Powerhouse Forebay and water flowing from the forebay through the adit to enter Portal Powerhouse flowline.

The flowline consists of Ward Tunnel (FERC Project No. 67) for a distance of approximately 32,000 ft., from Adit No. 2 to the base of a surge chamber on the tunnel and a rock trap immediately downstream of the surge chamber.

The surge chamber is 15 feet in diameter, bored through granite, concrete lined at its upper end, containing an overflow crest at an elevation of 7,180 feet msl. Overflow out the top of the surge chamber runs into a buried 72 - 48-inch diameter reinforced concrete pipe, approximately 556 ft. long, with an energy dissipation structure consisting of a compartmented, reinforced concrete box, approximately 25 ft. by 25 ft. by 15 ft. high at the downstream end which discharges into Rancheria Creek near Portal Powerhouse.

The penstock consists of a 114 to 102-inch diameter steel pipe, 1,180 ft. long, which bifurcates into two 96-inch diameter steel pipes just upstream of the turbine. The penstock upstream end intersects the rock trap in Ward Tunnel. The penstock is enclosed in a 12 feet diameter steel pipe from just upstream of the Ward Tunnel portal to the steel wye bifurcation. (The 12 feet diameter pipe is the old flowline exiting Ward Tunnel which discharged into Rancheria Creek prior to construction of Portal Powerhouse.) One branch of the penstock past the bifurcation, 81 feet long and guarded by a hydraulic-cylinder-operated 90-inch butterfly valve, supplies the turbine. The other branch, 89 feet long and controlled by a 90-inch electric-motor-operated Howell-Bunger valve, discharges to free air through a reinforced concrete dissipater hood.

Turbine discharge and discharge through the Howell-Bunger valve flow into a common discharge channel passing into Rancheria Creek and under State Highway 168 and into Huntington Lake.

When Ward Tunnel flow to Huntington Lake exceeds 746 cfs, the excess is bypassed through the Howell-Bunger valve at Portal Powerhouse. When flow exceeds approximately 1,500 cfs, the turbine must be shut down because of insufficient head, and all flow goes through the Howell-Bunger valve. The water conduit is designed to carry approximately 1,760 cfs under optimum conditions with the turbine shut down and all flow passing through the Howell-Bunger valve.

MAMMOTH POOL (FERC PROJECT NO. 2085) MAJOR COMPONENTS

Mammoth Pool Powerhouse operates under FERC license as Project No. 2085 issued on December 30, 1957, which expires on November 30, 2007. The project has an Exhibit M Generator Capacity of 190.00 MW. Project No. 2085 consists of Mammoth Pool Powerhouse, Mammoth Pool Dam & Reservoir, Mammoth Pool Fishwater Generator, Mammoth Pool Powerhouse Water Conveyance System, Rock Creek Diversion, Ross Creek Diversion, and the Mammoth Pool Powerhouse – Big Creek 3 Transmission Line.

Mammoth Pool Powerhouse - Mammoth Pool Powerhouse located on the San Joaquin River at an elevation of 2,235 feet msl was completed and placed into service on March 28, 1960. It contains two turbine/generator units operating on a static head of 1,100 feet from water impounded in Mammoth Pool Reservoir. This powerhouse, like Portal Powerhouse, was built with an all-outdoor design and is remotely operated.

The powerhouse contains two Francis-type vertical shaft hydraulic reaction (V-R) turbines. The turbines as installed in 1960 were designed for 950 feet of head and had a rated shaft horsepower of 88,000. The turbines were upgraded in 1982 to a design head of 1,004 feet with a rated shaft horsepower of 100,000.

The two generators are Y-connected, vertical shaft, three-bearing type, with closed circuit air-cooled/water heat exchangers. The generators originally had a rating of 66,000 kVA, unity power factor, were upgraded in 1980 to the current rating of 95,000 kVA.

Mammoth Pool Dam / Mammoth Pool Reservoir - The Mammoth Pool Reservoir, with a storage capacity of 119,940 acre feet, is formed by an earth-fill dam built across the San Joaquin River about eight miles upstream from its junction with Big Creek, at the 3030 feet msl elevation. The reservoir, with a length of over eight miles when filled to the spillway crest, covers about 1,100 acres of land.

The dam is a compacted earthfill structure. The crest of the dam is at elevation 3,361 feet msl or 31 feet above the spillway crest and approximately 330 feet above the stream bed. The length along the crest is approximately 828 feet, the top width is 30 feet, and the distance from upstream toe to downstream toe is approximately 2,100 feet msl. The downstream face has a slope of 2 to 1 above elevation 3,125 feet msl, and a 20 feet wide bench at a slope of 2 to 1 and a slope of 1.5 to 1 below this elevation. The upstream face has a slope of 3 to 1 above elevation 3,285 feet msl and 3.5 to 1 below this elevation to elevation 3,100 feet msl where the slope is 4 to 1 to the upstream toe.

The dam embankment has a chimney drain, plus a drainage blanket under a course granular downstream shell. A drain pipe extends from the drainage blanket through the rockfill zone to the toe. The upstream and downstream shells consists of compacted non-plastic coarse silty sands with occasional gravel. The core consists of fine to medium, slightly plastic, silty sands with some fine gravel. Both slopes of the embankment are protected by rip-rap. The downstream toe zone is dumped quarried rockfill.

The spillway is a separate overflow channel cut through a rock ridge approximately 1,500 feet west of the west abutment of the dam. It is an ungated, chute-type spillway having a modified ogee control section with an effective crest length of 403 feet at elevation 3,330 feet msl. It is designed to discharge 170,000 cfs with reservoir level at elevation 3355.7 feet msl or approximately five feet below the dam crest.

A 28 feet diameter, 2,150 feet long tunnel was built to divert the river during construction of the dam. This tunnel was converted to the low-level outlet works. A concrete plug was placed in the tunnel near the intersection with the dam axis. Two valves, a 72-inch diameter butterfly and a 60-inch diameter Howell-Bunger (HB) are connected in tandem to a 72-inch diameter conduit passing through the tunnel plug.

The lower of these two valves, the 60-inch diameter Howell Bunger valve, is the reservoir low-level outlet control valve. A 30-inch diameter penstock, with a 30-inch diameter manual control gate valve located just below the tunnel plug, passes through the plug and extends to the tunnel portal where it connects with a small turbine.

Mammoth Pool Dam Fishwater Generator - The fishwater turbine is a multi-nozzle horizontal impulse Pelton-type turbine. It is installed in a 30-inch diameter penstock at the downstream portal of the converted diversion tunnel for Mammoth Pool Dam. The turbine speed is 600 RPM, developing 1,400 HP at 310 feet effective head, using a six nozzle horizontal shaft hydraulic impulse turbine with a single cast runner.

The fishwater generator is a two bearing horizontal shaft, indoor, open type, self cooled waterwheel unit with an installed capacity of 937 kW, 75 percent power factor. The generator feeds into SCE's 12 kV Stevenson distribution line.

This turbine/generator is used to recover the energy of minimum flow water released from the reservoir through the dam. The unit is unattended with an out-of-service alarm at Big Creek 3 Dispatch Office. When the unit trips, a station operator must restart the unit locally.

Rock Creek Diversion – Rock Creek Diversion, located across Rock Creek approximately 3-1/2 miles south of Mammoth Pool Dam, is a concrete diversion approximately nine feet high. The crest length is approximately 93 feet and the spill elevation is 3,336 feet msl. Diverted water is conveyed through 434 feet of steel pipe with a 30 to 20 inch diameter to a 20 inch diameter vertical borehole into Mammoth Pool Power Tunnel.

Ross Creek Diversion – Ross Creek Diversion, located across Ross Creek approximately seven miles south of Mammoth Pool Dam, is a concrete diversion approximately seven feet high. The crest length is approximately 53 feet and the spill elevation is 3,359 feet msl. Diverted water is conveyed through 607 feet of steel pipe with a 12 to 10-inch diameter to a 10 inch vertical borehole into the Mammoth Pool Power Tunnel.

Mammoth Pool Powerhouse Water Conveyance System - A water conduit, consisting of the Mammoth Pool Power Tunnel and a penstock, connects Mammoth Pool Reservoir to Mammoth Pool Power House.

The power tunnel is approximately 39,350 feet long, (not including 211 feet of 13 feet diameter steel pipe at Shakeflat Creek Crossing) and extends from the Mammoth Pool Reservoir to the connection with the upper end of the single penstock. The tunnel consists essentially of a nominal 20 feet diameter horseshoe type section with a six-inch-thick concrete paved invert. In sections where the rock is not sound or self-supporting, the full section is concrete-lined and steel supported with a nominal diameter of 17 feet.

Intake to the tunnel is controlled by a fixed-wheel gate powered by an electrically operated hoist. The rock trap and surge chamber are located in the tunnel section approximately 490 feet and 800 feet respectively, above the outlet portal.

A single penstock 1,988 feet long and varying in outside diameter from 158 inches to 129 inches extends from the tunnel portal, to the Y-branch just above the powerhouse. A 144-inch butterfly valve is located in the penstock approximately 30 feet below the tunnel portal. The legs of the Y-branch are each 93 inches in outside diameter, approximately 93 feet long and extend to 90 inch butterfly valves located just ahead of the two turbines. The Mammoth Pool power conduit was designed to carry approximately 2,514 cfs under optimum conditions.

Mammoth Pool Powerhouse Transmission Line – Big Creek 3 – Mammoth Pool Powerhouse is connected to the transmission network by a 6.7 mile, 220 kV, transmission line to Powerhouse No. 3 switchyard. Licensed under FERC Project No. 2085, it transverses primarily rural and mountainous terrain with little access or development. It runs from the Powerhouse 3 switchyard north northeast across USFS land up a steep ridge. The line then turns to the northeast where it crosses private property at Kinsman Flat, more USFS land, and Dam 6 / Powerhouse No. 3 Forebay near Powerhouse No. 8. The line then turns to the northwest and connects to the switchyard at Mammoth Pool Powerhouse. It has one 605 kcm ACSR conductor per phase supported on single circuit lattice steel towers. The towers also support two overhead stranded steel ground wires for lightning protection.

VERMILION VALLEY (FERC PROJECT NO. 2086) MAJOR COMPONENTS

The Vermilion Valley project operates under FERC license as Project No. 2086, issued September 29, 1953, which expires on August 31, 2003. Project No. 2086 consists of water diversion and storage only. There is no generation associated with this project. The project consists of Vermilion Valley Dam, Lake Thomas A. Edison, and Warm Creek Diversion.

Vermilion Valley Dam - Vermilion Valley Dam is a zoned-type, rolled earth-fill dam, with an impervious core and a blanket extending upstream to increase the path of percolation through the foundation. A pervious zone downstream from the core provides drainage, by a reverse filter toe drain running the full length of the dam, and by an extensive system of relief wells draining the foundation into the toe drain. It is 161.5 feet high, with a crest length of 4,243 feet.

Lake Thomas A. Edison - Lake Thomas A. Edison, with a drainage area of 90 square miles and a storage capacity of 125,035 acre feet of water, was created by the construction of the Vermilion Valley Dam across Mono Creek, a tributary to the South Fork of the San Joaquin River. The lake stores water during runoff for later use at the Big Creek System powerhouses. The water stored at this facility is capable of providing an average of 617,000,000 kilowatt-hours of electric energy annually.

Spill water control consists of a radial gate controlled spillway at one abutment and an uncontrolled overflow spillway at the other. The one outlet valve is remotely controlled by microwave from Big Creek 3.

Warm Creek Diversion - Warm Creek Diversion, located across Warm Creek approximately 1-1/2 miles northwest of Lake Thomas A. Edison, is a gunite diversion approximately two feet high. Diverted water is conveyed through an open channel approximately 2,000 feet into a natural channel that flows into Lake Thomas A. Edison.

APPENDIX D

WATER QUALITY RESOURCE TABLES

Table D-1 Summary of Limnological Data from Lake Thomas A. Edison, Mammoth Pool Reservoir, Huntington Lake and Shaver Lake, Summer 1968

Chemical Characteristics of Reservoirs

Reservoir	ph	Ca^{+2} (mg/l)	Mg^{+} (mg/l)	Na^{+} (mg/l)	K^{+} (mg/l)	SO_4^{-2} (mg/l)	PO_4^{-3} (mg/l)	NO_3 (mg/l)	CL^{-} (mg/l)	TDS (mg/l)	Alkalinity
Lake Thomas A Edison	6.9	.17	0.7	2.1	0.0	2.8	.26	0.0	1.0	26.4	6.5
Mammoth Pool Reservoir	7.0	3.7	0.7	4.6	0.2	3.3	.02	1.1	6.2	44.4	12.5
Huntington Lake	6.7	1.8	0.0	0.7	0.0	3.6	.02	0.0	1.1	18.1	6.0
Shaver Lake	7.4	1.7	0.2	1.7	0.4	5.4	.14	0.0	0.6	21.9	6.5

Temperature and Dissolved Oxygen Characteristics, and Mean Secchi Disk Transparency of Reservoirs

	Mean epilim-nion Temp.	Surface D.O.	Metalimnion		Bottom			Degree of Stratifi-cation	Depth of Metalim-nion	Secchi Disc Transparency
			Temp °C	D.O °C	Temp.	D.O.	% sat.			
Lake Thomas A Edison	14.9	7.8	--	--	14.5	7.6	102.4	none	--	--
Mammoth Pool Reservoir	21.8	8.7	14.6	5.9	9.0			moderate	44.0-49.0	10.0
Huntington Lake	15.2	8.0	11.7	3.3	9.8	0.3	3.6	moderate	33.0-36.0	9.0
Shaver Lake	21.7	8.6	20.0	7.8	17.3	5.9	77.3	weak	14.0-17.0	4.2

Source: Nicola, S. J. and Cordone, A. J., A Limnological Survey of Reservoirs of the Sierra Nevada, California, September 1972. Department of Fish and Game.

Table D-2 Summary of surface water analyses at various sampling stations within Huntington Lake, Shaver Lake and Tributary Streams

(Constituents in milligrams per liter)

														As Nitrogen				As Phosphorous								
Station Location	Date Sampled	Time (PST)	Depth (meters)	Lab pH	Calcium	Magnesium	Sodium	Potassium	Alkalinity ($CaCO_3$)	Sulfate	Chlorine	Boron	Fluorine	NO_2	NO_3	NH_4	Org N	Ortho-Phosphate	Total Phosphorus	Electric Conductivity (uS/cm)	Total Dissolved Solids	Hardness	Turbidity (JTU)	Biological Oxygen Demand	VSS	SS
Huntington Lake																										
Big Creek Cove	6-05-79	0900	1	6.7	1.2	0.0	1.1	0.3	6	0.0	0.0	0.0	0.0	0.000	0.00	0.15	0.17	0.01	0.04	12	69	3	0	0.7	0.7	1.4
	8-07-79	1340	1	–	–	–	–	–	–	–	–	–	–	0.000	0.04	0.00	0.17	0.00	0.03	–	–	–	–	0.7	0.7	5.2
Home Creek Cove	6-05-79	1010	1	–	–	–	–	–	–	–	–	–	–	0.000	0.00	0.11	0.00	0.00	0.01	–	–	–	–	0.3	0.6	1.1
	8-07-79	1040	1	–	–	–	–	–	–	–	–	–	–	0.001	0.04	0.00	0.29	0.00	0.02	–	–	–	–	0.6	1.6	2.6
At Lakeshore	6-05-79	0830	1	6.8	1.2	0.0	1.3	0.3	6	0.0	0.0	0.0	0.0	0.000	0.00	0.07	0.08	0.01	0.02	12	6	3	0	0.9	1.0	1.7
	8-07-79	1130	1	6.9	1.0	0.0	1.0	0.2	5	0.0	0.5	0.0	0.0	0.001	0.04	0.00	0.30	0.02	0.02	12	9	2	0	0.7	1.6	2.9
At Main Dam (No. 1)	6-05-79	0950	1	6.9	1.2	0.0	1.1	0.3	6	0.0	0.0	0.0	0.0	0.000	0.00	0.06	0.00	0.00	0.04	13	5	3	0	0.8	0.6	0.9
	8-07-79	1015	1	6.9	1.0	0.0	1.0	0.2	5	0.5	0.5	0.0	0.0	0.001	0.04	0.00	0.23	0.00	0.02	13	8	2	0	0.6	1.3	4.6
Shaver Lake																										
At Dam	6-04-79	1030	1	7.0	1.6	0.0	1.8	0.4	8	0.0	0.0	0.0	0.0	0.000	0.02	0.11	0.11	0.00	0.04	17	9	4	0	0.7	0.7	1.8
	8-06-79	1620	1	6.9	2.0	0.0	1.4	0.3	8	0.5	0.0	0.0	0.0	0.000	0.07	0.00	0.33	0.00	0.04	17	13	5	1	0.7	3.8	6.2
Near Dorabelle	6-04-79	–	1	–	–	–	–	–	–	–	–	–	–	0.000	0.00	0.11	0.00	0.00	0.05	–	–	–	–	0.7	0.6	1.2
	8-06-79	1430	1	–	–	–	–	–	–	–	–	–	–	0.000	0.07	0.00	0.22	0.00	0.04	–	–	–	–	0.7	2.2	2.2
Near North Fork	6-04-79	1125	1	7.0	1.6	0.0	1.8	0.4	8	0.0	0.0	0.0	0.0	0.000	0.00	0.15	0.00	0.00	0.05	17	10	4	0	0.6	0.5	1.2
Stevenson Creek	8-06-79	1350	1	6.9	2.0	0.0	1.6	0.3	8	0.5	0.5	0.0	0.0	0.001	0.07	0.00	0.18	0.00	0.04	18	12	5	1	0.8	3.0	5.8
At Shaver Lake Point	6-04-79	–	1	–	–	–	–	–	–	–	–	–	–	0.000	0.00	0.07	0.11	0.00	0.04	–	–	–	–	0.6	0.6	1.3
	8-06-79	1520	1	–	–	–	–	–	–	–	–	–	–	0.001	0.09	0.00	0.33	0.01	0.04	–	–	–	–	0.7	2.6	6.2
Tributary Streams																										
Bear Creek	6-12-79	1330	Surface	–	–	–	1.2	–	–	1.4	0.0	–	–	0.000	0.00	0.00	0.19	0.00	0.01	–	10	–	–	0.3	2.6	4.2
near Lakeshore	8-08-79	0935	Surface	–	–	–	3.6	–	–	0.0	0.0	–	–	0.001	0.02	0.00	0.17	0.00	0.06	–	25	–	–	0.5	2.4	6.8
Big Creek at Golden	6-12-79	1200	Surface	–	–	–	0.8	–	–	0.0	0.0	–	–	0.000	0.00	0.00	0.30	0.00	0.02	–	19	–	–	0.5	3.0	5.2
Arrow Campground	8-08-79	0845	Surface	–	–	–	2.2	–	–	0.0	0.0	–	–	0.001	0.02	0.00	0.51	0.00	0.02	–	20	–	–	0.5	2.0	7.6
Deer Creek	6-12-79	1320	Surface	–	–	–	2.6	–	–	1.0	0.0	–	–	0.000	0.00	0.00	0.38	0.00	0.02	–	31	–	–	0.4	2.8	3.4
At Lakeshore	8-08-79	0920	Surface	–	–	–	5.0	–	–	0.5	0.0	–	–	0.001	0.11	0.00	0.24	0.00	0.35	–	34	–	–	0.5	1.8	6.7
Home Creek at	6-12-79	1400	Surface	–	–	–	1.0	–	–	2.9	0.0	–	–	0.000	0.00	0.00	0.21	0.00	0.01	–	11	–	–	0.3	3.0	6.8
Highway 168 Bridge	8-08-79	1005	Surface	–	–	–	2.6	–	–	0.0	0.5	–	–	0.001	0.00	0.00	0.21	0.00	0.02	–	25	–	–	0.6	1.4	4.2
Line Creek at	6-12-79	1345	Surface	–	–	–	0.5	–	–	0.5	0.0	–	–	0.000	0.00	0.00	0.28	0.00	0.01	–	24	–	–	0.7	3.0	7.0
Highway 168 Bridge	8-08-79	0950	Surface	–	–	–	3.0	–	–	0.0	0.0	–	–	0.001	0.00	0.00	0.18	0.00	0.02	–	14	–	–	0.5	2.6	7.4
Pitman Creek Near	6-12-79	1130	Surface	–	–	–	0.9	–	–	1.4	0.7	–	–	0.000	0.00	0.00	0.29	0.00	0.01	–	24	–	–	0.4	2.2	7.0
Tamarack Mountain	8-08-79	0820	Surface	–	–	–	3.2	–	–	0.0	0.5	–	–	0.001	0.00	0.00	0.21	0.00	0.03	–	26	–	–	0.7	2.0	7.4
Rancheria Creek at	6-12-79	1240	Surface	–	–	–	0.8	–	–	0.5	0.0	–	–	0.000	0.02	0.00	0.22	0.00	0.01	–	8	–	–	0.4	2.8	4.0
Highway 168 Bridge	8-08-79	0900	Surface	–	–	–	0.8	–	–	0.5	0.5	–	–	0.001	0.00	0.02	0.15	0.00	0.02	–	8	–	–	0.8	1.3	2.8
Stevenson Creek,	6-12-79	1025	Surface	–	–	–	0.7	–	–	1.4	0.0	–	–	0.000	0.02	0.00	0.28	0.00	0.00	–	11	–	–	0.4	2.4	4.0
North Fork (Tunnel Creek) above Shaver	8-08-79	1610	Surface	–	–	–	3.8	–	–	1.0	0.5	–	–	0.001	0.04	0.00	0.11	0.00	0.02	–	26	–	–	0.6	1.1	3.3

Source: Limnological Study of Huntington and Shaver Lakes, Department of Water Resources, 1980

Table D-3 Summary of Limnology data from Studies of Shaver Lake between 1968-1986. (Constituents in mg/l, except as noted)

										As Nitrogen																				
Station	Month	Year	Depth meter	Secchi (meters)	Temp. C	DO	pH	Alkalinity (CaCO3)	NH3 (N)	NH4 (N)	NO2 (N)	NO3 (N)	NO2+NO3 (NO2+NO3)	KJEL.N (N)	Organic N (N)	Total N (N)	Ortho-Phosphate	Total Phosphate	Chlorophyll A (ug/l)	Primary Productivity* mgC/m3	Conductivity umhos/cm	Total Dissolved Solids	Calcium	Magnesium	Sodium	Turbidity (JTU)	Biological Oxygen Demand	Fecal Coliforms MPH/100ml	Total Coliforms MPN/100ml	Source
DAM	June 4	1975	0.0	2.7	17.5	8.6	10.2	25.0	0.06	-	-	-	0.05	0.80	-	-	0.022	0.037	1.8	-	15.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1975	0.9	-	17.5	9.0	10.0	19.0	0.04	-	-	-	0.04	0.20	-	-	0.008	0.018	-	-	15.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1975	3.0	-	9.5	10.4	9.6	18.0	0.04	-	-	-	0.04	0.20	-	-	0.006	0.017	-	-	13.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1975	4.9	-	7.5	-	9.6	19.0	0.04	-	-	-	0.04	0.20	-	-	0.004	0.015	-	-	12.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1975	7.3	-	6.3	-	9.2	18.0	0.06	-	-	-	0.06	0.20	-	-	0.004	0.014	-	-	11.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1975	13.7	-	5.0	9.4	8.8	21.0	0.06	-	-	-	0.06	0.20	-	-	0.008	0.015	-	-	11.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1975	30.5	-	4.6	-	8.2	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 24	1975	0.0	-	15.7	7.8	5.9	12.0	0.03	-	-	-	0.02	0.30	-	-	0.002	0.018	1.2	-	30.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 24	1975	1.5	-	15.7	7.8	6.1	13.0	0.04	-	-	-	0.02	0.20	-	-	0.003	0.017	-	-	15.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 24	1975	6.1	-	15.5	7.8	6.0	13.0	0.03	-	-	-	0.02	0.20	-	-	0.004	0.130	-	-	15.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 24	1975	9.1	-	11.6	9.6	5.7	10.0	0.04	-	-	-	0.02	0.20	-	-	0.002	0.130	-	-	17.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 24	1975	18.3	-	8.8	9.2	6.2	11.0	0.03	-	-	-	0.02	0.20	-	-	0.002	0.120	-	-	23.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 24	1975	26.2	-	7.9	8.2	6.2	10.0	0.03	-	-	-	0.02	0.30	-	-	0.010	0.222	-	-	27.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	Nov. 13	1975	0.0	4.7	14.4	7.6	6.9	26.0	0.02	-	-	-	0.02	0.20	-	-	0.200	0.009	2.0	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	Nov. 13	1975	1.5	-	13.5	7.6	6.9	22.0	0.02	-	-	-	0.02	0.20	-	-	0.200	0.010	-	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	Nov. 13	1975	4.6	-	13.5	7.6	6.9	24.0	0.02	-	-	-	0.02	0.20	-	-	0.200	0.010	-	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	Nov. 13	1975	9.8	-	13.5	7.6	6.9	10.0	0.02	-	-	-	0.02	0.20	-	-	0.200	0.010	-	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	Nov. 13	1975	19.8	-	13.5	7.8	7.0	10.0	0.02	-	-	-	0.02	0.20	-	-	0.002	0.011	-	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)
DAM	June 4	1979	1.0	-	-	-	7.0	8.0	-	0.11	0.000	0.02	-	-	0.11	-	0.000	0.040	-	-	17.0	9.0	1.6	0.00	1.8	0.0	0.7	-	-	CDWR (1980)
DAM	Aug. 6	1979	1.0	-	-	-	6.9	8.0	-	0.00	0.000	0.07	-	-	0.33	-	0.000	0.040	-	-	17.0	13.0	2.0	0.00	1.4	1.0	0.7	-	-	CDWR (1980)
DAM	August	1985	0.0	-	21.7	7.8	7.0	8.6	<0.01	-	-	0.03	-	0.10	-	0.13	0.020	0.050	0.8	-	21.9	14.0	1.8	0.21	1.8	2.0	<0.5	<2	<2	EA (1986)
DAM	August	1985	Bottom	-	10.1	1.5	6.0	8.6	0.03	-	-	0.07	-	0.11	-	0.18	<0.01	0.070	0.7	-	25.5	19.0	2.1	0.30	1.6	0.8	<0.5	<2	5	EA (1986)
DAM	Oct	1985	0.0	-	13.0	8.1	6.7	10.0	0.01	-	-	0.03	-	0.27	-	0.30	<.010	0.030	3.8	-	24.0	17.0	2.2	0.30	2.0	1.8	<.5	<2	<2	EA (1986)
DAM	Oct	1985	Bottom	-	13.0	2.2	6.1	11.0	0.01	-	-	<.01	-	0.14	-	0.15	<.010	0.050	3.9	-	31.0	19.0	2.1	0.30	2.1	2.5	0.8	<2	2	EA (1986)
DAM	July	1986	0.0	-	20.5	7.8	7.0	5.3	0.01	-	-	0.02	-	0.10	-	0.12	0.010	0.010	0.8	-	18.0	17.0	1.6	0.60	1.3	0.8	<1.0	<2	11	EA (1986
DAM	July	1986	Bottom	-	12.0	8.2	6.8	5.6	0.01	-	-	0.05	-	0.13	-	0.18	<0.010	<0.010	0.6	-	19.0	17.0	1.8	0.60	1.3	0.4	<1.0	2	27	EA (1986)
Dorabelle	June 4	1979	1.0	-	-	-	-	-	-	0.11	0.000	0.00	-	-	0.00	-	0.000	0.050	-	-	-	-	-	-	-	-	0.7	-	-	CDWR (1980)
Dorabelle	Aug. 6	1979	1.0	-	-	-	-	-	-	0.00	-	0.07	-	-	0.22	-	0.000	0.040	-	-	-	-	-	-	-	-	0.7	-	-	CDWR (1980)
N. Fork Stevenson Cr.	June 4	1979	1.0	-	-	-	7.0	8.0	-	0.15	0.000	0.00	-	-	0.00	-	0.000	0.050	-	-	17.0	10.0	1.6	0.00	1.8	0.0	0.6	-	-	CDWR (1980)
	Aug. 6	1979	1.0	-	-	-	6.9	8.0	-	0.00	0.001	0.07	-	-	0.18	-	0.000	0.040	-	-	18.0	12.0	2.0	0.00	1.6	1.0	0.8	-	-	CDWR (1980)
Shaver Point	June 4	1979	1.0	-	-	-	-	-	-	0.07	0.000	0.00	-	-	0.11	-	0.000	0.040	-	-	-	-	-	-	-	-	0.6	-	-	CDWR (1980)
Shaver Point	Aug 6	1979	1.0	-	-	-	-	-	-	0.00	0.001	0.09	-	-	0.33	-	0.010	0.040	-	-	-	-	-	-	-	-	0.7	-	-	CDWR (1980)
Mid-Lake	7-1,9-30	1968	0.0	4.2	-	8.6	7.4	6.5	-	-	-	0.00	-	-	-	-	0.140	-		22.7*	-	21.9	1.7	0.20	1.7	-	-	-	-	Nicolo & Cordone (1972)
Mid-Lake	7-1,9-30	1968	mid epil	-	19.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Nicolo & Cordone (1972)

