COVER SHEET

FEDERAL ENERGY REGULATORY COMMISSION
FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE OROVILLE FACILITIES PROJECT
Docket No. P-2100-052

Cover Letter (and other information before the Table of Contents)
FEIS

Office of Energy Projects

May 18, 2007

FERC/FEIS–0202F

Final Environmental Impact Statement

Oroville Facilities
California
(FERC Project No. 2100)

888 First Street N.E., Washington, DC 20426

FERC/FEIS–0202F

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR HYDROPOWER LICENSE

Oroville Facilities—FERC Project No. 2100-052

California

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, DC 20426

May 2007

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FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, DC 20426

OFFICE OF ENERGY PROJECTS

TO THE PARTY ADDRESSED:

Attached is the final environmental impact statement (EIS) for the Oroville Facilities, located on the Feather River in the foothills of the Sierra Nevada in Butte County, California.

This final EIS documents the view of governmental agencies, non-governmental organizations, affected Indian tribes, the public, the license applicant, and Federal Energy Regulatory Commission (Commission) staff. It contains evaluations on the applicant's proposal and the alternatives for licensing the Oroville Facilities (FERC No. 2100-052).

Before the Commission makes a licensing decision, it will take into account all concerns relevant to the public interest. The final EIS will be part of the record from which the Commission will make its decision. The final EIS was sent to the U.S. Environmental Protection Agency and made available to the public on or before May 18, 2007.

Copies of the final EIS are available for review in the Commission's Public Reference Branch, Room 2A, located at 888 First Street, N.E., Washington, DC 20426. The final EIS also may be viewed on the Internet at www.ferc.gov under the eLibrary link.

Attachment: Final Environmental Impact Statement

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COVER SHEET

a.	Title:	Relicensing the Oroville Facilities located on the Feather River in the foothills of the Sierra Nevada in Butte County, California, Federal Energy Regulatory Commission (Commission or FERC) Project No. 2100.
b.	Subject:	Final Environmental Impact Statement
c.	Lead Agency:	Federal Energy Regulatory Commission
d.	Abstract:	The Oroville Facilities were developed as part of the California State Water Project, a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The existing license for the Oroville Facilities (issued by the FERC, on February 11, 1957) will expire on January 31, 2007. The California Department of Water Resources (DWR), through the Alternative Licensing Procedures, is seeking a new federal license to continue generating hydroelectric power while continuing to meet existing commitments and comply with regulations pertaining to water supply, flood control, the environment, and recreational opportunities.
e.	Contact:	James Fargo Federal Energy Regulatory Commission Office of Energy Projects 888 First Street, N.E. Washington, DC 20426 202-502-6095
f.	Transmittal:	This final environmental impact statement prepared by the Commission's staff on the hydroelectric license application filed by DWR for Oroville Facilities (FERC Project No. 2100) is being made available to the public on or about May 18, 2007, as required by the National Environmental Policy Act (NEPA) of 1969[1] and the Commission's regulations implementing NEPA (18 CFR Part 380).

[1] National Environmental Policy Act of 1969, amended (Pub. L. 91-190. 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, §4(b), September 13, 1982).

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FOREWORD

The Federal Energy Regulatory Commission (Commission), pursuant to the Federal Power Act (FPA)[2] and the U.S. Department of Energy Organization Act[3] is authorized to issue licenses for up to 50 years for the construction and operation of non-federal hydroelectric development subject to its jurisdiction, on the necessary conditions:

> That the project…shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses, including irrigation, flood control, water supply, and recreational and other purposes referred to in Section 4(e)…[4]

The Commission may require such other conditions not inconsistent with the FPA as may be found necessary to provide for the various public interests to be served by the project.[5] Compliance with such conditions during the licensing period is required. The Commission's Rules of Practice and Procedure allow any person objecting to a licensee's compliance or noncompliance with such conditions to file a complaint noting the basis for such objection for the Commission's