Table D-3 (continued) Summary of Limnology data from Studies of Shaver Lake between 1968-1986. (Constituents in mg/l, except as noted)

Station	Month	Year	Depth meter	Secchi (meters)	Temp. C	Dissolved Oxygen	pH	Alkalinity (CaCO3)	NH3 (N)	NH4 (N)	NO2 (N)	NO3 (N)	NO2+NO3 (NO2+NO3)	KJEL.N (N)	Organic N (N)	Total N (N)	OrthoPhos-phate	Total Phosphate	Chlorophyll A (ug/l)	Primary Productivity* mgC/m3	Conductivity umhos/cm	Total Dissolved Solids	Calicum	Magnesium	Sodium	Turbidity (JTU)	Biological Oxygen Demand	Fecal Cliforms MPH/100ml	Total Coliforms MPN/100ml	Source
Mid-Lake	7-1,9-30	1968	14.0-17.0	-	20.0	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Nicolo & Cordone (1972)
Mid-Lake	7-1,9-30	1968	bottom	-	17.3	5.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Nicolo & Cordone (1972)
Mid-Lake	June 4	1975	0.0	3.8	18.5	8.8	10.9	23.0	0.05	-	-	-	0.05	0.60	-	-	0.010	0.041	1.4	-	16.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 4	1975	0.9	-	18.5	9.0	9.6	21.0	0.05	-	-	-	0.05	0.20	-	-	0.006	0.015	-	-	16.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 4	1975	3.0	-	9.5	9.8	9.6	21.0	0.04	-	-	-	0.21	0.20	-	-	0.004	0.019	-	-	11.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 4	1975	4.9	-	8.0	10.0	9.2	10.0	0.04	-	-	-	0.04	0.20	-	-	0.003	0.013	-	-	12.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 4	1975	7.3	-	6.5	10.0	9.2	10.0	0.02	-	-	-	0.03	0.20	-	-	0.003	0.013	-	-	10.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 4	1975	12.2	-	5.4	9.6	9.4	10.0	0.04	-	-	-	0.06	0.20	-	-	0.004	0.019	-	-	10.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 4	1975	16.5	-	5.0	9.8	9.3	-	0.04	-	-	-	0.06	0.20	-	-	0.004	0.012	-	-	11.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 24	1975	0.0	3.0	14.7	8.4	8.2	-	-	-	-	-	-	-	-	-	-	-	1.5	-	64.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 24	1975	1.5	-	14.7	8.4	8.1	13.0	0.03	-	-	-	0.02	0.40	-	-	0.010	0.022	-	-	45.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 24	1975	6.1	-	14.3	9.0	7.5	12.3	0.07	-	-	-	0.02	0.40	-	-	0.005	0.014	-	-	14.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 24	1975	9.1	-	11.5	9.0	6.8	12.0	0.03	-	-	-	0.02	0.50	-	-	0.004	0.012	-	-	20.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 24	1975	18.3	-	9.5	9.0	6.9	10.0	0.02	-	-	-	0.02	0.40	-	-	0.003	0.012	-	-	29.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	June 24	1975	29.0	-	7.5	8.4	6.7	11.0	0.04	-	-	-	0.02	0.50	-	-	0.003	0.182	-	-	30.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	Nov. 13	1975	0.0	5.2	13.5	8.0	7.0	10.0	0.02	-	-	-	0.02	0.20	-	-	0.002	0.009	2.3	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	Nov. 13	1975	1.5	-	13.4	8.0	7.0	11.0	0.02	-	-	-	0.02	0.20	-	-	0.002	0.010	-	-	38.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	Nov. 13	1975	4.6	-	13.4	8.2	6.9	20.0	0.02	-	-	-	0.05	0.20	-	-	0.018	0.015	-	-	39.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	Nov. 13	1975	10.7	-	13.5	8.2	6.9	17.0	0.02	-	-	-	0.05	0.20	-	-	0.005	0.012	-	-	39.0	-	-	-	-	-	-	-	-	EPA (1978)
Mid-Lake	Nov. 13	1975	23.2	-	13.3	7.8	6.8	14.0	0.02	-	-	-	0.02	0.20	-	-	0.003	0.018	-	-	37.0	-	-	-	-	-	-	-	-	EPA (1978)

Source: Draft Technical Report on Shaver Lake Fisheries Studies conducted in support of the Big Creek Expansion Project, BioSystems Analysis, Inc. 1987

Table D-4 Water quality data for aquatic stations* in Shaver Lake and Tributary Creeks

Month/Parameter	Tamarack T-1	T-2	Pitman P-1	P-2	North Fork Stevenson Creek S-1	S-2	Balsam B-1	B-3	Shaver Lake SL-1	SL-5
October 1978										
Temperature	3.9°C	2.8 °C	4.2 °C	1.1 °C	9.0 °C	1.1 °C	11.0 °C	–	16.2 °C	–
Dissolved oxygen	–	–	–	–	–	–	–	–	–	–
Conductivity	0.1	0.1	0.1	0	0.15	0.1	0.2	–	0.1	–
pH	8.2	7.8	8.5	9.0	7.8	7.4	7.4	–	7.1	–
February 1979										
Temperature	1.3°C	–	–	1.4 °C	2.3 °C	–	0°C	–	–	–
Dissolved oxygen	8.5	–	–	8.5	9.2	–	8.2	–	–	–
Conductivity	12	–	–	15	14	–	28	–	–	–
pH	–	–	–	–	–	–	–	–	–	–
May-June 1979										
Temperature	10.0°C	10.2°C	4.0°C	5.9°C	11.0°C	3.6°C	9.4°C	14°C	17.0°C	17.°C
Dissolved oxygen	11.2	11.6	7.9	8.6	8.6	7.1	7.2	8.1	9.2	10.2
Conductivity	7.3	14.0	9.7	7.0	12.0	10.0	29.0	23	16	12.0
pH	8.6	8.0	8.2	9.2	7.9	7.9	7.9	8.5	8.3	7.6
August 1979										
Temperature	16°C	20°C	23.5°C	22.5°C	21°C	18°C	22°C	14°C	26°C	23°C
Dissolved oxygen	7.2	6.4	6.6	6.2	7.0	7.2	6.8	8.3	6.2	6.6
Conductivity	24	52	–	39	47	44	36	52	–	49
pH	7.3	8.4	6.4	8.3	7.8	8.3	8.0	8.3	8.4	8.2

*Station Locations:

T-1 Tamarack Creek
T-2 South Fork Tamarack Creek
P-1 Downstream of Tunnel Diversion
P-2 Upstream of Tunnel Diversion
S-1 Downstream of Tunnel Discharge
S-2 Upstream of Tunnel Discharge
B-1 West Fork Balsam Creek
B-3 Balsam Creek below confluence of West Fork
SL-1 Near Balsam Meadow site
SL-5 North Central near East Shore

Source: Balsam Meadow Development of Big Creek Project No. 67, Final Environmental Impact Statement, September 1982

Table D-5 Iron concentrations found in Mono Creek and control creek

			Analyses (mg/1)						
			MARCH 1984 (80 cfs)			SEPTEMBER 1984 (35 cfs)			
Location	Site Number	Replicate Sample	Ferrous	Ferric*	Total Iron	Ferrous	Ferric*	Total Iron	pH
Bear Creek (control)	5	a	.025	.06	.09	.026	.012	.038	7.65
		b	.015	.04	.06	.038	.007	.045	
	6	a	.010	.05	.06				
		b	.015	.04	.05				
Upper Mono Creek (control)	7	a	.005	.06	.06	.038	.007	.045	7.39
		b	.010	.06	.07	.033	.017	.050	
	8	a	.015	.04	.06				
		b	.015	.04	.05				
Outlet channel	9	a	0.15	.08	.09	.038	.030	.068	7.55
		b	.015	.08	.09	.037	.022	.059	
Toe drain	10	a	1.600	2.00	3.60	3.40	.30	3.70	7.01
		b	1.600	1.80	3.40	3.35	.25	3.60	
Mono Creek below confluence with toe drain	4	a	.015	.18	.20	.62	.13	.75	7.13
		b	.025	.17	.20	.62	.13	.75	
	11	a	.035	.16	.19	.29	.25	.54	7.20
		b	.040	.16	.20	.30	.22	.52	
	3	a	.025	.24	.27	.073	.15	.22	7.55
		b	.025	.18	.20	.078	.15	.23	
	1	a	.025	.16	.19	.15	.07	.22	7.47
		b	.035	.16	.20	.16	.07	.23	
Unnamed creek with iron	2	a	.065	.26	.33	.091	>009	.10	7.64
		b	.590	1.30	1.90	.090	.020	.11	

* Ferric concentration was calculated by subtracting ferrous from total iron concentration

Source: An Analysis of Iron Accumulation in Vermilion Valley Dam Drain Waters and Effects on Benthic Invertebrates and Fisheries of the Mono Creek Drainage. BioSystems 1986

Table D-6 Summary of Water Quality Analyses Lake Thomas A. Edison and Mono Creek, Summer 1984

	Date Sample	Mono Creek (below dam) (mg/l)	Mono Creek Forebay (mg/l)	Mono Creek (below Diversion dam) (mg/l)	Edison Lake 0.5m (mg/l)	Edison Lake 40.0m (mg/l)
Calcium	7/2/82	1.3	1.8	1.6	1.3	1.3
	8/24/92	1.2	1.3	1.3	1.3	1.2
	11/4/87	1.5	1.5	1.5	1.3	1.4
Magnesium	7/2/87	0.18	0.7	0.25	0.19	0.19
	8/24/82	0.15	0.17	0.18	0.19	0.15
	11/4/87	0.19	0.24	0.18	0.13	0.23
Sodium	7/2/87	1.4	1.6	1.5	1.6	1.6
	8/24/82	0.6	0.5	0.6	2.3	0.6
	11/4/87	1.3	2.6	2.0	1.3	2.2
Total Dissolved Solid	7/2/87	22	23	22	20	19
	8/24/82	14	17	21	25	20
	11/4/87	13	18	17	10	16
Nitrate Nitrogen	7/2/87	<0.01	<0.01	<0.01	<0.01	<0.01
	8/24/82	<0.01	<0.01	0.04	<0.01	<0.01
	11/4/87	0.03	2.0	0.04	0.05	0.05
Ortho-Phosphate	7/2/87	<0.03	<0.03	<0.03	<0.03	<0.03
	8/24/82	<0.03	<0.03	0.03	0.09	<0.03
	11/4/87	<0.03	0.04	1.7	<0.03	<0.03
Chlorophyll	7/2/87	--	--	--	<0.001	--
	8/24/82	--	--	--	–	0.002
	11/4/87	--	--	--	0.004 composite	0.004 composite

Source: EA Engineering, Science, and Technology, Inc., October 1984

Table D-7 Physical-Chemical Data of Water Samples Collected in the Dam 6 Pool an the San Joaquin River for Big Creek No. 3 Project (1985-1986)

		Above Dam 6		San Joaquin River		
Parameter	**Date**	**Top**	**Bottom**	**Below Dam 6**	**Above Powerhouse 3**	**pH 3 Afterbay**
Calcium	8/85	2.1	1.7	1.9	2.9	1.6
	10/85	3.7	--	3.1	3.7	2.9
	7/86	1.3	1.4	1.5	2.2	1.3
Magnesium	4/85	0.32	0.22	0.24	0.43	0.19
	10/85	0.80	--	0.70	0.50	0.50
	7/86	0.20	0.20	0.20	0.30	0.20
Potassium	8/85	0.37	0.38	0.28	0.74	0.22
	10/85	0.70	--	0.50	0.90	0.60
	7/86	0.30	0.40	0.20	0.60	0.20
Sodium	8/85	2.0	1.4	1.4	3.2	1.3
	10/85	5.8	--	3.3	3.8	3.4
	7/86	1.0	1.0	0.90	1.9	1.0
Total	8/85	19	25	10	29	14
Dissolved	10/85	35	--	24	29	19
Solid	7/86	26	24	15	23	13
Total	8/85	1.0	1.0	1.0	1.1	<0.50
Suspended	10/85	0.50	--	<0.50	<0.50	0.50
Solid	7/86	<0.50	2.4	<0.50	0.80	2.0
Turbidity	8/85	1.0	1.2	1.5	0.30	1.6
(NTU)	10/85	0.65	--	1.1	0.45	1.2
	7/86	1.5	2.5	0.90	0.50	1.0
Alkalinity	8/85	7.0	4.0	--	9.7	11
(as $CaCO_3$)	10/85	17	--	10	15	11
	7/86	4.6	4.7	5.2	7.8	4.8
Hardness	8/85	6.6	5.1	5.7	9.0	4.8
	10/85	12	--	11	11	9.3
	7/86	4.1	4.3	4.6	6.7	4.1
Bicarbonate	8/85	9.0	5.0	7.0	12	13
	10/85	21	--	12	19	14
	7/86	5.6	5.7	6.3	9.5	5.9
Biological	8/85	0.60	0.8	<0.50	<0.50	<0.50
Oxygen	10/85	<0.50	--	<0.50	0.60	<0.50
Demand	7/86	<1.0	<1.0	<1.0	<1.0	<1.0

Table D-7 (continued) Physical-Chemical Data of Water Samples Collected in the Dam 6 Pool and the San Joaquin River for Big Creek No. 3 Project (1985-1986)

		Above Dam 6		San Joaquin River		
Parameter	**Date**	**Top**	**Bottom**	**Below Dam 6**	**Above Powerhouse 3**	**pH 3 Afterbay**
Total	8/85	0.07	0.09	0.10	0.10	0.11
Kjeldahl	10/85	0.19	--	0.82	0.12	0.15
Nitrogen	7/86	0.05	0.08	0.06	0.12	0.06
Total	4/85	0.12	0.17	0.18	0.14	0.17
Nitrogen	10/85	0.24	--	0.85	0.13	0.16
	7/86	0.05	0.09	0.06	0.16	0.08
NH_3 as N	8/85	<0.01	0.01	0.02	<0.01	<0.01
	10/85	0.01	--	0.03	<0.01	0.02
	7/86	0.01	0.01	0.02	0.02	0.01
NO_3 as N	8/85	0.04	0.08	0.08	0.04	0.06
	10/85	0.05	--	0.03	<0.01	0.01
	7/86	<0.01	0.01	<0.01	0.01	0.02
Total	8/85	0.11	0.08	0.13	<0.05	0.05
Phosphorus	10/85	0.20	--	0.10	0.02	0.01
	7/86	<0.01	<0.01	<0.01	<0.01	<0.01
Ortho-	8/85	0.01	0.02	0.07	0.05	<0.01
Phosphorus	10/85	<0.01	--	<0.01	0.02	<0.01
(PO_4)	7/86	<0.01	0.02	0.02	0.02	0.02
$SO4^{--}$	8/85	<1.0	5.0	2.0	2.0	<1.0
	10/85	1.8	--	0.70	1.0	1.0
	7/86	0.80	0.70	0.60	0.80	0.80
Chlorine	8/85	2.3	1.6	<0.30	3.3	0.7
	10/85	7.3	--	6.1	4.6	4.0
	7/86	0.40	0.45	0.45	1.2	0.15
Chla	8/85	1.2	2.3	1.9	0.50	1.5
(ug/l)	10/85	0.70	--	1.0	0.50	1.0
	7/86	<0.50	<0.50	<0.50	<0.50	<0.50
Total	8/85	2	79	21	8	23
Coliforms	10/85	<2	--	<4	2	<2
(MPN/100ml)	7/86	8	33	33	11	49
Fecal	8/85	<2	<2	<2	8	<2
Coliform	10/85	<2	--	<2	<2	<2
(MPN/100ml)	7/86	<2	2	<2	<2	5

Table D-7 (continued) Physical-Chemical Data of Water Samples Collected in the Dam 6 Pool and the San Joaquin River for Big Creek No. 3 Project (1985-1986)

		Above Dam 6		San Joaquin River		
Parameter	**Date**	**Top**	**Bottom**	**Below Dam 6**	**Above Powerhouse 3**	**pH 3 Afterbay**
Dissolved Oxygen	8/85	7.9	8.7	9.1	9.4	10
	10/85	7.9	8.4	8.7	9.2	8.9
	7/86	9.4	9.8	9.2	8.6	9.8
Conductivity (umho)	8/85	24	20	21	38	19
	10/85	56	--	36	43	36
	7/86	14	14	14	24	16
PH	8/85	6.6	6.8	7.0	7.4	6.9
	10/85	6.9	7.0	7.1	7.1	7.0
	7/86	6.8	6.8	7.0	7.2	6.9
Temperature (C)	8/85	17.6	15.0	17.2	24.9	15.4
	10/85	13.5	12.9	13.0	14.0	13.0
	7/86	13.3	14.4	14.5	20.5	13.5

A. Except as noted; in mg/l.

Source: Draft, Report on Water Use and Water Quality for Big Creek Powerhouse No. 3, EA Engineering, Science, and Technology, Inc., August 1987.

Table D-8 Physical and Chemical Data of Water Samples Collected in the Big Creek No. 4 Project Waters (1985 and 1986)

Parameter	Sample Date	Redinger Lake Top	Redinger Lake Bottom	San Joaquin River Below Dam 7	San Joaquin River Above Power-house 4	Below Power-house 4
Calcium	8/1/85	1.9	2.4	1.8	2.2	1.8
	10/1/85	2.7	2.5	2.6	3.4	2.8
	7/1/86	1.3	1.6	1.3	2.2	1.3
Magnesium	8/1/85	0.25	0.41	0.22	0.28	0.23
	10/1/85	0.50	0.50	0.50	0.50	0.40
	7/1/86	0.20	0.60	0.20	0.40	0.20
Potassium	8/1/85	0.40	0.46	0.35	0.41	0.37
	10/1/85	0.40	0.50	0.40	0.70	0.50
	7/1/86	0.20	0.20	0.20	0.50	0.40
Sodium	8/1/85	1.70	2.40	1.50	2.20	1.50
	10/1/85	2.90	2.20	2.60	3.70	2.70
	7/1/86	0.09	0.90	0.80	2.20	1.40
Total	8/1/85	14	24	16	21	17
Dissolved	10/1/85	18.0	22.0	22.0	28.0	20
Solids	7/1/86	10.0	12.0	10.0	39.0	48
Total	8/1/85	<0.50	1.10	1.70	1.00	2.70
Suspended	10/1/85	<0.50	<0.50	0.50	0.80	2.50
Solids	7/1/86	3.20	2.00	0.50	<0.50	1.20
Turbidity	8/1/85	1.10	2.50	1.00	0.30	1.20
(NTU)	10/1/85	0.45	0.75	0.70	0.20	0.65
	7/1/86	0.80	1.00	1.20	0.30	1.40
Alkalinity	8/1/85	5.4	13	5	8	6.5
(as $CaCO_3$)	10/1/85	10	10	9	15	10
	7/1/86	4.9	6.1	4.8	8.8	4.9
Hardness	8/1/85	5.8	7.7	5.4	6.6	5.4
	10/1/85	8.8	8.3	8.5	10	8.6
	7/1/86	4.1	4.8	4	7.1	4.1
Total	8/1/85	0.18	0.11	0.1	0.05	0.07
Kjeldahl	10/1/85	0.14	0.15	0.1	0.16	0.16
Nitrogen	7/1/86	0.06	0.12	0.05	0.07	0.09
Total	8/1/85	0.27	0.26	0.15	0.15	0.12
Nitrogen	10/1/85	0.15	0.27	0.13	0.19	0.2
	7/1/86	0.07	0.12	0.06	0.07	0.11

Table D-8 (continued) Physical and Chemical Data of Water Samples Collected in the Big Creek No. 4 Project Waters (1985 and 1986)

Parameter	Sample Date	Top	Bottom	Below Dam 7	Above Power-house 4	Below Power-house 4
NH_3	8/1/85	<0.01	0.03	0.01	0.01	<0.01
(as N)	10/1/85	<0.01	<0.01	0.01	0.01	<0.01
	7/1/86	0.01	0.01	0.01	<0.01	0.01
NO_3	8/1/85	0.09	0.15	0.05	0.1	0.05
(as N)	10/1/85	0.01	0.12	0.03	0.03	0.04
	7/1/86	0.01	<0.01	0.01	<0.01	0.02
Total	8/1/85	0.08	0.08	0.09	0.06	<0.05
Phosphorus	10/1/85	0.02	<0.01	0.2	0.09	0.02
	7/1/86	<0.01	<0.01	<0.01	0.05	<0.01
Orthophos-	8/1/85	<0.01	0.02	0.01	0.04	<0.01
Phate	10/1/85	0.02	<0.01	0.04	0.02	0.01
(PO_4)	7/1/86	0.02	<0.01	0.01	<0.01	0.01
SO_4^{-2}	8/1/85	4.00	<1	1.00	<1	1.60
	10/1/85	1.20	0.10	1.40	1.20	0.60
	7/1/86	0.60	0.70	0.70	0.60	0.70
Chlorine	8/1/85	1.70	2.60	1.00	0.40	2.00
	10/1/85	3.10	1.20	3.20	4.30	3.70
	7/1/86	0.50	0.55	0.55	1.80	0.45
Chla	8/1/85	1.30	0.30	1.60	0.90	1.70
(ug/L)	10/1/85	1.10	0.30	0.80	0.30	1.60
	7/1/86	2.00	<0.5	<0.5	<0.5	<0.5
Total	8/1/85	2	2	<2	7	5
Coliforms	10/1/85	<2	<2	4	49	23
(MPN/100 ml)	7/1/86	2	2	23	49	23
Fecal	8/1/85	<2	<2	<2	2	5
Coliforms	10/1/85	<2	<2	2	<2	<2
(MPN/100 ml)	7/1/86	<2	<2	2	<2	<2
Biological	8/1/85	<0.5	<0.5	<0.5	<0.5	<0.5
Oxygen	10/1/85	<0.6	<0.5	<0.5	<0.5	<0.5
Demand (mg/l)	7/1/86	<1	<1	<1	<1	<1
Dissolved	8/1/85	9.9	8.4	9.1	9.8	9.6
Oxygen	10/1/85	-	4.4	10.0	10.6	9.5
(mg/l)	7/1/86	9.6	8.6	10.0	9.0	10
Conductivity	8/1/85	20	29	22	27	20

Table D-8 (continued) Physical and Chemical Data of Water Samples Collected in the Big Creek No. 4 Project Waters (1985 and 1986)

Parameter	Sample Date	Top	Bottom	Below Dam 7	Above Power-house 4	Below Power-house 4
(umho)	10/1/85	32	29	30	41	31
	7/1/86	15	17	14	26	14
PH	8/1/85	7	7	7	7	7
(^{o}C)	10/1/85	7	6	7	7	7
	7/1/86	7	6	7	7	7
Temperature	8/1/85	25	9	15	21	17
(C)	10/1/85	15.0	9.5	14.0	14.5	14
	7/1/86	17.5	12.5	13.0	19.5	15

Source: Draft, Report on Water Use and Quality for Big Creek Powerhouse No. 4, EA Engineering. Science, and Technology, Inc., August 1987.

Table D-9 Laboratory Analytical Results of Water Samples Collected from Big Creek No. 4 Project Waters (1994/1995)

Station Location	Date Sampled	BC4-1A 200 ft Upstream of Dam 7 (surface)	BC4-1B 200 ft Upstream of Dam 7 (131 ft)	BC4-2 300 ft Downstream of Dam 7	BC4-3 500 ft Upstream of Powerhouse No. 4	BC4-3Dup	BC4-4 500 ft Downstream of Power House No. 4
Total Dissolved Solids @180C	9/1/94	20	15	23	27		24
	5/24/95	18	32	48	36	40	36
Total Suspended Solids	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	1.7	2.3	N/D	N/D	N/D	N/D
Hardness as CaCO3	9/1/94	9.3	10	8.2	9.8		8.6
	5/24/95	7.9	8.2	7.6	7.6	7.8	7.8
Turbidity	9/1/94	0.36	0.24	0.35	0.22		0.38
	5/24/95	1.7	2.1	2.7	2.1	1.9	2.2
Calcium	9/1/94	2.9	3.1	2.6	3.1		2.7
	5/24/95	2.3	2.4	2.2	2.2	2.3	2.3
Magnesium	9/1/94	0.5	0.56	0.41	0.49		0.44
	5/24/95	0.53	0.54	0.5	0.52	0.51	0.51
Sodium	9/1/94	3.5	3.6	2.8	3.9		3
	5/24/95	2.5	2.4	2.3	2.3	2.3	2.3
Potassium	9/1/94	0.6	0.6	0.5	0.6		0.6
	5/24/95	0.8	0.7	0.7	0.7	0.7	0.7
Hydroxide	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Carbonate	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Bicarbonate	9/1/94	16.5	16.5	13.9	15.7		13.9
	5/24/95	14.8	16.5	15.7	16.5	15.7	14.8
Chloride	9/1/94	2	2	N/D	3.2		1.8
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Fluoride	9/1/94	0.06	0.06	0.06	0.06.		0.05
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Sulfate	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D

Table D-9 (continued) Laboratory Analytical Results of Water Samples Collected from Big Creek No. 4 Project Waters (1994/1995)

Station Location	Date Sampled	BC4-1A 200 ft Upstream of Dam 7 (surface)	BC4-1B 200 ft Upstream of Dam 7 (131 ft)	BC4-2 300 ft Downstream of Dam 7	BC4-3 500 ft Upstream of Powerhouse No. 4	BC4-3Dup	BC4-4 500 ft Downstream of Power House No. 4
Ortho-phosphate	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	0.36	N/D	N/D	N/D	N/D	N/D
Total Kjeldahl Nitrogen	9/1/94	0.2	0.2	N/D	N/D		N/D
	5/24/95	0.2	0.2	0.2	0.4	0.2	0.2
Nitrate/Nitrite as NO3	9/1/94	N/D	N/D	N/D	N/D	N/D	N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Ammonia as NH3	9/1/94	N/D	N/D	N/D	0.1	N/D	N/D
	5/24/95	N/D	N/D	N/D	0.1	N/D	N/D
Biochemical Oxygen Demand	9/1/94	1.5	0.9	1.5	1.2		0.6
	5/24/95	N/D	4.8	---	---	---	---
Chlorophyll – a	9/1/94	N/D	N/D	N/D	N/D	N/D	N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Total Coliform	9/1/94	900	50	1600	170		350
	5/24/95	30	17	170	280	130	170
Fecal Coliform	9/1/94	< 2	< 2	4	14		2
	5/24/95	< 2	< 2	< 2	4	13	7
Arsenic – Dissolved	9/1/94	2.8	N/D	3	3.2		3.2
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Arsenic – Total	9/1/94	3	2.4	3.6	3.4		4.2
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Copper – Dissolved	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Copper – Total	9/1/94	N/D	22	11	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Iron – Dissolved	9/1/94	N/D	N/D	N/D	N/D	N/D	N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Iron – Total	9/1/94	56	51	130	55		82
	5/24/95	110	1170	106	125	130	134

Table D-9 (continued) Laboratory Analytical Results of Water Samples Collected from Big Creek No. 4 Project Waters (1994/1995)

Station Location	Date Sampled	BC4-1A 200 ft Upstream of Dam 7 (surface)	BC4-1B 200 ft Upstream of Dam 7 (131 ft)	BC4-2 300 ft Downstream of Dam 7	BC4-3 500 ft Upstream of Powerhouse No. 4	BC4-3Dup	BC4-4 500 ft Downstream of Power House No. 4
Lead – Dissolved	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Lead – Total	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Manganese – Dissolved	9/1/94	N/D	16	N/D	N/D		N/D
	5/24/95	N/D	16	N/D	N/D	N/D	N/D
Manganese – Total	9/1/94	10	17	12	N/D		N/D
	5/24/95	N/D	51	N/D	N/D	N/D	N/D
Mercury – Dissolved	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	1	N/D	N/D	N/D	N/D
Mercury – Total	9/1/94	N/D	0.8	N/D	N/D		N/D
	5/24/95	N/D	0.8	N/D	N/D	N/D	N/D
Molybdenum - Dissolved	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Molybdenum - Total	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Zinc - Dissolved	9/1/94	N/D	N/D	N/D	N/D	N/D	N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D
Zinc - Total	9/1/94	N/D	N/D	N/D	N/D		N/D
	5/24/95	N/D	N/D	N/D	N/D	N/D	N/D

See notes on following page.
--- Not analyzed.
NA Not available.
? Dependent on temperature and pH.
* Secondary MCL (Title 22 of CCR, Section 64449).
** MCL-Inorganic Chemicals (Title 22 of CCR, Section 64431).
*** In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml nor shall more than 10 percent of the total number of the total samples taken during any 30-day period exceed 400/100m
Source: Big Creek No. 4 Water Power Project, Application for New License for Major Project Existing Dam. SCE, 1997

Table D-9 (continued) Laboratory Analytical Results of Water Samples Collected from Big Creek No. 4 Project Waters (1994/1995)

Physical and Chemical Data of Water Samples Collected from Big Creek No. 4 Project Waters (1994-1995)

Station Location	Date Sampled	BC4-1A 200ft Upstream of Dam 7 (surface)	BC4-2 300 ft Downstream of Dam 7	BC4-3 500 ft Upstream of Power-house No. 4	BC4-4 500 ft downstream of Power-house No. 4
Air Temperature (C)	9/1/94	34.5	25.5	30.5	30.9
	5/24/95	**			
	5/25/95		**	19.0	22.0
Water Temperature (C)	9/1/94	23.0	17.8	21.8	19.4
	5/24/95	10.2			
	5/25/95		9.5	9.9	9.6
pH	9/1/94	7.20	6.68	7.06	6.76
	5/24/95	6.67			
	5/25/95		6.93	7.22	7.2
Conductivity (uS/cm)	9/1/94	**	30.2	41.0	32.9
	5/24/95	29.1			
	5/25/95		28.5	26.2	29.3
Total Dissolved Solids (mg/L)	9/1/94	**	14.9	20.4	16.5
	5/24/95	14.4			
	5/25/95		14.3	13.3	15.2
Dissolved Oxygen (mg/L)	9/1/94	8.2	8.7	8.9	8.9
	5/24/95	10.3			
	5/25/95		10.9	11.4	11.3

NOTES:
** Data not collected.
(1)Central Valley Regional Water Quality Control Board Basin Plan, December 9, 1994.
(2)Receiving water temperature shall not be altered unless it can be demonstrated that such alteration does not adversely affect beneficial uses. At no time or place shall the temperature of cold or warm intrastate waters be increased more than 5 degrees F above natural receiving water temperature.

Source: SCE, Big Creek No. 4 Water Power Project, application for New License for Major Project Existing Dam, February 1997

APPENDIX E

WATER USE

TABLES AND FIGURES

Table E-1
Big Creek System
Water Rights Licenses and Permits

Application Number	Permit Number	License Number
1341	-	1617
1342	-	1618
1343	-	1619
1344	-	1620
1345	-	1621
1346	-	1622
2522	-	2539
11352	-	3633
11115	-	5730
16102	-	5732
10338	-	6001
13928	-	6002
13929	-	8739
24701	16866	-
26533	19261	-
26534	20672	-
26534	20672	-
26534	20672	-
26534	20672	-
26535	20673	-
26535	20673	-
26535	20673	-
26546	20674	-
26542	20675	-
26543	20676	-
26544	20678	-
26547	20683	-
26545	20695	-
26832	20704	-
26832	20704	-
26832	20704	-
26536A	20744	-
26536A	20744	-
26536A	20744	-
26536B	20745	-

Table E-2 Big Creek System/Mammoth Pool Operating Agreement

Mammoth Pool Operating Contract September 30 Storage Constraints & Minimum Flow Constraints

Computed Natural Runoff @ Friant Dam (acre-feet)	***10/1 Beginning Storage*** (acre-feet)	***9/30 Maximum Allowable Year-Ending Storage*** (acre-feet)	***Minimum Allowable Flow Past Dam 7*** (cubic feet per second)
A-J = April to July FWY = Full Water Year			---
A-J ≤ 650,000	*(1st year)*	≤ 152,500	---
A-J ≤ 650,000	*(2nd sequential year)*	Not to exceed beginning storage	---
A-J > 650,000 FWY ≤ 1,200,000	≥ 202,500 & < 325,000	Equal as nearly as possible to beginning storage	---
A-J > 650,000 FWY ≤ 1,200,000	≥ 325,000	Not more than beginning storage and not less than 325,000	---
A-J > 650,000 FWY ≤ 1,200,000	< 202,500	Not more than beginning storage (plus amount computed A-J runoff at Friant exceeds 750,000) but not to exceed 202,500	---
FWY > 1,200,000 ≤ 1,600,000	≥ 202,500	Not less than beginning storage plus amount of FWY computed runoff at Friant less 1,200,000	≥ 615,000 Jun 1 – Sept 30 ≥ 450,000 Jul 1 – Sept 30 *(shall be reduced if necessary to meet storage criteria)*
FWY > 1,200,000 ≤ 1,600,000	< 202,500	Not less than 202,500 but may exceed beginning storage by up to 50,000 but total cannot exceed 325,000	≥ 615,000 Jun 1 – Sept 30 ≥ 450,000 Jul 1 – Sept 30 *(shall be reduced if necessary to meet storage criteria)*
FWY > 1,600,000	---	≥ 350,000	≥ 465,000 Jul 1 – Sept 30 *(shall be reduced if necessary to meet storage criteria)*

Table E-2 Big Creek System/Mammoth Pool Operating Agreement (continued)

Mammoth Pool Operating Contract March 1 Storage Constraints

Preceding Year Computed Natural Runoff @ Friant Dam (acre-feet)	***10/1 Beginning Storage*** (acre-feet)	***3/1 Minimum Storage*** (acre-feet)
---	≤ 300,000	Not less than beginning storage less 150,000
≤ 1,400,000	> 300,000	Not less than the greater of (i) 150,000 or (ii) beginning storage less 175,000
> 1,400,000	> 300,000	Not less than 50% of beginning storage
> 2,000,000	> 350,000	As much as 50,000 less than 50% of beginning storage

Mammoth Pool Operating Contract Maximum Flow Constraints

Current Mar 1 Forecast of FWR Runoff @ Friant Dam *	***Maximum Allowable Flow Passing Dam 7 for Month of March***	***March 1-20 Flows***	***March 21-31 Flows***
< 1,500,000	≤ 95,000 or the Dam 7 computed natural flow, whichever is greater	If the flow passing Dam 7 during the first 20 days of March does not exceed 61,000…	…then allowable flow may be exceeded if the flow for the month passing Dam 7 does not exceed the natural runoff by more than 61,000 during the last 11 days of the month
≥ 1,500,000	No restrictions		
***** As stipulated in the Contract			

Table E-3 Description of USGS Stream Gage Stations Located in the Big Creek Relicensing Basin Watershed

USGS STA. NO.	STREAM REACH	LOCATION				ELEVATION (feet)	DRAINAGE AREA (mi^2)	USGS period of record	
		Latitude	Longitude	Legal Description	General Description			from	to
FERC #2175 Big Creek No's 1 & 2									
11237000	Big Creek below Huntington Lake	37°13'17"	119°12'42"	SE1/4, NW1/4, Sec. 23, T.8S., R.25E.	On right bank 800 ft. upstream from Grouse Creek, 1.0 mi. south of main dam of Huntington Lake, and 2.1 mi. northeast of town of Big Creek.	6630	81.1	06/09/25 10/01/86	09/30/70 09/30/98
FERC # 67, Big Creek 2A, 8 & Eastwood									
11230530	Bear Creek below Diversion	37°20'08"	118°58'29"	T.7S., R.27E.	On right bank 60 ft. downstream from diversion dam, 2.5 mi. south of Lake Thomas A. Edison, and 18.3 mi. east of town of Big Creek.	7338.3	52.8	10/1/1986	9/30/1998
11231600	Mono Creek below Diversion	37°21'36"	118°59'51"	T.6 1/2S.,R.27E.	On left bank 20 ft. downstream from diversion dam, 1.0 mi. southwest of Lake Thomas A. Edison, and 2.5 mi. northeast of Mono Hot Springs.	7340	92.8	10/01/70 05/08/78 07/15/78 02/18/80 07/13/80 10/01/83	09/30/71 05/09/78 09/08/78 02/18/80 08/27/80 09/30/98
11230215	South Fork San Joaquin River below Hooper Creek	37°18'35"	118°57'40"	T.7S.,R.27E.	On right bank 0.1 mi. downstream from Hooper Creek, 3.5 mi. downstream from Florence Lake Dam, and 17 mi. northeast of town of Big Creek.	6949.1	184	10/01/75 10/01/78 10/01/96	06/07/78 09/30/95 09/30/97
11237700	Pitman Creek near Tamarack Mountain	37°11'57"	119°12'51"	NW1/4, NW1/4, Sec. 35, T.8S., R.25E.	On right bank 400 ft. downstream from Huntington-Shaver Conduit Tunnel, 0.9 mi. downstream from confluence of Tamarack and South Fork Tamarack Creeks, 1.3 mi. upstream from mouth, and 1.8 mi. east of town of Big Creek.	7000	23.0	10/01/74 10/01/96 03/25/97	09/30/95 11/16/96 09/30/98
11241500	Stevenson Creek below Shaver Lake	37°08'41"	119°18'27"	NE1/4, SE1/4, Sec. 13, T.9S., R.24E.	On right bank 400 ft. downstream from Highway 168, 1,600 ft. downstream from Shaver Lake Dam, 2.6 mi. north of town of Shaver Lake, and 5.1 mi. southwest of town of Big Creek.	5200	29.4	10/01/16 10/01/19 04/09/22 11/01/24 10/01/86	08/08/19 09/30/20 09/30/24 09/30/28 09/30/98
11238500	Big Creek near Mouth (below Dam 5)	37°12'28"	119°19'13"	SE1/4, NW1/4, Sec. 26, T.8S., R24E.	On right bank 0.6 mi. upstream from mouth and 3.9 mi. west of town of Big Creek.	2620	131	05/10/23 10/01/86	09/30/28 09/30/98
11230600	Camp 62 Creek below Diversion	37°18'32"	119°01'37"	T.7S.,R.27E.	On right bank 30 ft. downstream from diversion dam, 1.4 mi. southwest of Mono Hot Springs, and 13.5 mi. northeast of town of Big Creek.	7320	1.97	10/01/83 04/10/85 07/03/86 04/16/87 04/27/88 04/23/89 04/14/90 04/26/91 04/18/92 04/28/93 07/15/93 04/18/94 08/14/95 03/26/96	09/30/84 11/30/85 09/30/86 09/30/87 07/01/88 07/05/89 07/06/90 07/31/91 08/18/92 05/24/93 09/06/93 07/18/94 10/15/95 08/04/96

Table E-3 Description of USGS Stream Gage Stations Located in the Big Creek Relicensing Basin Watershed (continued)

USGS STA. NO.	STREAM REACH	LOCATION				ELEVATION (feet)	DRAINAGE AREA (mi^2)	USGS period of record	
		Latitude	Longitude	Legal Description	General Description			from	to
FERC # 67, Big Creek 2A, 8 & Eastwood (continued)									
11230560	Chinquapin Creek below Diversion	37°18'26"	119°01'08"	T.7S.,R.27E.	30 ft. downstream from diversion dam to Ward Tunnel, 0.7 mi. upstream from mouth, 1.7 mi. south of Mono Hot Springs, and 14.0 mi. northeast of town of Big Creek.	7260	1.65	05/12/86 04/17/87 09/12/87 04/27/88 04/24/89 04/15/90 04/25/91 04/18/92 04/30/93 07/16/93 04/19/94 08/09/95 03/26/96	09/30/86 06/27/87 09/30/87 06/27/88 06/21/89 06/21/90 07/12/91 07/17/92 05/24/93 08/08/93 06/16/94 09/30/95 07/30/96
11230670	Bolsillo Creek below Diversion	37°18'43"	119°02'23"	T.7S.,R.27E.	50 ft. downstream from diversion dam, 1.5 mi. upstream from mouth, 1.7 mi. southwest of Mono Hot Springs, and 13.3 mi. northeast of town of Big Creek.	7600	1.40	10/01/85 04/16/87 04/13/88 04/24/89 04/10/90 04/24/91 10/26/91 04/20/92 04/28/93 04/18/94 04/29/95 03/21/96 01/01/97 05/24/98	09/30/86 06/27/87 07/26/88 06/26/89 06/20/90 07/22/91 10/26/91 08/14/92 08/22/93 06/20/94 09/14/95 08/06/96 09/17/97 07/25/98
11230200	Hooper Creek below Diversion							10/1/1986	9/30/1998
11239300	No. Fk. Stevenson Creek above Shaver Lake	37°08'13"	119°15'13"	SE1/4, NW1/4, Sec. 21, T.9S., R.25E.	On right bank 100 ft. upstream from Perimeter Road and 4.8 mi. south of town of Big Creek.	5740	4.42	1/25/1989	9/30/1998
11238270	Balsam Creek below Balsam Meadow Forebay	37°09'46"	119°15'12"	NE1/4, NW1/4, Sec. 9, T.9S., R.25E.	On left bank 80 ft. downstream from control house at base of Balsam Meadows Dam, 2.6 mi. south of Big Creek.	6560	not determined	1/24/1989	9/30/1998

Table E-3 Description of USGS Stream Gage Stations Located in the Big Creek Relicensing Basin Watershed (continued)

USGS STA. NO.	STREAM REACH	LOCATION				ELEVATION (feet)	DRAINAGE AREA (mi^2)	USGS period of record	
		Latitude	Longitude	Legal Description	General Description			from	to
11238600	San Joaquin River below Dam 6 (above Stev. Cr.)	37°12'28"	119°19'44"	T.8S., R.24E.	In intake structure near left bank, 300 ft. upstream from Dam 6, 3.5 mi. upstream from Stevenson Creek, 4.4 mi. west of town of Big Creek, and at mile 313.6.	2200	1197	10/01/73 10/01/92 10/01/95	09/30/87 09/30/94 09/30/98
FERC #2017 Big Creek No. 4									
11242000	San Joaquin River above Willow Creek	37°08'40"	119°27'13"	SW1/4, SW1/4, Sec.15, T.9S., R.23E.	On right bank 1,000 ft. downstream from Redinger Lake Dam, 0.4 mi. upstream from Willow Creek, and 4.2 mi. northeast of Auberry.	1175.54	1295	3/7/1951	9/30/1998
11246500	Willow C A Mouth near Auberry	37°09'03"	119°27'34"	SE1/4, NE1/4, Sec. 16, T.9S., R.23E.	On left bank 40 ft. upstream from bridge, 0.4 mi. upstream from mouth, 1.3 mi. downstream from Whiskey Creek, and 4.3 mi. northeast of Auberry.	1174.69	130	1/1/1952	9/30/1998
FERC #2085 Mammoth									
11234760	San Joaquin River above Shakeflat Creek	37°19'00"	119°19'43"	NE1/4, SE1/4, Sec.15, T.7S., R.24E.	On right bank 1,500 ft. upstream from Shakeflat Creek, 4,900 ft. downstream from Mammoth Pool Dam, and 9.0 mi. northwest of town of Big Creek.	2865.50	1003	10/1/1959	9/30/1998
FERC #2086 Vermilion									
11231500	Mono Creek below Lake T. A. Edison	37°21'41"	118°59'28"	T.6 1/2S.,R.27E.	On left bank 0.5 mi. upstream from diversion dam, 0.9 mi. downstream from Vermilion Valley Dam, and 1.9 mi. south of Lake Thomas A. Edison.	7380	92.5	10/1/2021	9/30/1998
11231700	Warm Creek below Diversion	37°23'31"	119°01'39"	T.6S., R.27E.	On left bank, 40 ft. downstream from diversion dam, 1.5 mi. northwest of Lake Thomas A. Edison, and 17.4 mi. northeast of town of Big Creek.	8030	2.14	10/01/85 05/26/86 04/24/87 04/15/88 04/22/89 04/12/90 04/27/91 04/18/92 10/01/92 04/28/93 04/20/94 06/23/95 04/08/96 11/21/96 03/23/97 04/21/98	10/19/85 10/31/86 09/30/87 07/01/88 07/01/89 06/18/90 07/29/91 07/18/92 11/03/92 11/01/93 11/01/94 10/31/95 08/26/96 01/10/97 07/29/97 09/01/98

Table E-4
Description of USGS Lake Storage Gages Located in the Big Creek Relicensing Basin Watershed

USGS STA. NO.	RESERVOIR	LOCATION				USABLE CAPACITY ELEVATION RANGE (ft)	DRAINAGE AREA (mi2)	USGS period of record	
		Latitude	Longitude	Legal Description	General Description			from	to
FERC # 2086 Vermilion Valley									
11231000	Lake Thomas A. Edison	37°22'09"	118°59'17"	T.6 1/2S., R.27E.	In outlet works of Vermilion Valley Dam on Mono Creek 18.1 mi. northeast of town of Big Creek.	7508.9 - 7642.50	90.0	1954	1998
FERC #2085 Mammoth Pool									
11234700	Mammoth Pool Reservoir	37°19'40"	119°19'38"	SE1/4, SE1/4, Sec. 10, T.7S., R.24E.	In gatehouse of power tunnel intake 0.7 mi. northwest of dam on San Joaquin River, 9.0 mi. northwest of town of Big Creek.	3100.00 - 3330.00	995	1959	1998
FERC # 67 Big Creek 2A, 8 & Eastwood									
11229600	Florence Lake	37°16'20"	118°58'17"	T.8S., R.27E.	In gatehouse of Ward Tunnel intake, 0.3 mi. west of dam on South Fork San Joaquin River and 16 mi. northeast of town of Big Creek.	7220.94 - 7327.50	171	1925	1998
11239500	Shaver Lake	37°08'41"	119°18'06"	SW1/4, SE1/4, Sec. 13, T.9S., R.24E.	Near center of dam on Stevenson Creek, 5.2 mi. southwest of town of Big Creek.	5225 - 5370.13	29.1	1927	1998
FERC #2175 Big Creek Nos. 1 & 2									
11236000	Huntington Lake	37°14'04"	119°12'44"	SW1/4, Sec. 14, T.8S., R.25E.	In gate tower of dam 1 on Big Creek, 2.7 mi. northeast of town of Big Creek.	6819.90 - 6950.00	80.5	1926	1998
FERC #2017 Big Creek No. 4									
11241950	Redinger Lake	37°08'42"	119°26'58"	NE1/4, SW1/4, Sec. 15, T.9S., R.23E.	At intake structure on Dam No. 7 on San Joaquin River, 4.2 mi. northeast of Auberry.	1320.00 - 1403.00	1295	1965[(1)]	1998

Footnotes

(1) Big Creek No. 4 Period of record; from 1950 to 1965 months end contents only.

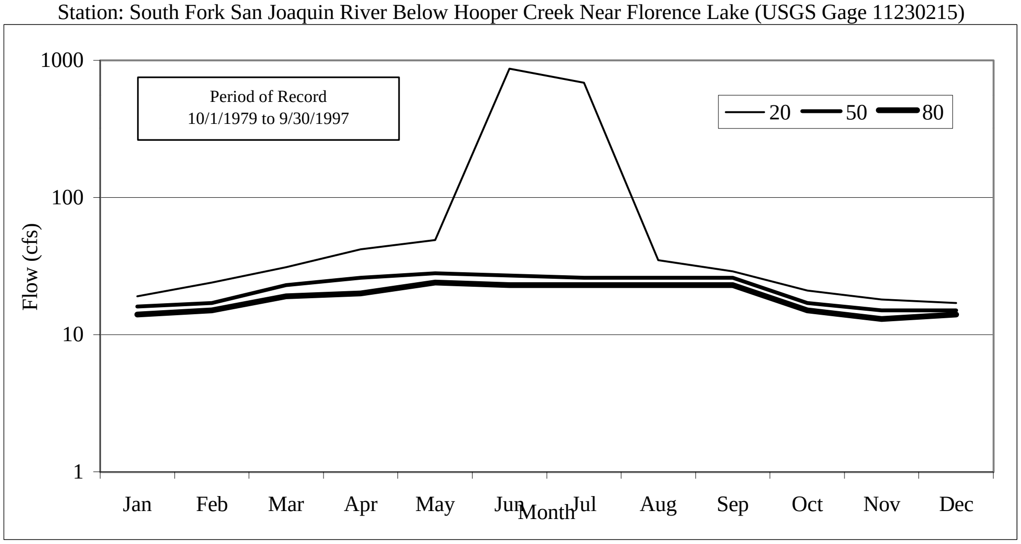
Table E-5
Summary of USGS Powerhouse Flow Gages
Big Creek Relicensing Basin Watershed

USGS STA. NO.	Powerhouse	LOCATION			Elevation (ft NGVD)	* USGS period of record	
		Latitude	Longitude	County		from	to
FERC #2085 Mammoth Pool							
11235100	Mammoth Pool Powerhouse	37°13'30"	119°20'13"	Madera	2230	10/1/1980 10/1/1984	9/30/1983 9/30/1998
FERC # 67 Big Creek 2A, 8 & Eastwood							
11238400	Powerhouse 2A	37°11'57"	119°18'16"	Fresno	2950	10/1/1980 10/1/1984	9/30/1983 9/30/1998
11238550	Powerhouse 8	37°12'35"	119°19'40"	Fresno	2250	10/1/1980 10/1/1984	9/30/1983 9/30/1999
11238250	Eastwood Powerhouse	37°07'55"	119°15'39"	Fresno	---	10/1/87	9/30/98
FERC #2175 Big Creek Nos. 1 & 2							
11238100	Powerhouse 1	37°12'15"	119°14'20"	Fresno	4820	10/1/1980 10/1/1984	9/30/1983 9/30/1999
11238380	Powerhouse 2	37°11'56"	119°18'20"	Fresno	2950	10/1/1980 10/1/1984 10/1/1995	9/30/1983 9/30/1994 9/30/1998
FERC #120 Big Creek No. 3							
11241800	Powerhouse 3	37°08'55"	119°23'08"	Madera	1410	10/1/1980 10/1/1984	9/30/1983 9/30/1998
FERC #2017 Big Creek No. 4							
11246530	Powerhouse 4	37°08'20"	119°29'20"	Madera	990	10/1/1980 10/1/1984	9/30/1983 9/30/1998
FERC #2174 Portal							
11235500	Portal Powerhouse	37°15'25"	119°09'30"	Fresno	6999	10/1/27	9/30/98

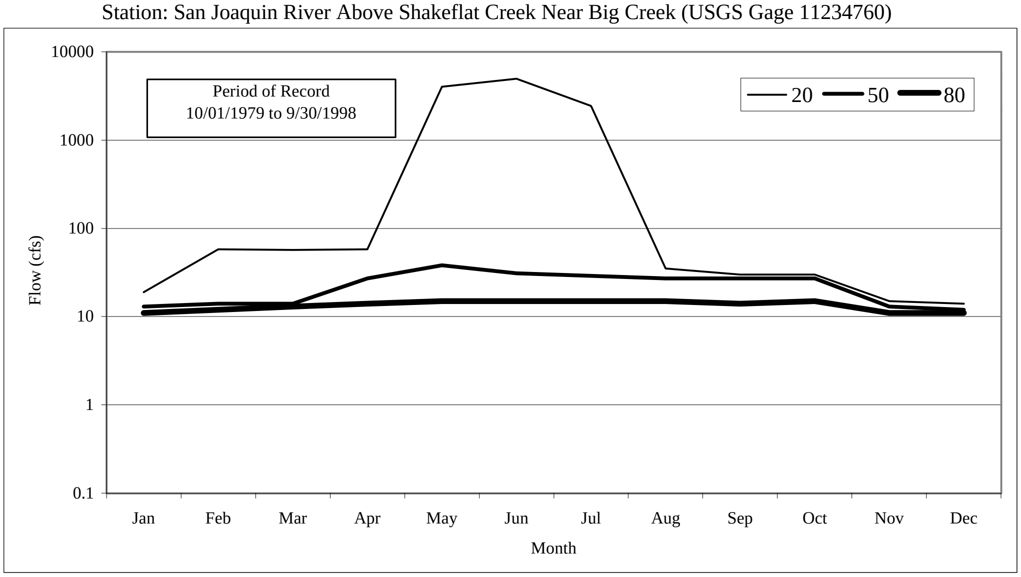
Note:
* = Period of record available of USGS NWIS-W Data Retrieval web page

E-6 - Exceedence Graphs and Tables in cubic feet per second for River Gaging Stations in the Big Creek Relicensing Basin

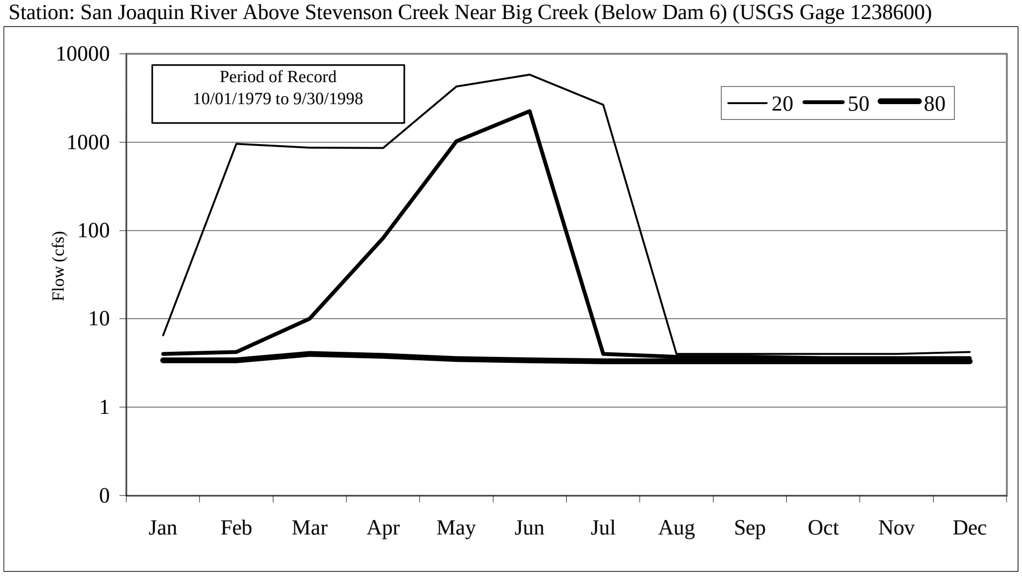
Station: South Fork San Joaquin River Below Hooper Creek Near Florence Lake (USGS Gage 11230215)



Station: San Joaquin River Above Shakeflat Creek Near Big Creek (USGS Gage 11234760)

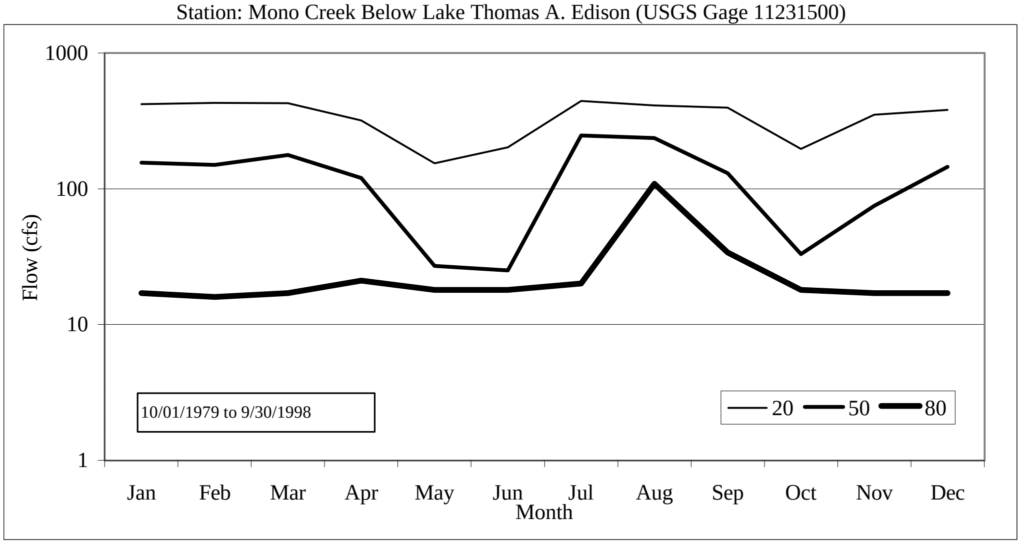


Station: San Joaquin River Above Stevenson Creek Near Big Creek (Below Dam 6) (USGS Gage 1238600)

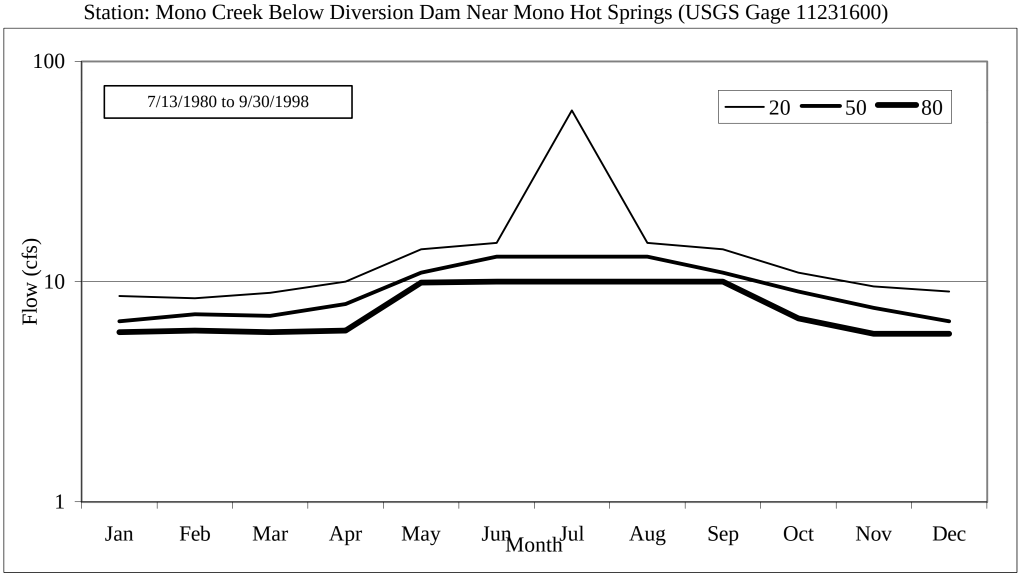


E-6 - Exceedence Graphs and Tables in cubic feet per second for Upper Elevation Stream and Creek Gaging Stations in the Big Creek Relicensing Watershed (continued)

Station: Mono Creek Below Lake Thomas A. Edison (USGS Gage 11231500)



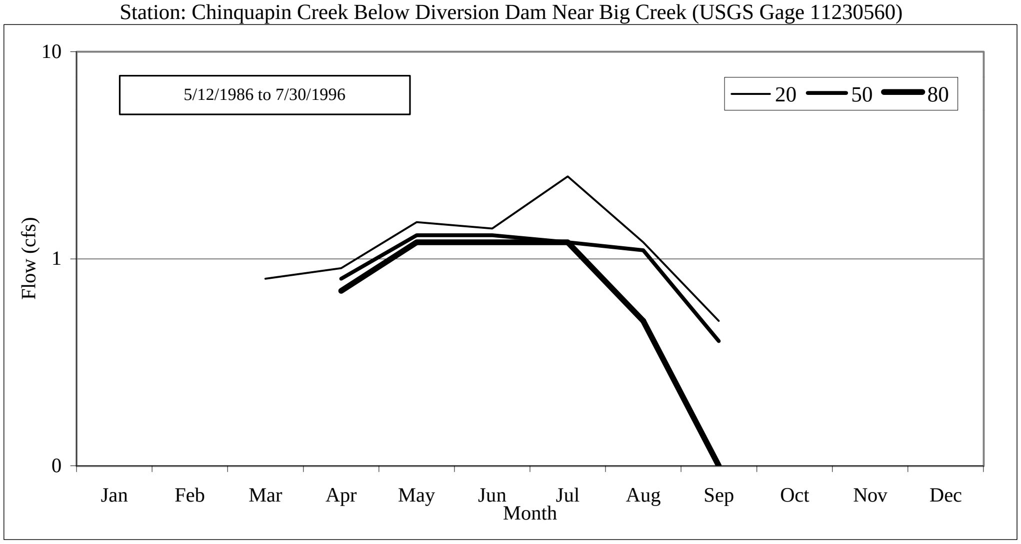
Station: Mono Creek Below Diversion Dam Near Mono Hot Springs (USGS Gage 11231600)



Station: Warm Creek Below Diversion Dam Near Lake Thomas A. Edison (USGS Gage 11239300)

E-6- Exceedence Graphs and Tables in cubic feet per second for Upper Elevation Stream and Creek Gaging Stations in the Big Creek Relicensing Basin (continued)

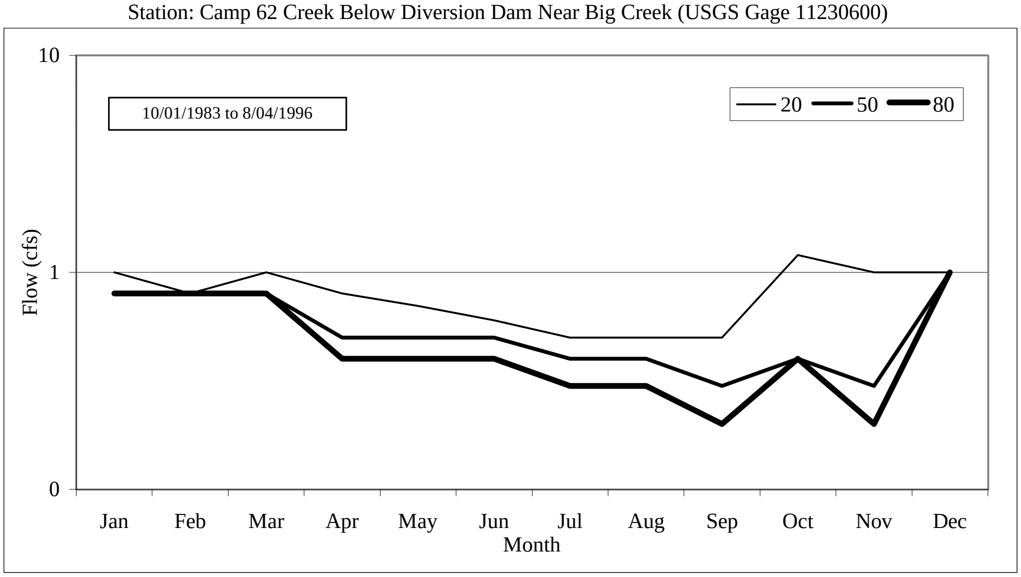
Station: Chinquapin Creek Below Diversion Dam Near Big Creek (USGS Gage 11230560)



Station: Chinquapin Cr
(5/12/1986 to 7/30/199

Percent	Jan
20	0.00
50	0.00
80	0.00

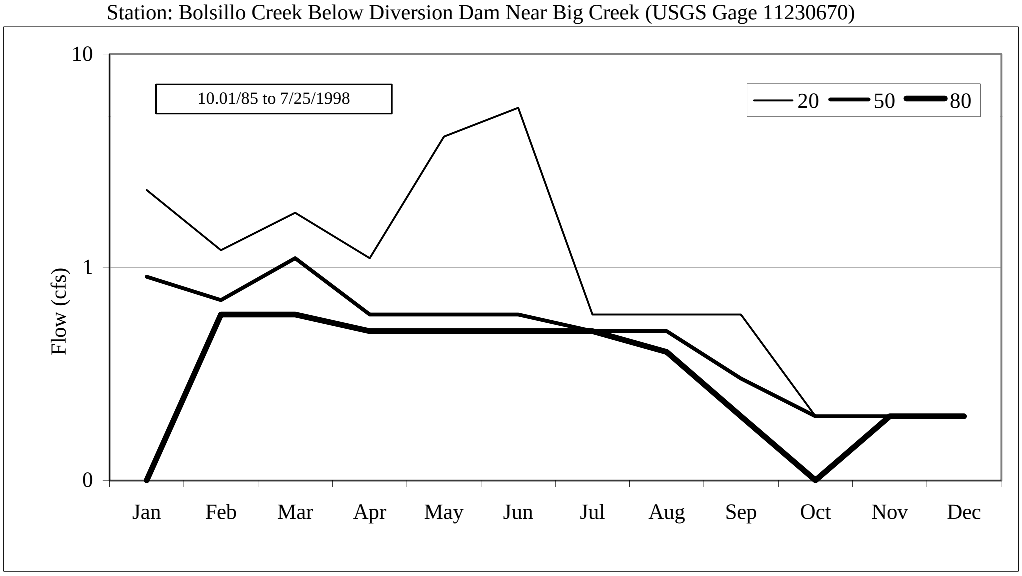
Station: Camp 62 Creek Below Diversion Dam Near Big Creek (USGS Gage 11230600)



Station: Camp 62 Creel
(10/01/1983 to 8/04/19

Percent	Jan
20	1.0
50	0.8
80	0.8

Station: Bolsillo Creek Below Diversion Dam Near Big Creek (USGS Gage 11230670)

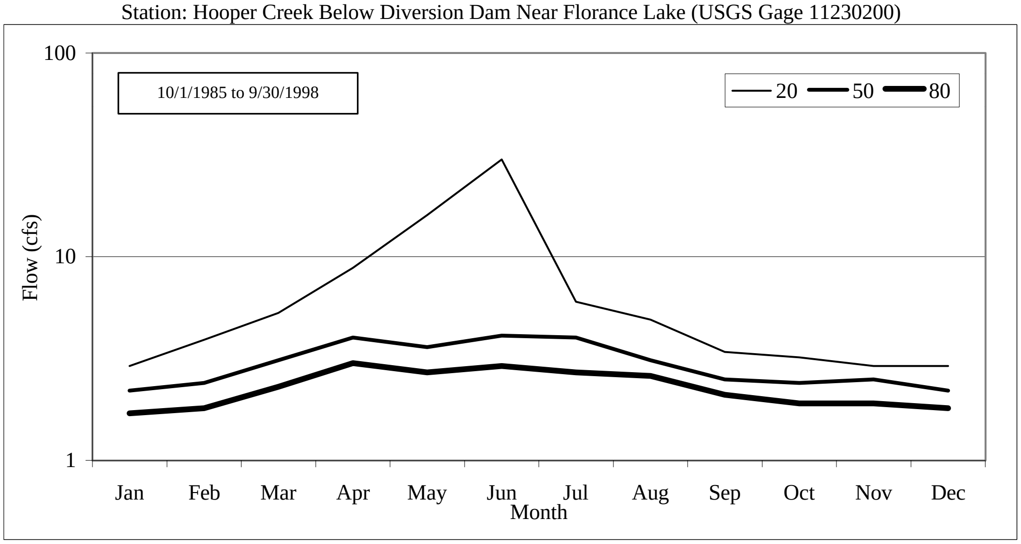


Station: Bolsillo Creek
(10/01/1985 to 7/25/19

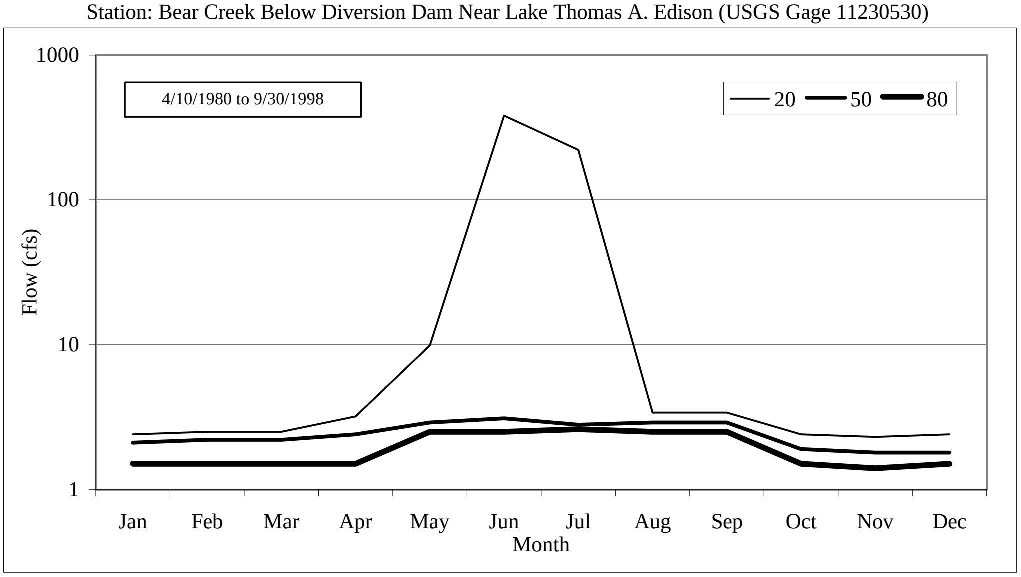
Percent	Jan
20	2.3
50	0.9
80	0.1

E-6 - Exceedence Graphs and Tables in cubic feet per second for Upper Elevation Stream and Creek Gaging Stations in the Big Creek Relicensing Basin (continued)

Station: Hooper Creek Below Diversion Dam Near Florance Lake (USGS Gage 11230200)

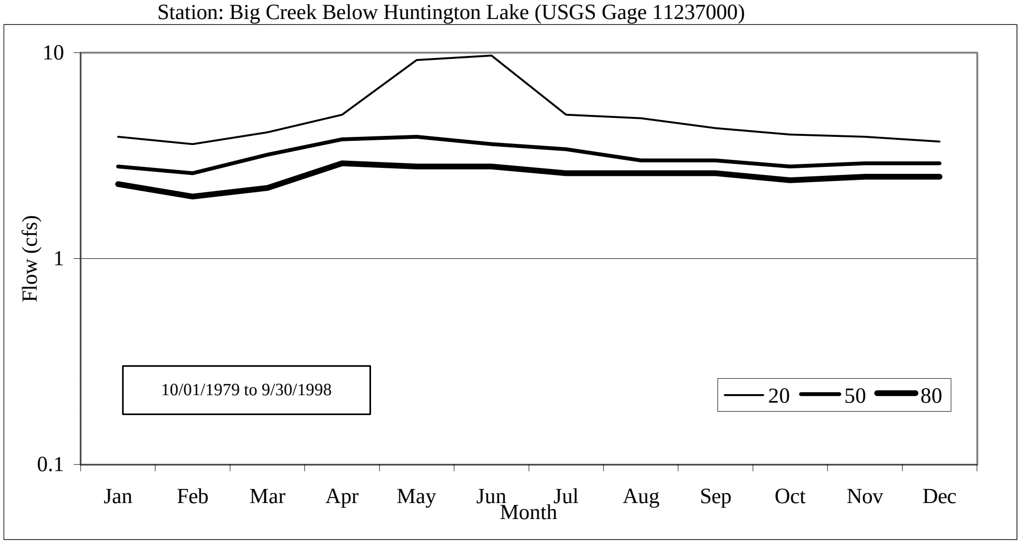


Station: Bear Creek Below Diversion Dam Near Lake Thomas A. Edison (USGS Gage 11230530)

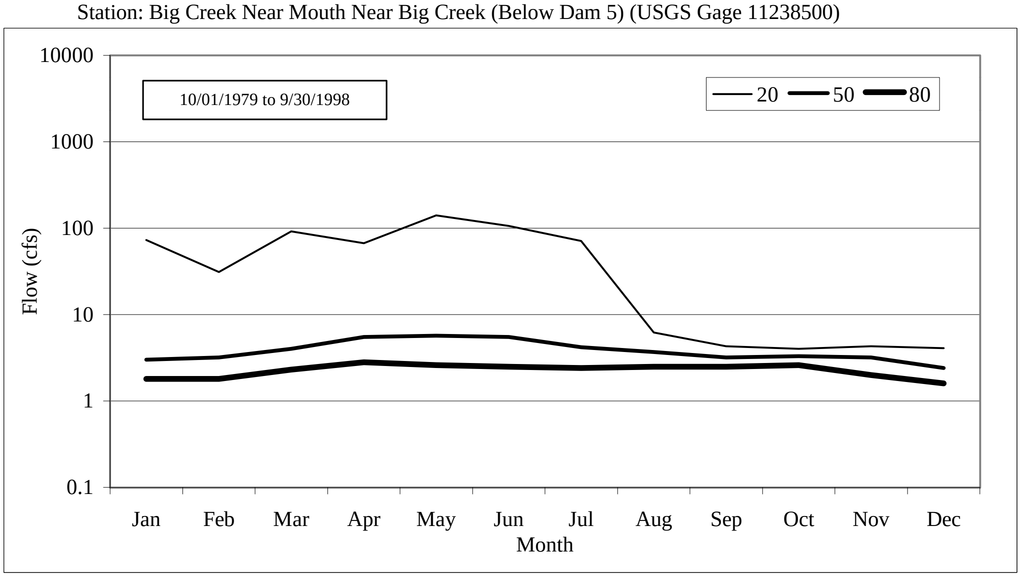


E-6 - Exceedence Graphs and Tables in cubic feet per second for Middle Elevation Stream and Creek Gaging Stations in the Big Creek Relicensing Basin (continued)

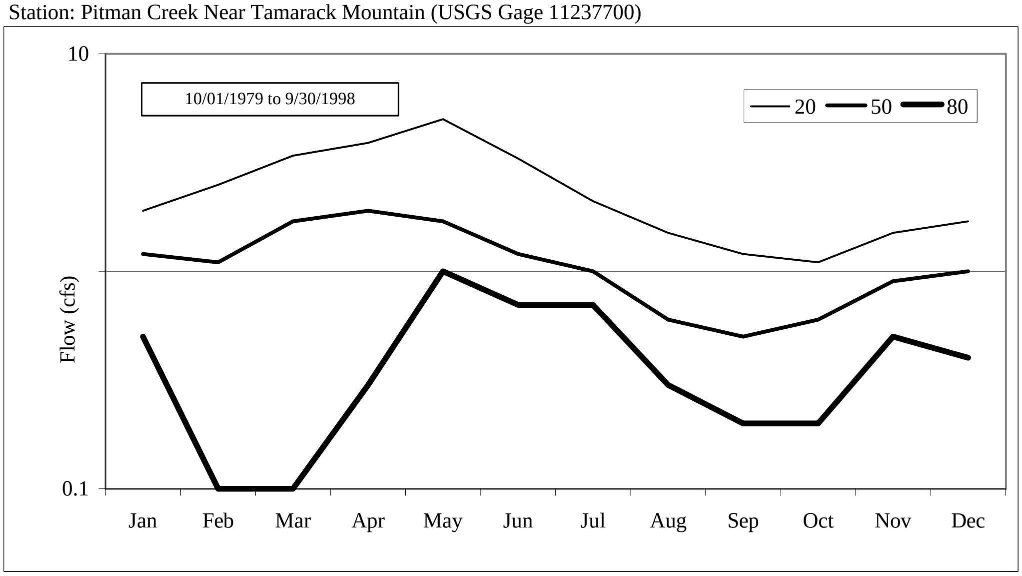
Station: Big Creek Below Huntington Lake (USGS Gage 11237000)



Station: Big Creek Near Mouth Near Big Creek (Below Dam 5) (USGS Gage 11238500)

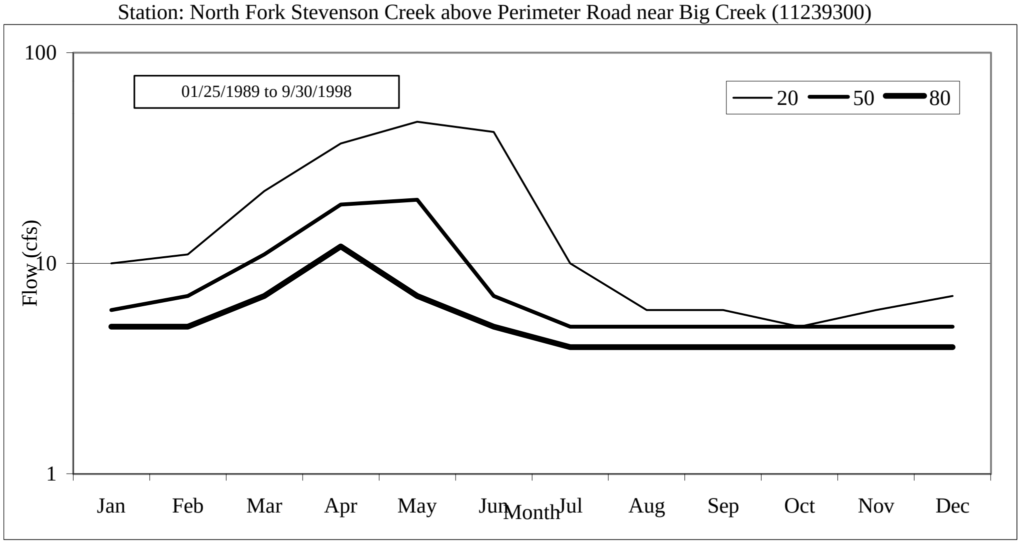


Station: Pitman Creek Near Tamarack Mountain (USGS Gage 11237700)

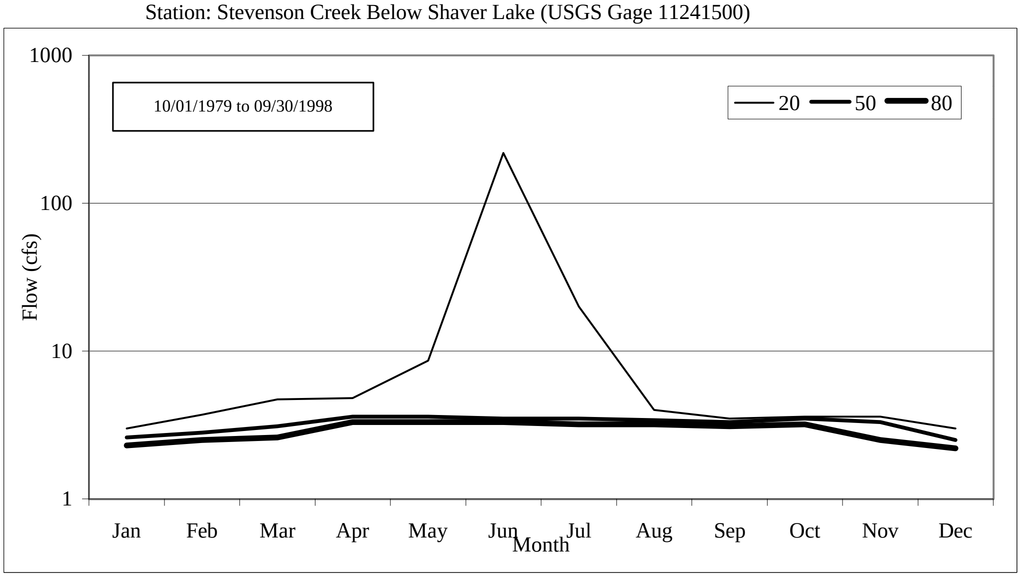


E-6 - Exceedence Graphs and Tables in cubic feet per second for Middle Elevation Stream and Creek Gaging Stations in the Big Creek Relicensing Basin (continued)

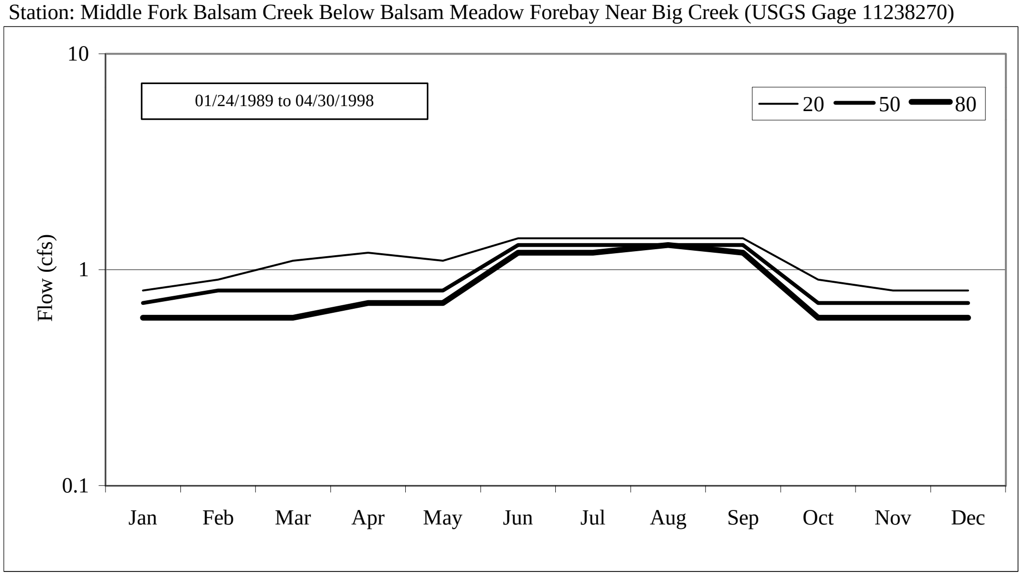
Station: North Fork Stevenson Creek above Perimeter Road near Big Creek (11239300)



Station: Stevenson Creek Below Shaver Lake (USGS Gage 11241500)

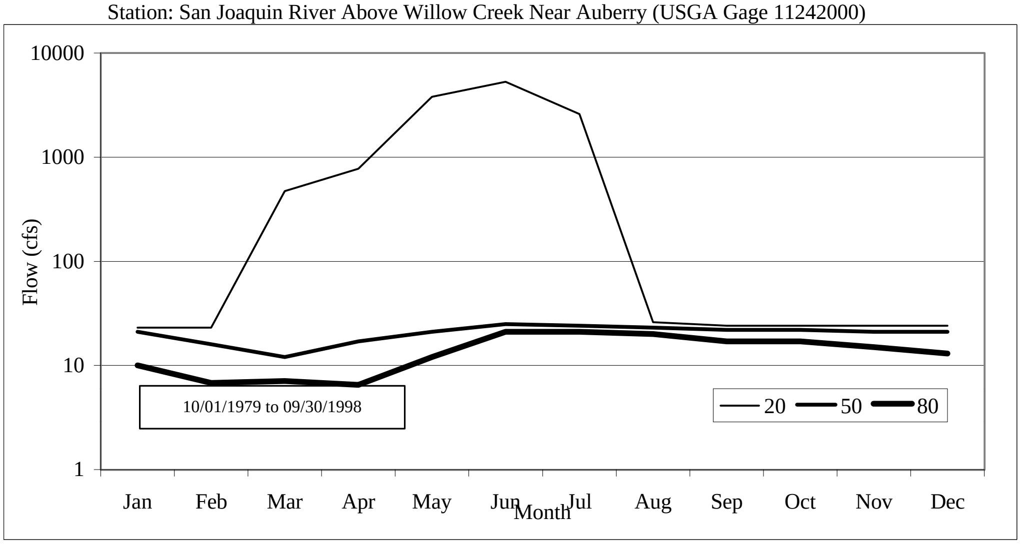


Station: Middle Fork Balsam Creek Below Balsam Meadow Forebay Near Big Creek (USGS Gage 11238270)

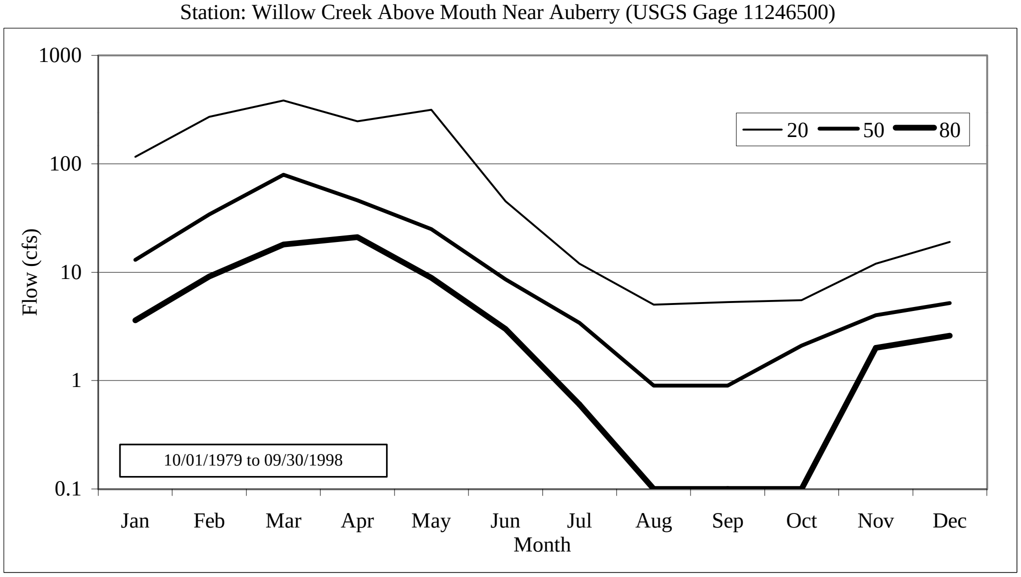


E-6 - Exceedence Graphs and Tables in cubic feet per second for Lower Elevation Stream and Creek Gaging Stations in the Big Creek Relicensing Basin (continued)

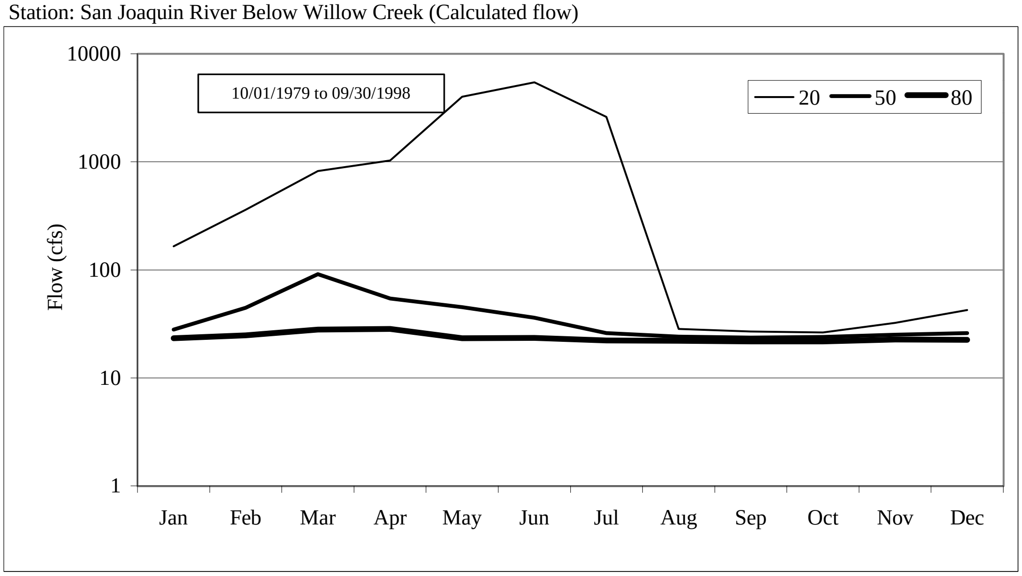
Station: San Joaquin River Above Willow Creek Near Auberry (USGA Gage 11242000)



Station: Willow Creek Above Mouth Near Auberry (USGS Gage 11246500)

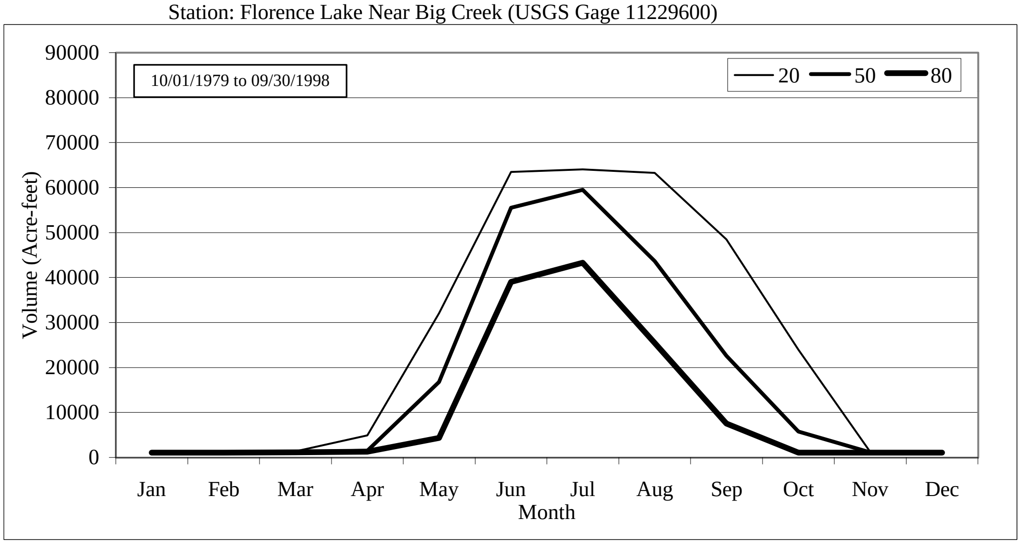


Station: San Joaquin River Below Willow Creek (Calculated flow)

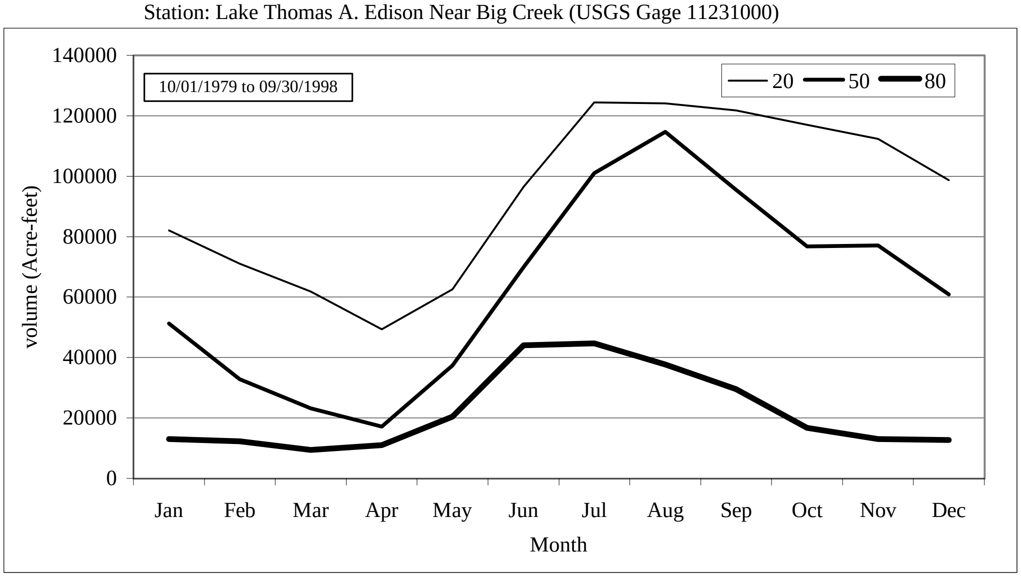


E-6 - Exceedence Graphs and Tables of Lake Storage in Acre-Feet for Lakes in the Big Creek Relicensing Basin (continued)

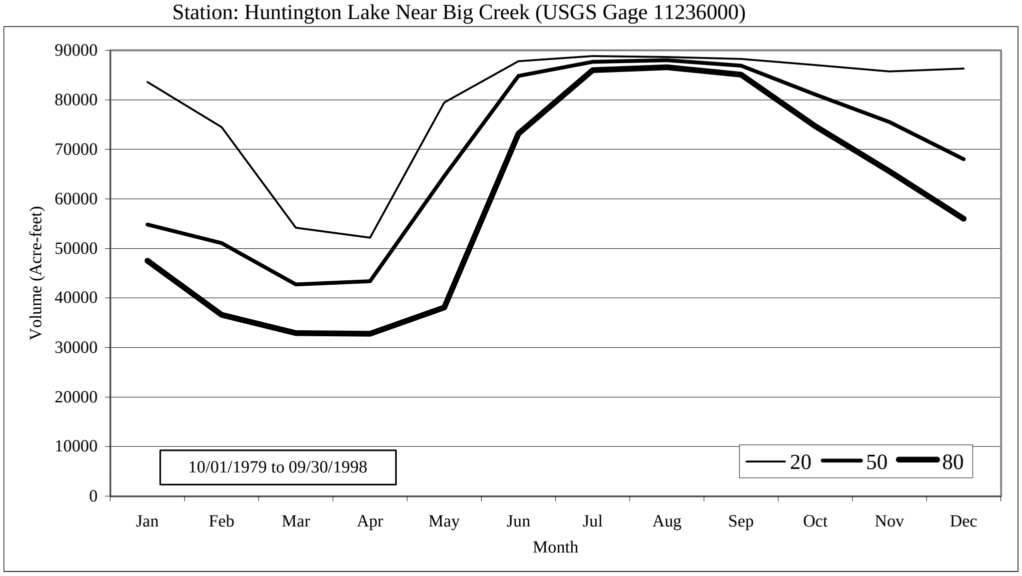
Station: Florence Lake Near Big Creek (USGS Gage 11229600)



Station: Lake Thomas A. Edison Near Big Creek (USGS Gage 11231000)

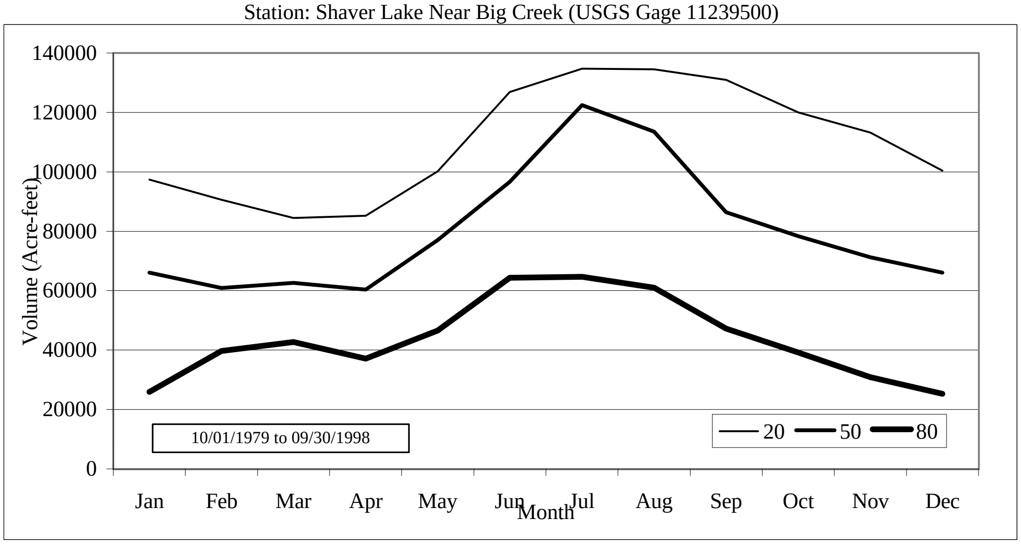


Station: Huntington Lake Near Big Creek (USGS Gage 11236000)

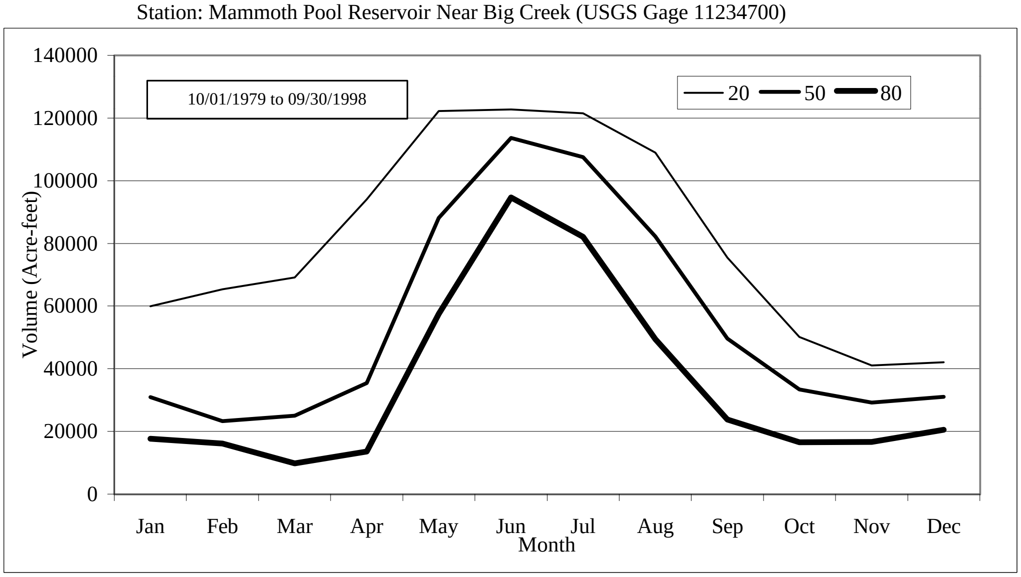


E-6 - Exceedence Graphs and Tables of Lake Storage in Acre-Feet for Lakes in the Big Creek Relicensing Basin (continued)

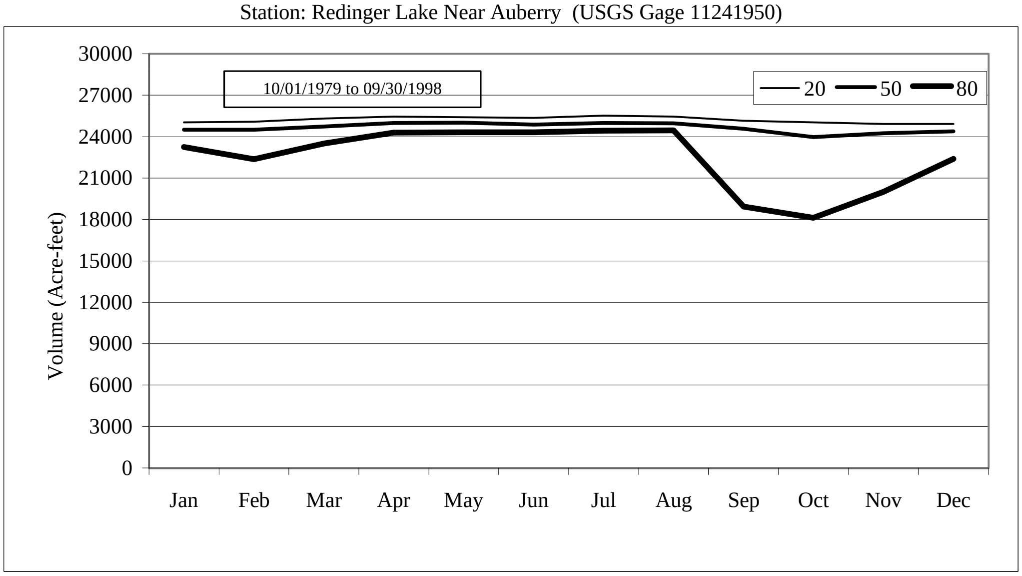
Station: Shaver Lake Near Big Creek (USGS Gage 11239500)



Station: Mammoth Pool Reservoir Near Big Creek (USGS Gage 11234700)

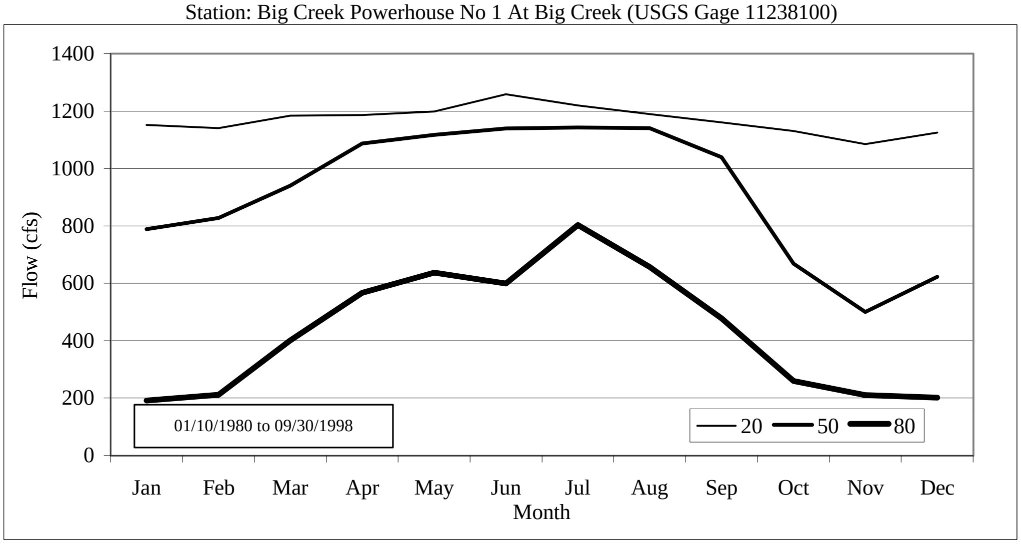


Station: Redinger Lake Near Auberry (USGS Gage 11241950)

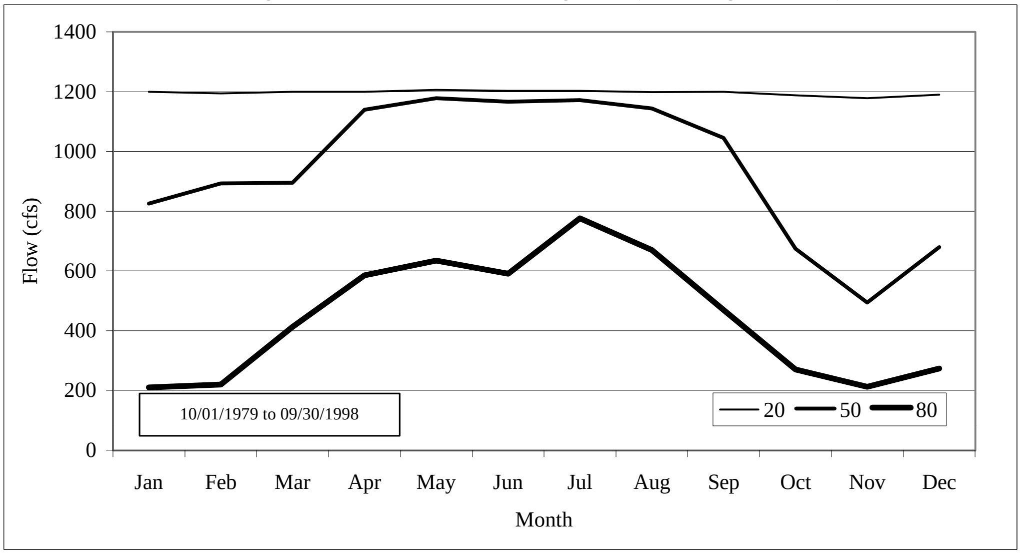


E-6 - Exceedence Graphs and Tables in cubic feet per second for Powerhouses in the Big Creek System (continued)

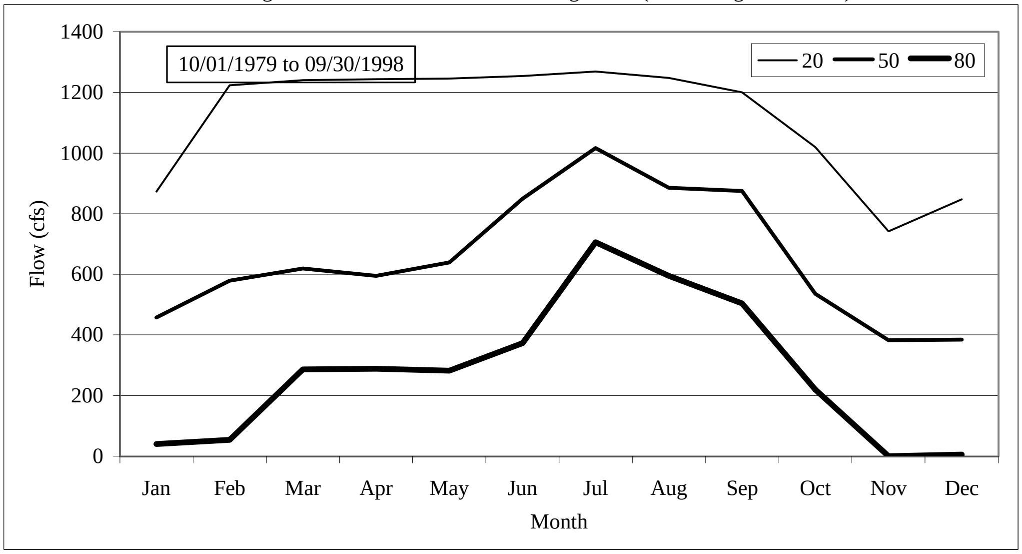
Station: Big Creek Powerhouse No 1 At Big Creek (USGS Gage 11238100)



Station: Big Creek Powerhouse No 2 Near Big Creek (USGS Gage 11238380)

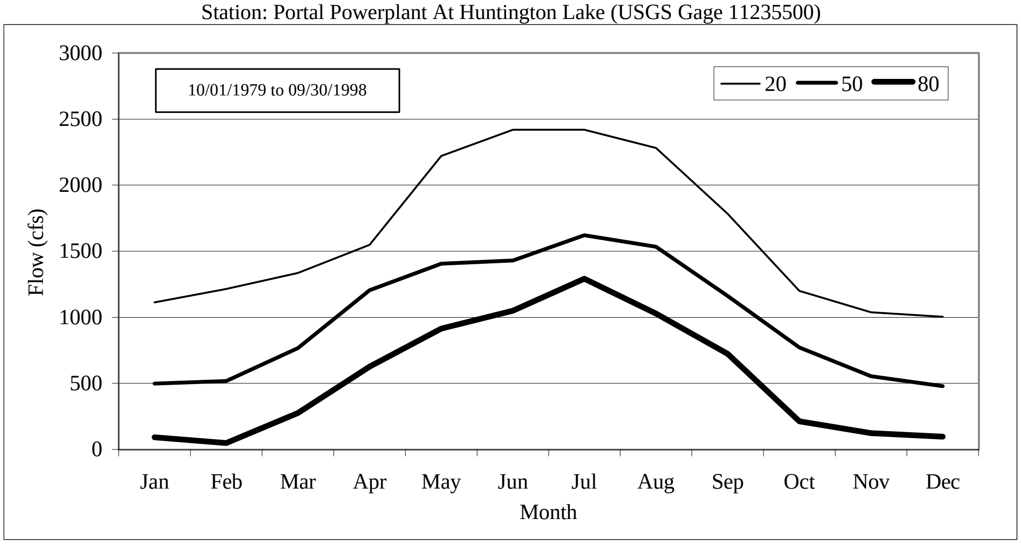


Station: Big Creek Powerhouse No 2a Near Big Creek (USGS Gage 11238400)

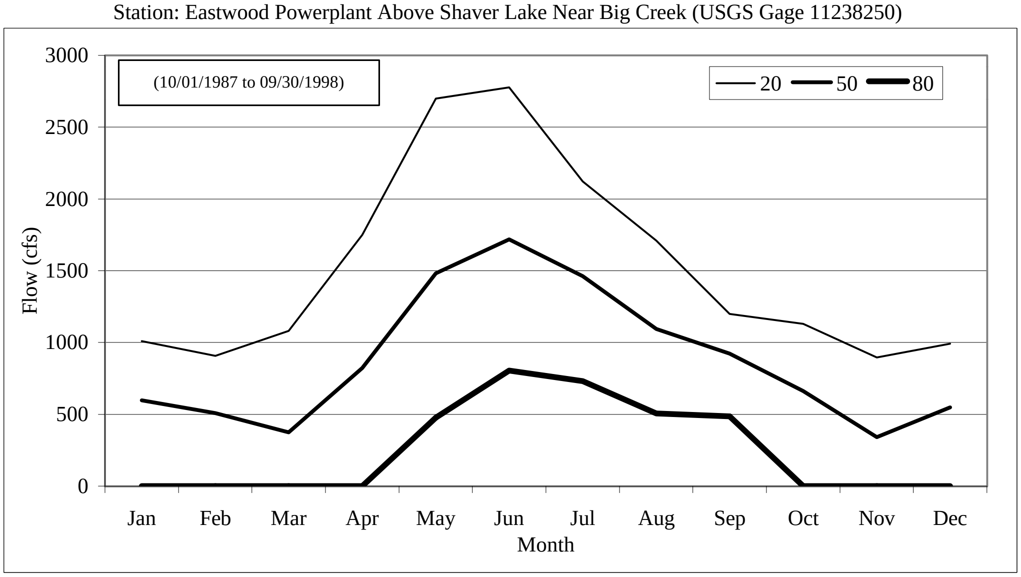


E-6 - Exceedence Graphs and Tables in cubic feet per second for Powerhouses in the Big Creek System (continued)

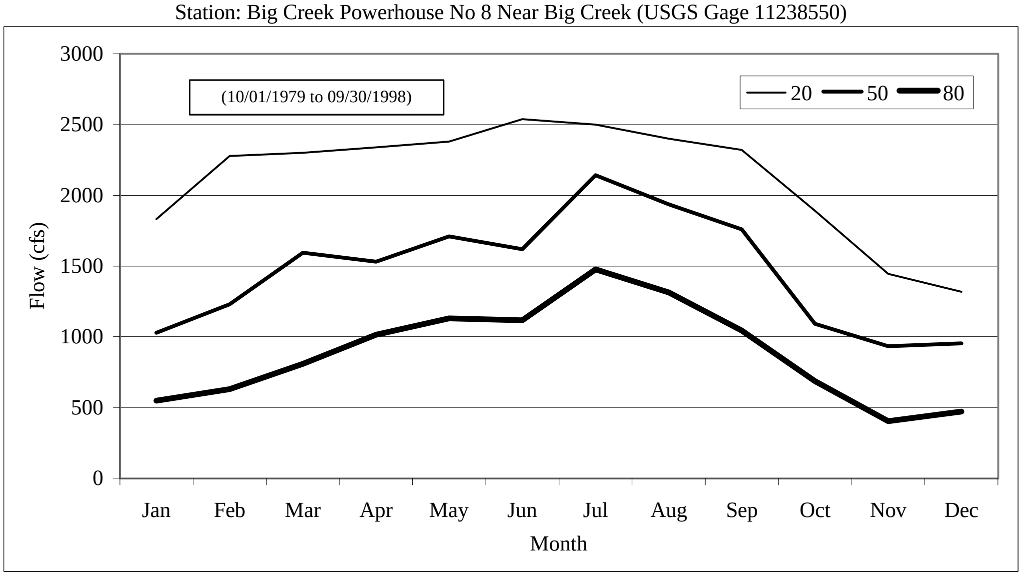
Station: Portal Powerplant At Huntington Lake (USGS Gage 11235500)



Station: Eastwood Powerplant Above Shaver Lake Near Big Creek (USGS Gage 11238250)

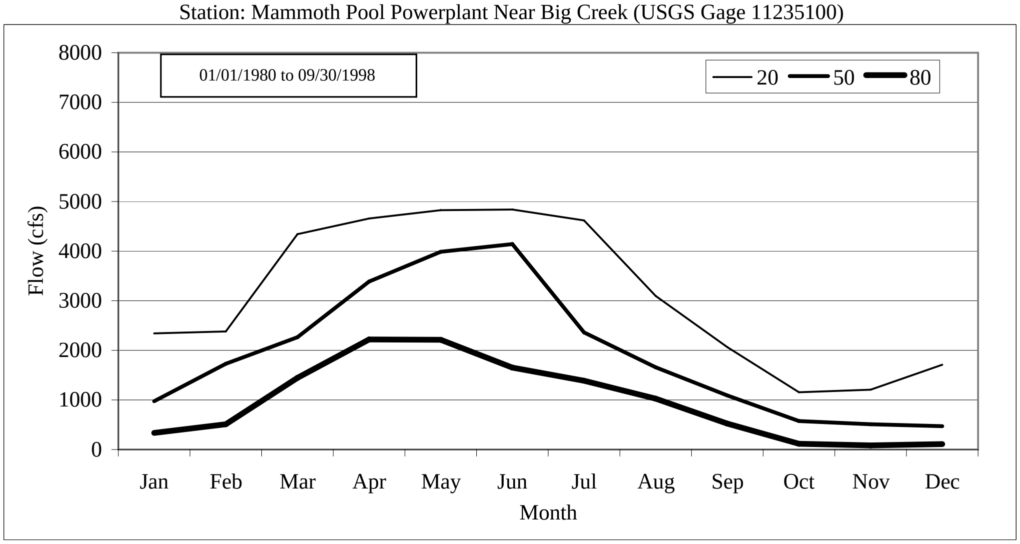


Station: Big Creek Powerhouse No 8 Near Big Creek (USGS Gage 11238550)

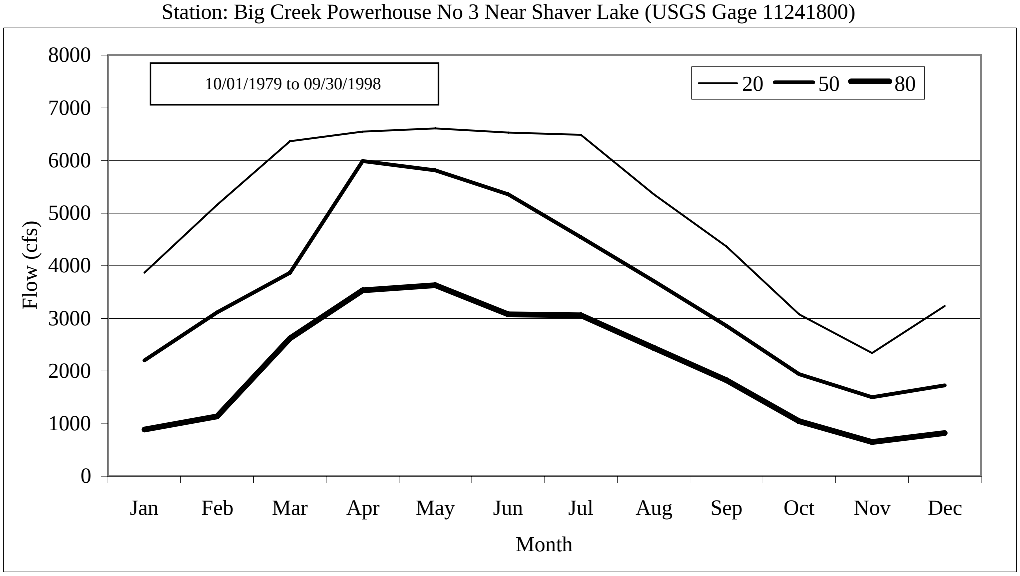


E-6 - Exceedence Graphs and Tables in cubic feet per second for Powerhouses in the Big Creek System (continued)

Station: Mammoth Pool Powerplant Near Big Creek (USGS Gage 11235100)



Station: Big Creek Powerhouse No 3 Near Shaver Lake (USGS Gage 11241800)



Station: Big Creek Powerhouse No 4 Near Auberry (USGS Gage 11246530)

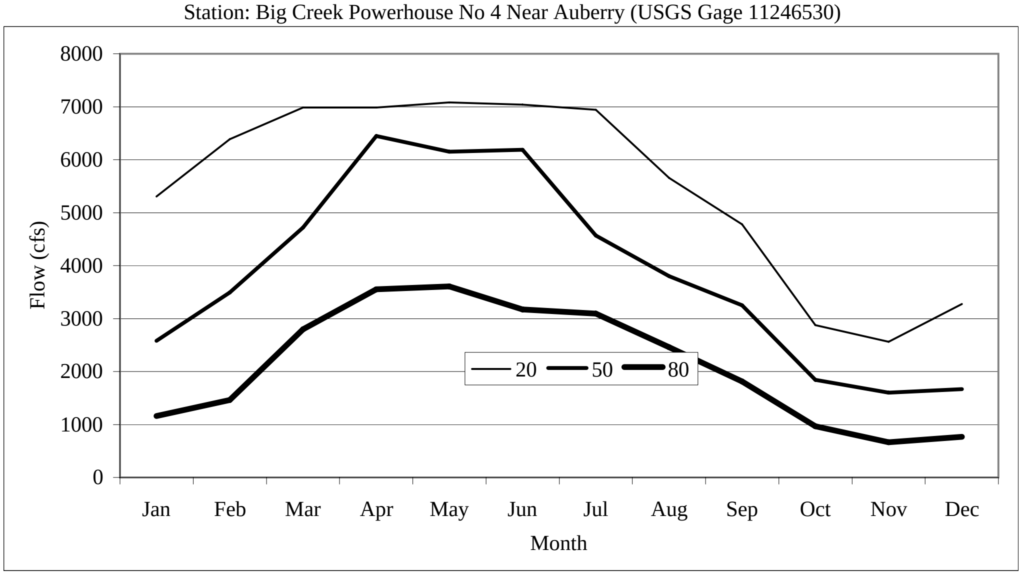
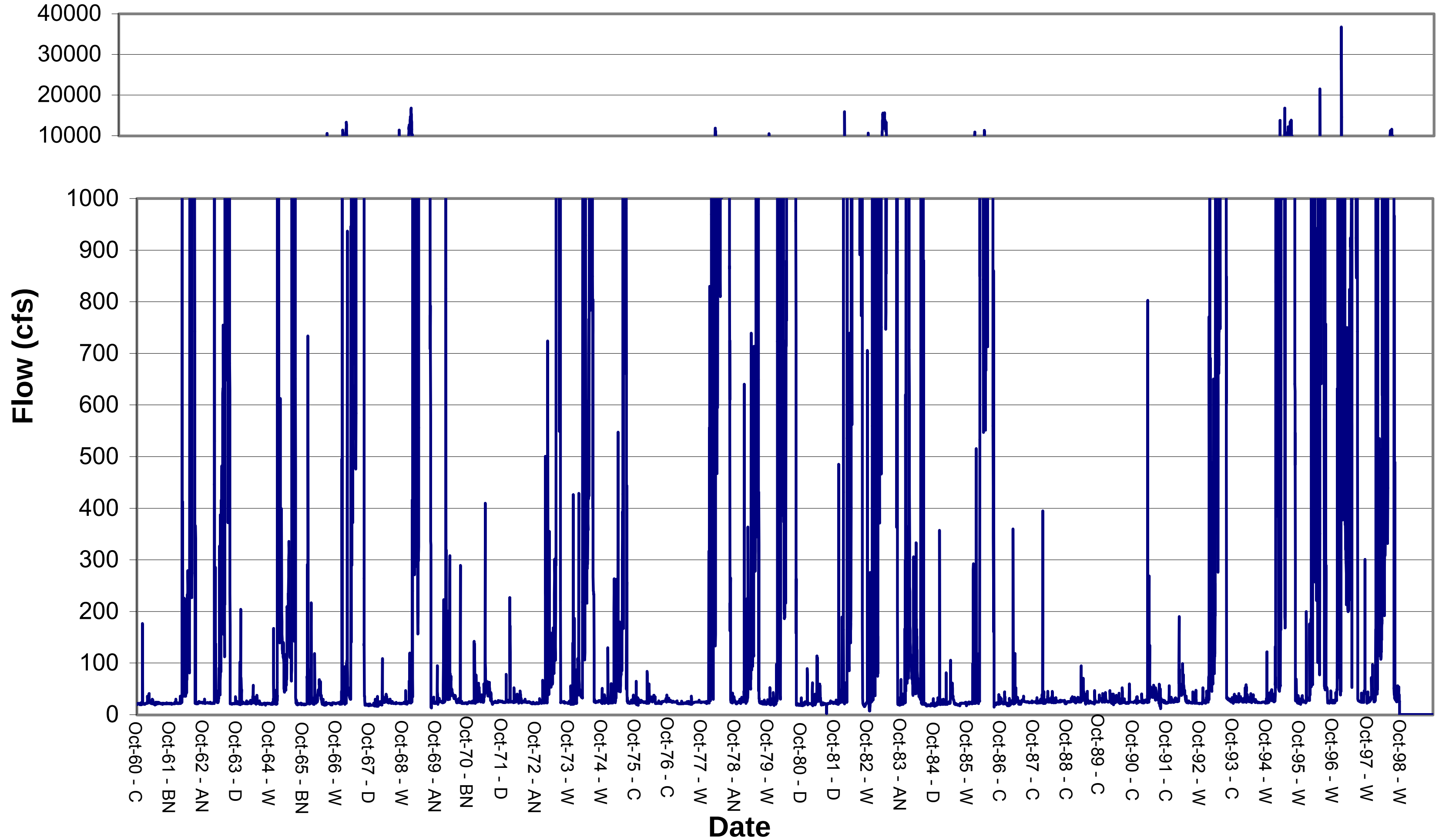


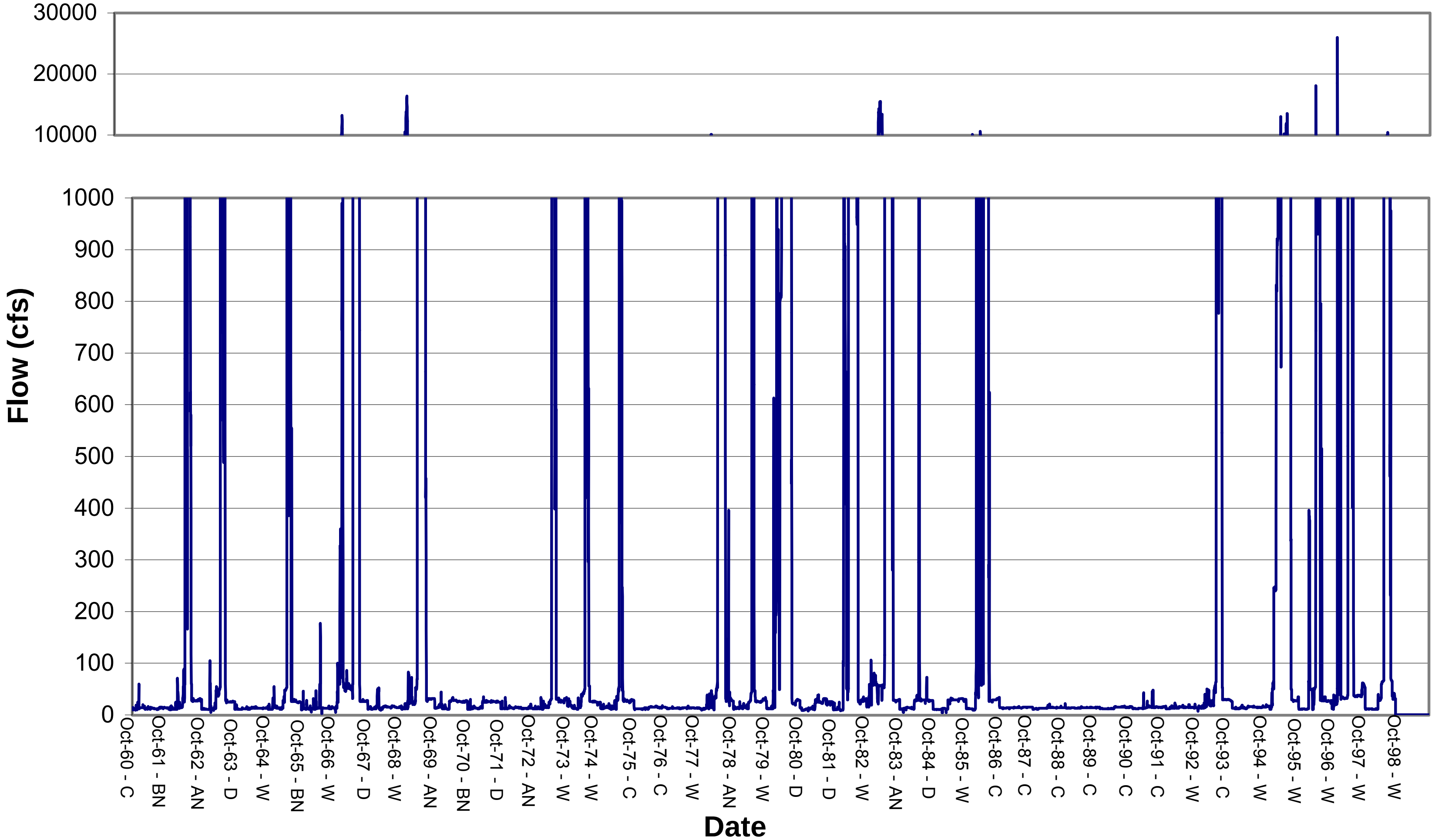
Figure E-7. San Joaquin River Below Willow Creek



W = Wet AN = Above Normal BN = Below Normal C = Critical D= Dry

Figure E-7

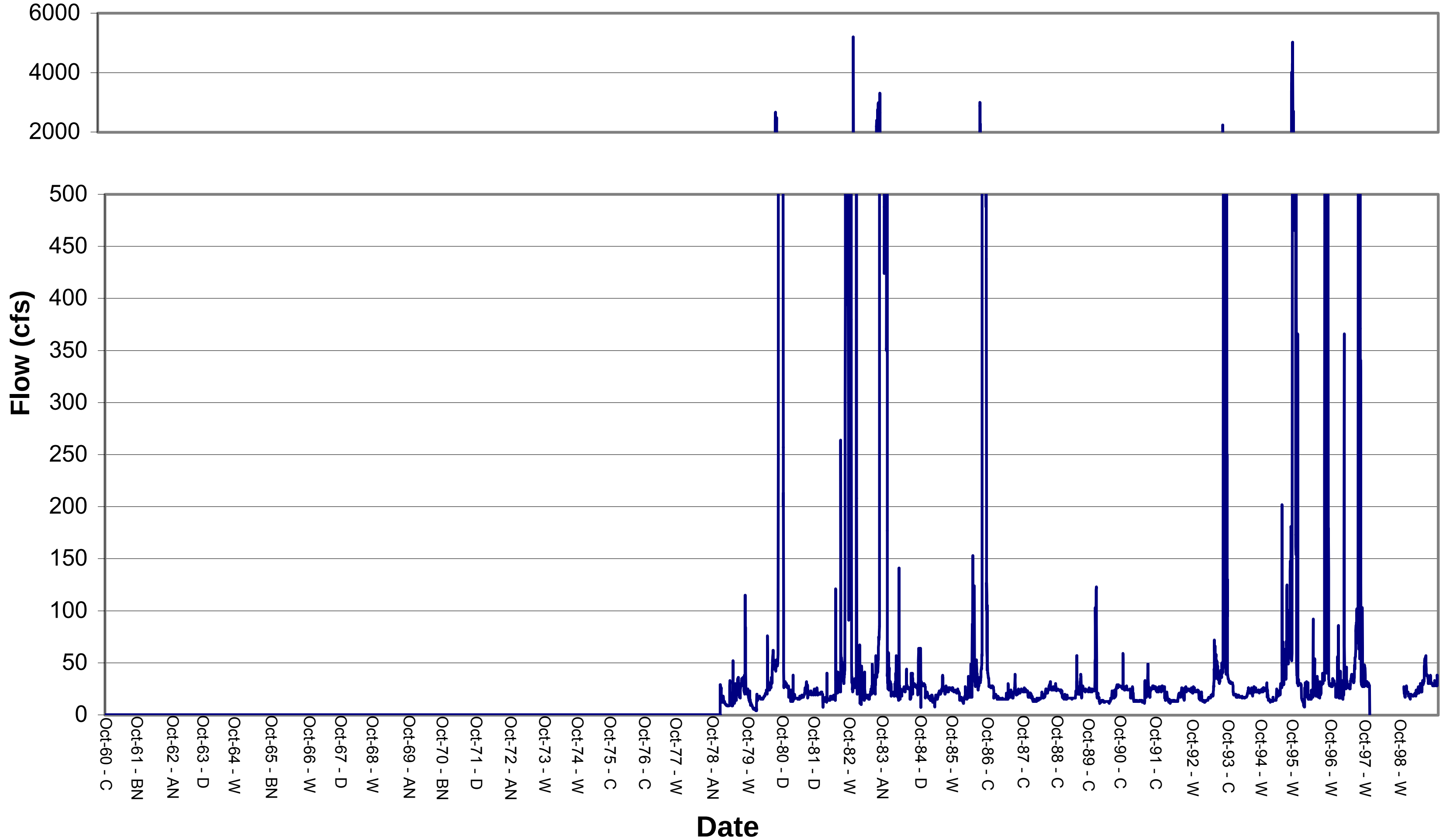
Figure E-8. San Joaquin River Below Mammoth Pool



W = Wet   AN = Above Normal   BN = Below Normal   C = Critical   D= Dry

Figure E-8

Figure E-9. South Fork San Joaquin River Below Hooper Creek



W = Wet AN = Above Normal BN = Below Normal C = Critical D= Dry

Figure E-9

APPENDIX F

FISHERIES RESOURCE TABLES

Table F-1. Fish Species In the Big Creek System Basin

Species	Status	Special Status
Threadfin shad (*Dorosoma petenense*)	I	
Coho salmon (*Oncorhynchus kisutch*)	I	
Kokanee (*Oncorhynchus nerka*)	I	
Brook trout (*Salvelinus fontinalis*)	I	
Brown trout (*Salmo trutta*)	I	
Rainbow trout (*Oncorhynchus mykiss*)	N	**
Golden trout (*Oncorhynchus mykiss*	I	*
Rainbow-Golden trout hybrid	I	
Carp (*Cyprinus carpio*)	I	
Goldfish (*Carassius auratus*)	I	
Golden shiner (*Notemigonus crysoleucas*)	I	
Hardhead (*Mylopharodon conocephalus*)	N	FSS, CSC
Hitch (*Lavinia exilicauda*)	N	
Sacramento pikeminnow (*Ptychocheilus*	N	
Sacramento sucker (*Catostomus*	N	
Channel catfish (*Ictalurus punctatus*)	I	
White catfish (*Ictalurus catus*)	I	
Brown bullhead (*Ictalurus nebulosus*)	I	
Black bullhead (*Ictalurus melas*)	I	
Catfish (*Ictalurus spp.*)	I	
Threespine Stickleback (*Gasterosteus*	N	
Striped bass (*Morone saxatilis*)	I	
Black crappie (*Pomoxis nigromaculatus*)	I	
White crappie (*Pomoxis annularis*)	I	
Crappie (*Pomoxis spp.*)	I	
Warmouth (*Lepomis gulosus*)	I	
Green sunfish (*Lepomis cyanellus*)	I	
Bluegill (*Lepomis macrochirus*)	I	
Redear sunfish (*Lepomis microlophus*)	I	
Sunfish (*Lepomis spp.*)	I	
Largemouth bass (*Micropterus salmoides*)	I	
Smallmouth bass (*Micropterus dolomieui*)	I	
Prickly sculpin (*Cottus asper*)	N	
Riffle sculpin (*Cottus gulosus*)	N	

Legend:
N = Native
I = Introduced
FSS = USFS Region 5 Sensitive Species
CSC = California State Species of Special Concern
*Special status only in native range (South Fork Kern River).
**Non-native strains introduced to Project Area

Table F-2. Fish Distribution in Streams of the Big Creek System Basin

	South Fork San Joaquin River															Mammoth Reach			Big Creek Reach											Stevenson Creek			
Stream Reach Reference Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Species	Tombstone Creek	Crater Creek Diversion	South Slide Creek	North Slide Creek	Hooper Creek	Crater Creek	Bear Creek	Chinquapin Creek	Camp 62 Creek	Bolsillo Creek	Camp 61 Creek	Creek Div.)	Joaquin River)	Warm Creek	SF San Joaquin River	Rock Creek	Ross Creek	Dam to PH)	Rancheria Creek	to confluence)	Big Creek (Dam 1 to Dam 4)	Big Creek (Dam 4 to PH 2)	Big Creek (Dam 5 to PH 8)	Pitman Creek	Balsam Creek (Dam to Low.Div.FB)	Creek)	Creek	Ely Creek	Adit # 8 Creek	NF Stevenson Creek	Stevenson Creek	San Joaquin River Stevenson Reach	San Joaquin River Horseshoe Bend
Threadfin shad																																	
Coho salmon																																	
Kokanee																						X	X										
Brook trout						X	X	X	X	X	X	X			X	X		X	X		X			X						X	(X)		
Brown trout					X		X					X	X		X	X	X	X	X		X	X	X	X						X		X	X
Rainbow trout					X		X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X						X	X	X	X
Golden trout	X				X		X											X															
Rainbow-Golden trout hybrids							X															X											
Carp																																	
Goldfish																																	
Golden shiner													X																				
Hardhead																		X				X	X									X	X
Hitch																		X														X	X
Sacramento pikeminnow																		X				X	X									X	X
Sacramento sucker															X		X	X				X	X							X		X	X
Channel catfish																																	
White catfish																																	X
Brown bullhead																															X		
Threespine Stickleback																																	X
Striped bass																																X	X
Black crappie																																	
White crappie																																	
Warmouth																																	
Green sunfish																																X	X
Bluegill																																	
Redear sunfish																																	
Largemouth bass																																	
Smallmouth bass																																	X
Prickly sculpin																						X	X							X		X	X
Riffle sculpin																		X				X	X							X		X	X
Sculpin																		X				X	X							X		X	X

(X) Fish have been planted in the past, current status unknown

Table F-3. Fish Distribution in Reservoirs of the Big Creek System Basin

Species	Shaver Lake	Lake Thomas A. Edison	Mammoth Pool Reservoir	Huntington Lake	Florence Lake	Redinger Lake	Balsam Meadows Forebay	Big Creek PH 3 Forebay	Portal Forebay (Camp 61 Creek)	Big Creek PH 2 Forebay	Big Creek PH 8 Forebay	Mono Creek Diversion Forebay	Hooper Creek Diversion Forebay	Bear Creek Diversion Forebay	Warm Creek Diversion Forebay
Threadfin shad						(X)									
Coho salmon			(X)												
Kokanee	X			X	(X)		X								
Brook trout	X	X	X	X	X	(X)	X	X	X	X	X	X			
Brown trout	X	X	X	X	X	X	X	X	X	X	X	X		X	
Rainbow trout	X	X	X	X	X	X	X	X	X	X	X	X	X	X	x
Golden trout		X											X	X	
Rainbow-Golden trout hybrids														X	
Carp	X						X								
Goldfish	X														
Golden shiner		X	X		X	X	X								
Hardhead						X		X							
Hitch						X		X							
Sacramento pikeminnow						X		X							
Sacramento sucker	X		X	X		X		X		X	X				
Channel catfish															
White catfish															
Brown bullhead	X						X								
Black bullhead	X														
Threespine Stickleback															
Striped bass						(X)									
Black crappie	X					X	X								
White crappie															
Crappie	X					(X)	X								
Warmouth															
Green sunfish	X					X	X								
Bluegill	X					X									
Redear sunfish															
Sunfish	X					X									
Largemouth bass	X					X									
Smallmouth bass	X					(X)	X								
Prickly sculpin	X					X	X								
Riffle sculpin	X		X			X									
Sculpin	X		X			X	X								

(X) Fish have been planted in the past, current status unknown

Table F-4. Summary of Data Collection in the Big Creek System Basin

	Stream	Reach Length (mile)	Upper Elevation (ft)	Habitat Mapping	Fisheries Studies	Temperature Monitoring	Temperature Model	Instream Flow Model
South Fork San Joaquin River	Creek	0.8	7673		CDFG 1970			
	Crater Creek Diversion	1.6	8762					
	South Slide Creek	0.25	8100	CDFG 1970	CDFG 1970			
	North Slide Creek	0.25	8050	CDFG 1970	CDFG 1970			
	Hooper Creek	1.2	7505	CDFG 1970	CDFG 1970			
	Crater Creek	1.1	8765	ESA 1985	CDFG 1970			
	Bear Creek	1.8	7350	Bartholomew 1985; CDFG 1970				
	Chinquapin Creek	0.6	7330	ESA 1985; CDFG 1970	CDFG 1970			
	Camp 62 Creek	1.3	7353					
	Bosillo Creek	1.5	7535	CDFG 1970	CDFG 1970			
	Camp 61 Creek	1.9	7180		CDFG 1970			
	Mono Creek	1.4	7643	ENTRIX 1999; ESA 1985	SCE 1985			Biosystems 1984
	Mono Creek	5.1	7615	Bartholomew 1985; CDFG 1970; SCE 1971	Bartholomew 1985; CDFG 1970; SCE 1971	CDFG 1970		
	Warm Creek	5.8	8004	ENTRIX 1999; ESA 1985				
	SF San Joaquin River	26.8	3986	Bartholomew 1985; CDFG 1970	Bartholomew 1985; CDFG 1970	CDFG 1970		
Mammoth Reach	Rock Creek	0.4	3336		ESA 1985			
	Ross Creek	0.8	3359		ESA 1985			
	San Joaquin River	8.1	3361	Biosystems 1987b	Bartholomew 1985; Biosystems 1987b	Biosystems 1985, 1987b	Biosystems 1985, 1987b	Biosystems 1985, 1987b

Table F-4. Summary of Data Collection in the Big Creek System Basin (cont.)

	Stream	Reach Length (mile)	Upper Elevation (ft)	Habitat Mapping	Fisheries Studies	Temperature Monitoring	Temperature Model	Instream Flow Model
Big Creek Reach	Rancheria Creek	0.2	6960					
	Big Creek	4.2	4800	Biosystems 1987b; ENTRIX 1995 unpubl; CDFG 1970	ESA 1985; Biosystems 1987b; CDFG 1970	Biosystems 1987b; CDFG 1970	Biosystems 1987b	
	Big Creek	2.7	2950	Biosystems 1987a,b; ENTRIX 1995 unpubl; CDFG 1970	Biosystems 1987a,b	Biosystems 1987a,b		
	Big Creek	0.7	6920	ENTRIX 1995 unpubl.				
	Lower Big Creek	1.7	2256	ENTRIX 1995 unpubl.; Biosystems 1987b	Biosystems 1987b	Biosystems 1987b		
	Pitman Creek	1.4	6998	CDFG 1970	SCE unpubl.			
	Balsam Creek	0.6	5560					
	Balsam Creek	0.7	4873		SCE unpubl.	ESA 1985		
	Ely Creek	0.9	4842			ESA 1985		
	Adit #8 Creek	0.9	4816			ESA 1985		
Stevenson Reach	NF Stevenson Creek	1.75	7832	Biosystems 1988	Biosystems 1988 and 1993; ENTRIX 1993 unpubl; ESA 1985; CDFG 1980; SCE unpubl.			
	Stevenson Creek	3.8	6000	CDFG 1970	Biosystems 1987c, 1988; ENTRIX 1993 unpubl; ESA 1985	CDFG 1970		
	SJR Stevenson Reach	5.6	2145	Biosystems 1987b; CDFG 1979	Biosystems 1987a,b	Biosystems 1987b	Biosystems 1987b	Biosystems 1987b
	SJR Horseshoe Bend Reach	5.9	1216	Biosystems 1987c	Biosystems 1987a,c	ENTRIX 1995 unpubl.; Biosystems 1987c	Biosystems 1987c	Biosystems 1987c
Total Stream Reach		**91.75**						

Table F-5. Summary of Reservoir Data Collected in the Big Creek System Basin

Waterbody	Surface Elevation (ft)	Acre-Feet	Fisheries Studies	Limnologic Studies
Florence Lake	7329	64406	BioSystems 1987d	
Lake Thomas A. Edison	7651	125035	BioSystems 1987d	Nicola and Cordone 1972
Shaver Lake	5371	135568	BioSystems 1987e, 1994; ENTRIX 1992	BioSystems 1987e; CDWR 1980; Nicola and Cordone 1972
Huntington Lake	6954	89166	BioSystems 1987d	CDWR 1980; Nicola and Cordone 1972
Mammoth Pool Reservoir	3361	123000	BioSystems 1987d	Nicola and Cordone 1972
Redinger Lake	1414	26119	BioSystems 1987d	SCE 1997
Portal Forebay	7185			
Balsam Meadows Forebay	6675	1547	ENTRIX 1992	
Big Creek PH 2 Forebay	4810	60	BioSystems 1987d	*
Big Creek PH 8 Forebay	2940	49	BioSystems 1987d	*
Big Creek PH 3 Forebay	2230	990	BioSystems 1987d	*

Note: This table is currently incomplete, additional entries will be added.

Table F-6. Summary of Collected Water Temperature Data

			Stream Temperature (°C)					
			MAY	JUN	JUL	AUG	SEP	OCT
San Joaquin								
	downstream of Dam 7	Mean Daily	9.3	10.1	12.9	13.6	14.4	14.8
		Maximum Daily	10.3	11.7	19.1	15.3	15.7	15.7
	downstream of PH 3	Mean Daily	8.8	9.3	11.9	13	14.3	14.9
		Maximum Daily	9.7	11.1	14.2	14.5	15.1	19.8
	Horseshoe Bend	Mean Daily	10	10.5	12.6	18.9	19	16.5
		Maximum Daily	10.8	12.2	15.7	30.2	30.5	25.6
	upstream of PH 3	Mean Daily	8.6	9.2	11.9	15.9	17.3	14.6
		Maximum Daily	9.5	10.9	13.9	21.9	20.2	15.9
	upstream of PH 4	Mean Daily	8.6	10.6	12.2	17.9	17.2	15.8
		Maximum Daily	10.8	12.2	15.7	22.9	20.9	18.6
Willow Creek								
	near SJ confluence	Mean Daily	13.6	14	22.3	21.6	20	16.1
		Maximum Daily	16.1	17.7	23.7	25	23.6	18.8
Big Creek								
	downstream of Dam 1	Mean Daily	11.8	12.9	12.2	8.1	7.1	
		Maximum Daily	14.4	15.5	14.2	13	8.2	
	downstream of Dam 4	Mean Daily	13.8	14.9	14.7	12.1	10.8	
		Maximum Daily	16	16.9	16.3	15.4	27.9	
	downstream of P.H. 2	Mean Daily	13.2	14.7	16.1	14.6	11.8	
		Maximum Daily	14.4	16	17.2	16.7	13.9	
	upstream of P.H. 1	Mean Daily	14.3	14.4	12.3	6.2	5.1	
		Maximum Daily	17.8	18.5	16.1	12.9	5.8	
	upstream of P.H. 2	Mean Daily	19.8	19.6	16.3	10.4	8.6	
		Maximum Daily	22.1	22.7	19.8	16.1	9.2	

Table F-6. Summary of Collected Water Temperature Data (cont.)

			Stream Temperature (^oC)					
			MAY	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**
	upstream of P.H. 8	Mean Daily	17.3	17.7	16.9	12.7	10.3	
		Maximum Daily	19.8	20.6	20.6	18.3	12.3	
Stevenson Creek	above Railroad Grade	Mean Daily	15.3	15.2	13.9	10.3	8.9	
		Maximum Daily	18.1	18.8	16.5	15.1	10.9	
	below Shaver Lake	Mean Daily	12.9	14	15.3	15.6	13.7	
		Maximum Daily	13.9	14.9	16.2	16.7	14.5	
	at transmission road	Mean Daily	18.1	17.8	15.5	10.2	8.5	
		Maximum Daily	20.4	21.1	18.6	16.1	10.5	

APPENDIX G

BOTANICAL AND WILDLIFE

SPECIAL STATUS SPECIES TABLES

TABLE G-1. SPECIAL-STATUS VEGETATION POTENTIALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES[1]

Scientific/Common Name	Status	Habitat	Big Creek Nos. 1 & 2 (2175)	Big Creek Nos. 2A, 8, & Eastwood (67)	Big Creek No. 3 (120)	Big Creek No. 4 (2017)	Mammoth Pool (2085)	Portal (2174)	Vermilion (3086)
Allium yosemitense									
Yosemite onion	CR, CNPS 1B, USFS	broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest: rocky, metamorphic. (1755) 2600-7200 ft	Potential	Potential	No	No	No	No	Potential
Botrychium ascendens, B. crenulatum, B. lunaria, B. montanum Moonwort	CR, CNPS 1B, USFS	lower montane coniferous forests, oak woodlands, and chaparral: open rocky slopes. 2600-7200 feet	Potential	Potential	No	No	No	Potential	No
Calyptridium pulchellum									
Mariposa pussypaws	FT, CNPS 1B, USFS	cismontane woodland: in shallow granite soils on granitic domes, restricted to exposed sites. 1300-3600 ft	Potential	Potential	No	No	No	No	No
Camissonia sierrae ssp. alticola									
Mono Hot Springs evening primrose	FSoC, CNPS 1B, USFS	Upper montane coniferous forest. Known from few occurrences in Fresno & Mariposa Cos: sand or gravel pans over granite in mixed conifer forest: 5000-7500 ft	Potential	Potential	No	No	Potential	Potential	Yes
Carex praticola									
meadow sedge	CNPS 2	moist to wet meadows. 0-10500 ft	No	No	Potential	No	Potential	No	No

TABLE G-1. SPECIAL-STATUS VEGETATION POTENTIALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES[1] (continued)

Scientific/Common Name	Status	Habitat	Big Creek Nos. 1 & 2 (2175)	Big Creek Nos. 2A, 8, & Eastwood (67)	Big Creek No. 3 (120)	Big Creek No. 4 (2017)	Mammoth Pool (2085)	Portal (2174)	Vermilion (3086)
Carpenteria californica									
tree-anemone	CT, CNPS 1B, USFS	cismontane woodland, chaparral. endemic to Fresno Co. very localized on well-drained granitic soils, mostly on N-facing ravines and drainages.1500-4000 ft	Potential	Potential	Yes	Yes	Potential	No	No
Ceanothus fresnensis									
Fresno ceanothus	CNPS 4	cismontane woodland, lower montane coniferous forest. 2900-6500 ft	No	Potential	No	No	No	No	No
Clarkia biloba ssp. australis									
Mariposa clarkia	CNPS 1B, USFS	chaparral, cismontane woodland: Merced River canyon and adjacent tributaries. 1000-3100 ft	Potential	Potential	Potential	No	Potential	No	No
Clarkia lingulata									
Merced clarkia	CE, CNPS 1B, USFS (removed from Federal candidate status, 9/19/97)	closed-cone coniferous forest, chaparral, cismontane woodland: known from few populations in the Merced River canyon. 1300-1500 ft	Potential	Potential	Potential	No	Potential	No	No
Collomia rawsoniana									
flaming trumpet	FSoC, CNPS 1B, USFS	riparian forest, lower montane coniferous forest: on stabilized alluvium in riparian zones: at mid elevations along perennial streams north of the San Joaquin River. 2500-7200 ft	Potential	Potential	Potential	No	Yes	Potential	Potential

TABLE G-1. SPECIAL-STATUS VEGETATION POTENTIALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES[1] (continued)

Scientific/Common Name	Status	Habitat	Big Creek Nos. 1 & 2 (2175)	Big Creek Nos. 2A, 8, & Eastwood (67)	Big Creek No. 3 (120)	Big Creek No. 4 (2017)	Mammoth Pool (2085)	Portal (2174)	Vermilion (3086)
Cypripedium montanum mountain lady's-slipper	CNPS 4, USFS	broad-leaved upland and lower montane coniferous forests: moist or dry shaded slopes. 700-7200 ft	Potential	Potential	Potential	No	Potential	Potential	Potential
Delphinium inopinum unexpected larkspur	CNPS 1B	Alpine boulder and rock field: at high elevations in rocky soil at the extreme southern boundary of the Sierra National Forest. 7200-9200 ft	Potential	Potential	No	No	No	Potential	Potential
Dicentra nevadensis Tulare County bleeding heart	CNPS 4, USFS	subalpine coniferous forest: gravelly openings. 7200-10000 ft	Potential	Potential	No	No	No	Potential	No
Epilobium howellii subalpine fireweed	CNPS 1B	meadows, subalpine coniferous forest. wet meadows, mossy seeps. 6500-9000 ft	Potential	Potential	No	No	No	Yes	Potential
Erigeron aequifolius Hall's daisy	CNPS 1B	broad-leaved upland forest, lower and upper montatne coniferous forest, pinyon-juniper woodland: rocky soils. 4900-8000 ft	No	Potential	No	No	No	No	No
Eriogonum prattenianum var. avium Kettle Dome buckwheat	CNPS 4, USFS	upper montane coniferous forest (granitic). 3900-8500 ft	Potential	Potential	No	No	No	Potential	Potential

TABLE G-1. SPECIAL-STATUS VEGETATION POTENTIALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES[1] (continued)

Scientific/Common Name	Status	Habitat	Big Creek Nos. 1 & 2 (2175)	Big Creek Nos. 2A, 8, & Eastwood (67)	Big Creek No. 3 (120)	Big Creek No. 4 (2017)	Mammoth Pool (2085)	Portal (2174)	Vermilion (3086)
Eriophyllum congdonii									
Congdon'swoolly sunflower	CR, CNPS 1B, USFS	chaparral, cismontane woodland, lower montane coniferous forest: on metamorphic soils. 1600-6200 ft	Potential	Potential	Potential	No	Potential	No	No
Erythronium pluriflorum									
Shuteye Peak fawn lily	CNPS 1B, USFS	upper montane coniferous forest, meadows, subalpine coniferous forest. rocky granitic outcrops and slopes. 2060-2550m	No	Potential	No	No	Potential	No	Potential
Ivesia unguiculata									
Yosemite ivesia	CNPS 1B, USFS	meadows, subalpine coniferous forest, upper montane coniferous forest. moist, open slopes & meadows. 4900-9600 ft	Yes	Yes	No	No	Potential	Yes	Yes
Lewisia congdonii									
Congdon's lewisia	CR, CNPS 1B, USFS	chaparral, cismontane woodland, lower montane coniferous forest, upper montane coniferous forest: granitic, moist places: on metamorphic soils. 1600-9200 ft	Potential	Potential	Potential	No	Potential	Potential	Potential

TABLE G-1. SPECIAL-STATUS VEGETATION POTENTIALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES[1] (continued)

Scientific/Common Name	Status	Habitat	Big Creek Nos. 1 & 2 (2175)	Big Creek Nos. 2A, 8, & Eastwood (67)	Big Creek No. 3 (120)	Big Creek No. 4 (2017)	Mammoth Pool (2085)	Portal (2174)	Vermilion (3086)
Lewisia disepala Yosemite lewisia	CNPS 1B	lower montane coniferous forest, pinyon juniper woodland, upper montane coniferous forest. fine gravel on rock outcrops or domes. 6200-11000 ft	Potential	Potential	No	No	Potential	Potential	Potential
Linanthus serrulatus Madera linanthus	CNPS 1B	cismontane woodland, lower montane coniferous forest. dry slopes. 1000-4000 ft	Yes	Potential	Potential	No	Potential	No	No
Lupinus citrinus var. citrinus orange lupine	FSoC, CNPS 1B, USFS	chaparral, cismontane woodland, lower montane coniferous forest. rocky granitic outcrops, usually in open areas (forest openings), on flat to rolling terrain. 2000-5000 ft (600-1700 m)	No	Potential	Potential	Potential	Potential	No	No
Mimulus gracilipes slender-stalked monkeyflower	CNPS 4	lower and upper montane coniferous forest, pinyon-juniper woodlands: granitic sand. 1600-4300 ft	No	Potential	No	No	No	No	No

TABLE G-1. SPECIAL-STATUS VEGETATION POTENTIALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES[1] (continued)

Scientific/Common Name	Status	Habitat	Big Creek Nos. 1 & 2 (2175)	Big Creek Nos. 2A, 8, & Eastwood (67)	Big Creek No. 3 (120)	Big Creek No. 4 (2017)	Mammoth Pool (2085)	Portal (2174)	Vermilion (3086)
Sphenopholis obtusata									
prairie wedge grass	CNPS 2, USFS	cismontane woodland, meadow & seep, riparian scrub? open moist sites, along rivers & springs, alkaline desert seeps. 950-6500 ft	No	Yes	No	No	No	Potential	Potential
Wyethia ela[1]ta									
Hall's wyethia	CNPS 4	cismontane woodland, lower montane coniferous forest. 3000-4500 ft	Potential	No	Potential	Yes	No	No	No

FE = federal endangered, FT = federal threatened, FSoC = federal species of concern, CE = California endangered, CT = California threatened, CR = California rare, FSS = U.S. Forest Service special status species, CNPS = California Native Plant Society lists, 1B = plants rare, threatened, or endangered in California and elsewhere, 2 = plants rare, threatened, or endangered in California, but more common elsewhere, 4 = plants of limited distribution

[1] CNPS List 4 species are included as potentially present only if they were identified in other sources as likely to be in the project areas. Species listed as potentially present in the Big Creek 4 area include only those found in recent relicensing surveys or with CNDDB listed populations in the vicinity. Table does not include an unidentified Clarkia sp. Reported from above Ely Meadow at FERC Project No. 67.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES

Species	Status State[1] Federal[2]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Referen-ce Source	Comments Regarding Potential Occurrence
INVERTEBRATES											
Valley elderberry longhorn beetle (VELB) *Desmocerus californicus dimorphus*	none FT	Occurs on its host plant (elderberry) throughout the central Valley and adjacent foothills.	No*	No	No	No	No	Potential	No	1, 2	Elderberries occur in some lower elevation locations in the project region, but not adjacent to Edison facilities. The only known record for the valley elderberry longhorn beetle (VELB) within the project region was reported in May 1995, just west of Highway 168, approximately 2.5 miles southeast of Auberry, and about five miles south of Big Creek 4. * Surveys conducted in the relicensing of Big Creek No. 4 did not document any VELB occurrences in the project vicinity.
AMPHIBIANS											
California tiger salamander *Ambystoma tigrinum californiense*	CSC C	Vernal pools, annual grassland, and the grassy understory of valley-foothill oak woodland habitats. Requires seasonal wetlands or slow moving stream courses for reproduction.	No	No	No	No	No	No	No	2	Not expected within the Project area, due to the lack of suitable breeding and rearing habitat.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Limestone salamander *Hydromantes brunus*	ST FSC-FSS	Associated with limestone outcroppings in foothill woodland and chaparral habitats of Merced Canyon in Mariposa County. Known from the Sierra National Forest.	No	No	No	No	No	No	No	2, 7; 8; 9, 14, 15	Although limestone salamanders are found in the Sierra National Forest, the Project area is outside the known distribution of this species, which only extends to the western edge of the Sierra National Forest near Briceburg.
Mt. Lyell salamander *Hydromantes platycephalus*	CSC FSC	Mesic rocky areas, including outcrops, seeps, streams, and water-falls. Known from the Sierra National Forest at elevations ranging from 4,800 to 12,000 feet.	No	No	No	No	Yes	No	No	2, 7; 8; 9	Mt. Lyell salamanders are not expected at the elevations of the Project. However, they have been report near the summit of Bald Mountain.
Relictual slender salamander *Batrachoseps relictus*	CSC FSC-FSS	Debris ranging from rocks to bark and other tree debris. Known from the Sierra National Forest at elevations ranging from 600 to 8,000 feet.	No	No	No	No	No	No	No	7; 9	Although relictual slender salamanders are found in the Sierra National Forest, the Project area is outside the known distribution of this species, which only extends to the western edge of the Sierra National Forest near Briceburg.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Western spadefoot toad *Scaphiopus hammondii*	CSC none	Occurs primarily in grassland habitat, and occasionally in valley-foothill oak woodlands, and some orchard-vineyard habitat. Requires seasonal wetland habitat for breeding.	No	No	No	No	No	No	No	2 (E-11-1); 7; 8	This species is not known from Madera County or the Sierra National Forest.
Yosemite toad *Bufo canorus*	CSC FSC-FSS	Occurs in high mountain meadows and forest borders, breeding in shallow pools, at lake margins, or in pools of quiet streams at elevations ranging 4,800 to 12,000 feet. Known from the Sierra National Forest.	No	No	Yes	No	No	No	Yes	2, 6; 8; 9	Located along Rancheria Creek, a tributary to Huntington Lake, Papoose Lake and vicinity north of Lake Thomas A. Edison, Lakecamp Creek and Lake, about 1.5 mi south of Mount Givens and north of Big Creek; Fleming Creek, about 0.5 miles north of Devils Punchbowl

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	**Status** State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
California red-legged frog *Rana aurora draytonii*	CSC FT	Occurs in quiet streams, marshes, and occasionally ponds, riverine, riparian, heavily vegetated streamside shorelines, below 4,000 feet. Sierran streams historically supported populations of red-legged frog, however, these populations have been eliminated..	No	No	No	No	No	No	No	1, 2	Believed to be extirpated from the Project area.
Foothill yellow-legged frog *Rana boylii*	CSC FSC- FSS	Elevations ranging from 0 to 6,000 feet, rocky streams in a variety of habitats, including valley-foothill woodland, riparian, yellow pine forest, mixed conifer forest, coastal scrub, mixed chaparral, and wet-meadows. Known from the Sierra National Forest.	Yes	No	No	No	No	No	No	1,2, 6; 8; 9	Known from the Willow Creek watershed area, including South Fork Willow Creek; Rush Creek approximately 3 miles south of Shaver Lake; and Little Finegold Lake.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Mountain yellow-legged frog *Rana muscosa*	CSC FSC-FSS	In the Sierras at elevations ranging from 4,500 to 12,000 feet, this species is associated with streams, lakes, and ponds in montane riparian, lodgepole pine, subalpine conifer, and wet meadow habitats. Known from the high elevations of the Sierra National Forest.	No	No	Yes	No	No	No	Yes	2 (E-11-2); 6; 8; 9	Recorded near Kaiser Pass, approximately 4 km west of Portal Forebay; Lakecamp Lake, Lakecamp Creek upstream from lake and meadow, about 2.2 km south of Mt. Givens.

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
REPTILES											
Western pond turtle *Clemmys marmorata*	CSC FSC- FSS	Associated with permanent or near permanent water in a wide variety of habitat types, including freshwater emergent wetlands, ponds, lakes and streams.	Yes	No	No	Yes	Yes	Yes	Yes	1, 2 ,6; 8; 9	Observed at several locations along the shoreline of Redinger Lake and Willow Creek. Other location records for creeks flowing into Huntington Lake, Mammoth Pool Reservoir, and Meadow Lakes area between Shaver Lake and Redinger Lake. Individuals observed at Kerckhoff Reservoir, approx. 4 miles north of New Auberry, at confluence of San Joaquin River and Italian Creek in the Pine Ridge District of the Sierra National Forest; 1.0 KM SSW of Highway 168 on Lodge Road east of Whispering Pines Lane; Jose Creek from the SCE Powerhouse 3 south for approx. 6 mi.; West Fork of Chiquito Creek northwest of Mammoth Pool Reservoir.; Ross Creek below confluence with Clearwater Creek and unnamed tributary below Clearwater Forest Service Station.
California horned lizard *Phrynosoma cronatum frontale*	CSC FSC	Valley-foothill oak woodland, conifer, riparian, pine-cypress, juniper, annual grassland, washes, and floodplain habitats.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2	Expected resident.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
BIRDS											
Common loon *Gavia immer*	CSC (nesting) none	Uncommon on large deep lakes in the Central Valley, foothills, and mountains.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	2, 10	Occasional winter visitor but no known nesting records.
Double-crested cormorant *Phalacrocorax auritis*	CSC (rookery sites) none	Yearlong resident along the entire coast of California and on inland lakes, in fresh, salt, and estuarine waters.	Yes	Potential	Potential	Potential	Potential	Potential	Potential	2, 10	Occasional visitor but no known rookery sites.
Cooper's hawk *Accipiter cooperi*	CSC none	Breeding resident through most of the wooded portions of the State in dense stands of live oak, riparian deciduous, or other forests near water.	Yes	Potential	Potential	Potential	Potential	Yes	Potential	1, 2 ,10	Year-round resident. A Cooper's hawk was observed at several locations surrounding Redinger Lake.
Northern goshawk *Accipiter gentilis*	CSC FSC-FSS	Prefers middle to high elevation, mature, dense conifer forests. Casual in foothills during winter, and northern deserts in pinyon-juniper woodland and low elevation riparian habitats.	Yes	Yes	Potential	Potential	Yes	Yes	Yes	2, 6; 9; 10, 14, 15	Breeding record locations exists for the Huntington Lake area, Lake Thomas A Edison area, and Big Creek.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Sharp-shinned hawk *Accipiter striatus*	CSC none	Breeds in ponderosa pine, black oak, riparian deciduous, mixed conifer, and Jeffrey pine habitats; prefers but not restricted to riparian habitat.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Year-round resident.
Golden eagle *Aquila chrysaetos*	CSC-CFP none	Typically found in rolling foothills and mountain areas.	Yes	Potential	Potential	Potential	Potential	Potential	Yes	1, 2 , 10, 14, 15	Year-round resident. Observed in the Powerhouse 4, Big Creek area and San Joaquin River..
Swainson's hawk *Buteo swainsoni*	ST none	Nests in riparian habitat and scattered trees throughout the Central Valley. Forages in open habitats including grassland and cropland habitat. Winters in South America.	Yes	No	No	No	No	No	No	1, 2, 10	Observed at Redinger Lake. Not a resident species to the area but may pass through area during migration.
White-tailed kite *Elanus caeruleus*	CFP none	Coastal and valley lowlands, rarely found away from agricultural areas.	Potential	No	No	No	No	No	No	2, 10	Occasional visitor.
Bald eagle *Haliaeetus leucocephalus*	SE-CFP FT Propose d delisting on 7/6/99	Local winter migrant to various California lakes. Most of the breeding population is restricted to more northern counties. Regular winter migrant to the region.	Yes	No	No	Yes	Yes	Yes	Yes	1, 2 ; 3, 10, 14, 15	Wintering Populations appear to be static at 5 to 10 individuals and are most commonly observed at Pine Flat Reservoir, Mammoth Pool. Millerton Lake and Bass Lake. Less frequent sightings at Wilson, Shaver, Huntington and Redinger Lakes.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Osprey *Pandion haliaetus*	CSC none	Breeds in northern California, associated strictly with large fish-bearing waters, primarily in ponderosa pine and mixed conifer habitats.	Yes	Potential	Potential	Potential	Potential	Yes	Potential	1, 2, 10	Year-round visitor. Ospreys were observed fishing over Redinger Lake on several occasions (although, no nest sites were observed).
Merlin *Falco columbarius*	CSC none	Winter visitor to coastlines, open grasslands, savannas, woodlands, lakes, wetlands, and the edges or early successional stages of ponderosa pine and montane hardwood-conifer habitats.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	2, 10	Occasional visitor.
Prairie falcon *Falco mexicanus*	CSC none	Distributed from low-elevation annual grasses to high-elevation alpine meadows, associated primarily with perennial grasslands, savannas, rangeland, some agricultural fields, and desert scrub.	Yes	Potential	Potential	Potential	Yes	Yes	Potential	1, 2, 10, 14, 15	Possible nesting species. Juvenile individual observed foraging in the Horseshoe Bend area. Prairie falcons have been observed near Powerhouse 8.
American peregrine falcon *Falco peregrinus anatum*	SE-CFP Former FE (Delisted on 8/20/99)	Woodlands, forests, coastal habitats, riparian areas, coastal and inland wetlands.	Yes	Potential	Potential	Potential	Potential	Yes	Potential	1, 2, 10, 14, 15	Occasional visitor. Observed foraging over Redinger Lake.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	**Status** State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
California gull *Larus californicus*	CSC none	Nests on islands in alkali or freshwater lakes and salt ponds. Inland, frequents lacustrine, riverine, cropland habitat, landfill dumps, and urbanized areas.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	2 (E-11-4); 10	Uncommon visitor.
Short-eared owl *Asio flammeus*	CSC none	Open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, saline and fresh emergent wetlands. Needs elevated sites for perching and dense vegetation for roosting.	Potential	No	No	No	No	Potential	No	1, 2, 10	Rare winter visitor.
Long-eared owl *Asio otus*	CSC none	Frequents dense riparian and live oak thickets near meadow edges, and nearby woodland and forest habitats. Also found in dense conifer stands at higher elevations.	Yes	No	No	No	No	Yes	No	1 2, 10	Summer visitor. Calls noted in oak woodland habitats above Redinger Lake.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Great gray owl *Strix nebulosa*	SE FSS	Nests in montane coniferous forests and forages in montane meadows. Distribution includes high elevations of the Sierra Nevada and Cascade Ranges. Known to nest from the region at elevations above the Project Site.	Yes	Potential	Potential	Potential	Yes	Yes	Yes	2, 6; 9; 10, 14, 15	Nesting records in the vicinity of Redinger Lake and individuals were heard near Black Point, west of Huntington Lake.
California spotted owl *Strix occidentalis occidnetalis*	CSC FSC- FSS	Resides in dense, old-growth, multi-layered mixed conifer, redwood, Douglas fir and oak woodland habitats, from sea level up to approximately 7,600 feet. Known from the Sierra National Forest.	Yes	Potential	Yes	Potential	Yes	Potential	Yes	1, 2, 3; 4; 6; 9;10, 14, 15	Winter visitor, possible nesting species. Owls heard calling at three locations on Redinger Lake. Owls recorded 3-4 miles south of Powerhouse 8. Also recorded near Huntington and Shaver Lakes.
Vaux's swift *Chaetura vauxi*	CSC none	Prefers redwood and Douglas-fir habitats with nest sites in large, hollow trees and snags, especially tall, burned-out stubs. Forages over moist terrain and habitats, preferring rivers and lakes.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Possible summer visitor.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Black swift *Cypseloides niger*	CSC none	Nests in moist crevices or caves, or on cliffs near waterfalls in deep canyons. Forages widely over many habitats; seems to avoid arid regions. Known from the high elevations of the Sierra National Forest.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	2, 10	Uncommon summer visitor.
Willow flycatcher *Empidonax traillii brewsteri*	SE FSS	Wet meadow and montane riparian habitats from 2,000 to 8,000 feet. Most often occurs in broad, open river valleys or large mountain meadows with lush growth of shrubby willows Known from the Sierra National Forest.	Yes	Potential	Yes	Potential	Yes	Potential	Potential	1, 2, 3; 6; 9; 10, 14, 15	Willow flycatchers have been detected at several locations in the Sierra National Forest including: Beasore Meadow, Poison Meadow, Long Meadow, Lost Meadow, Summit Meadow, Dinkey Meadow, Lilly Pad, Markwood Meadow, Summit Creek, Shaver Lake Meadow, and Stevenson Creek.
California horned lark *Eremophilia alpestris actia*	CSC FSC	Grasslands along the coast and deserts near sea level to high-elevation alpine dwarf-shrub habitat above treeline. Prefers grasslands and other open habitats with low, sparse vegetation .	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Expected year-round resident.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Purple martin *Progne subis*	CSC none	Old-growth, multi-layered, open forest and woodland with snags. Forages over riparian areas.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Possible summer visitor.
Loggerhead shrike *Lanius ludrovicianus*	CSC FSC	Open habitats with sparse shrubs and trees (or other suitable perch sites) and bare ground and/or low, sparse herbaceous cover.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Expected year-round resident

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Least Bell's vireo *Vireo bellii pusillus*	SE FE	Willows and other low, dense valley-foothill riparian habitat and the lower portion of canyons (Zeiner et al. November 1990). Summer resident below 2,000 feet in Santa Barbara, Ventura, San Bernardino, Riverside, San Diego, Imperial, and Inyo counties.	No	No	No	No	No	No	No	2, 10; 11	Because of the limited range of this species, Least Bell's vireo are not expected within the Project area.
Tricolored blackbird *Agelaius tricolor*	CSC FSC	Breeds near freshwater, preferably in emergent wetland with tall dense cattails or tules, but also in thickets of willow, blackberry, wild rose, and tall herbs. Feeds in grassland and cropland habitats.	No	No	No	No	No	No	No	2, 10	Tricolored blackbirds are not expected within the Project area.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Yellow warbler *Dendroica petechia brewsteri*	CSC none	Breeds in riparian woodlands from coastal and desert lowlands up to 8,000 feet in Sierra Nevada. Also breeds in montane chaparral, open ponderosa pine and mixed conifer habitats with substantial amounts of brush.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Possible summer visitor.
Yellow-breasted chat *Icteria virens*	CSC none	Dense, brushy thickets and tangles near water, and thick understory in riparian woodland.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 10	Possible summer visitor.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
MAMMALS											
Mt. Lyell shrew *Sorex lyelli*	CSC FSC	Occurs in high elevation montane communities of the central Sierra Nevada. Known from the eastern portion of the Sierra National Forest.	No	Potential	Potential	No	Potential	No	Potential	2 , 12; 13	Mt. Lyell shrews potentially occurs at higher elevations in the Project area..
Pallid bat *Antrozous pallidus*	CSC none	Inhabits grasslands, shrublands, woodlands, and forests from sea level up through mixed conifer forests. Most common in open, dry habitats with rocky areas for roosting.	Potential	No	No	Potential	Potential	Potential	No	1, 2, 13	Possible year-round resident.
Spotted bat *Euderma maculatum*	CSC FSC	Habitats range from arid deserts and grasslands through mixed conifer forests up to 10,600 feet. Prefers sites with adequate roosting habitat, such as cliffs. Feeds over water and along marshes. Known from the Sierra National Forest.	Potential	Potential	Potential	Potential	Potential	Potential	Potential	1, 2, 13	Possible year-round resident

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Pale big-eared bat *Plecotus townsendii pallescens*	CSC none	Found in all but alpine and subalpine habitats; most abundant in mesic habitats. Requires caves, mines, tunnels, buildings, or other man-made structures for roosting. Known from the Sierra National Forest.	Potential	No	No	Potential	Potential	Potential	No	1, 2, 13	Possible year-round resident.
California mastiff bat *Eumops perotis californicus*	CSC FSC	Occurs in many open, semi-arid to arid habitats including conifer and deciduous woodlands, coastal scrub, annual and perennial grasslands, chaparral, desert scrub, urban areas.	Potential	No	No	Potential	Potential	Potential	No	1, 2, 13	Possible year-round resident.
Snowshoe hare *Lepus americanus*	CSC none	Montane riparian habitats with thickets of alders and willows, and stands of young conifers interspersed with chaparral above 4,800 feet in the southern Sierras. Known from the higher elevations of the Sierra National Forest.	No	Potential	Potential	No	Potential	No	Potential	13	Snowshoe hares potentially occurs at higher elevations in the Project area.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Sierra Nevada red fox *Vulpes vulpes necator*	ST FSC-FSS	Occurs throughout the Sierra Nevada at elevations above 7,000 feet in forests interspersed with meadows or alpine fell-fields. Open areas are used for hunting, forested habitats for cover and reproduction. Known from the higher elevations of the Sierra National Forest.	No	Potential	Potential	Yes	Yes	No	Potential	2, 3: 4; 13	The Sierra Nevada red fox is expected at elevations above 7,000 feet..
California wolverine *Gulo gulo luteus*	ST-CFP FSC	Mixed conifer, red fir, and lodgepole habitats, and probably sub-alpine conifer, alpine dwarf shrub, wet meadow, and montane riparian habitats. Occurs in Sierra Nevada from 4,300 to 10,800 feet.	No	Potential	Potential	No	Potential	No	Potential	2, 3; 4; 13, 14, 15	The wolverine potentially occurs at higher elevations in the Project area.

Table G-2. SPECIAL-STATUS ANIMALS PERIODICALLY OCCURRING NEAR THE BIG CREEK SYSTEM FACILITIES (continued)

Species	Status State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
Pine marten *Martes americana*	none FSS	Within the Sierra National Forest, martins are known from the high elevation forested plant communities. Optimal habitats are various mixed evergreen forests with more than 40% crown closure and large trees and snags for den sites.	No	Potential	Potential	No	Yes	No	Potential	2, 3; 4; 13, 14, 15	The American martin potentially occurs at the elevations in the Project area.
Pacific fisher *Martes pennanti pacifica*	CSC FSC- FSS	Suitable habitat consists of large areas of mature, dense forest stands with snags and greater than 50% canopy closure. Known from 4,000 to 8,000 ft elevations in the Sierra National Forest.	No	Potential	Potential	No	Yes	No	Potential	2, 3; 4; 13, 14, 15	Pacific fishers potentially occurs at higher elevations in the Project area.

Species	**Status** State[3] Federal[4]	Habitat	Big Creek No. 4	Vermilion Reservoir	Portal	Mammoth Pool	Big Creek Nos. 2A, 8 & Eastwood	Big Creek No. 3	Big Creek Nos. 1 & 2	Reference Source	Comments Regarding Potential Occurrence
California bighorn sheep *Ovis canadensis californiana*	ST FPE- FSS	Historically found along the east side of the Sierra Nevada in steep open terrain with available water. Winters in sagebrush scrub at lower elevations. Herds known from Inyo, Tulare, Modoc, Fresno, and Mono counties. Known from higher elevations in the Sierra National Forest.	No	No	No	No	No	No	No	2, 12; 13	Not expected within the Project area, as the site is well removed from the current range of the species.
Mule Deer Migration Corridors	N/A	Mule deer are common throughout most of California, except in the desert and intensively farmed areas without cover. Occurs mostly in early to intermediate succession stages of most forest, woodland and brush habitats. There are numerous deer herds in the Sierra National Forest.	Soldier Mdw -Green Mtn. Pop. Winter Range; San Joaquin Hero and Huntington deer herds	No	No	Beasore and 77 Corrala - Iron Mtn Pop. Holding Area; Deer Migration Route; San Joaquin Hero and Huntington deer herds	San Joaquin winter and summer ranges and holding areas	Beasore and 77 Corrala - Iron Mtn Pop. Holding Area; Deer Migration Route; San Joaquin Hero and Huntington deer herds	Beasore, 77 Corrala - Iron Mtn, and Soldier Mdw -Green Mtn Holding Area; Kaiser Wilderness Population Center; Deer Migration Route; San Joaquin Hero and Huntington deer herds	3; 5; 13, 14, 15	Mule deer holding areas, migration routes, summer ranges and winter ranges are located in the Project area.

[1] State Status

CFP California Fully Protected
CSC California Species of Special Concern
SE State Endangered
ST State Threatened

[2] Federal Status

FC Candidate Species for which there is enough data on file to support a listing as threatened or endangered
FE Federal Endangered
FPE Federally-proposed for listing as endangered
FSS Forest Service Sensitive
FT Federal Threatened

[3] References

1 Southern California Edison 1997. Big Creek No. 4 Water Power Project (FERC Project No. 2017), Volume 2, Exhibit E.
2 Southern California Edison 1997. Big Creek No. 4 Water Power Project (FERC Project No. 2017), Volume 3, Exhibit E.
3 United States Dept. of Agriculture. 1991. Final Environmental Impact Statement, Forest Land and Resource Management Plan, Sierra National Forest.
4 United States Dept. of Agriculture. 1991. Map Packet, California Spotted Owl and Sensitive Furbearer Element. Land and Resource Management Plan, Sierra National Forest.
5 United States Dept. of Agriculture. 1991. Map Packet, Wildlife Element. Land and Resource Management Plan, Sierra National Forest.
6 California Natural Diversity Data Base. 2000. California Natural Diversity Data Base. 1998. California Department of Fish and Game File Data on Sensitive Species and Habitats. California Department of Fish and Game, Sacramento, California/
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[1] State Status (as reported by the CDFG's *Special Animals List* (August 1994)

CFP California Fully Protected
CSC California Species of Special Concern
SE State Endangered
ST State Threatened

[1] Federal Status (as reported by the USFS and USFWS [61 FR 7595/61 FR 64481])

C Candidate species for which there is enough data on file to support a listing
FE Federal Endangered
FPE Federally proposed for listing as endangered.
FSS Forest Service Sensitive
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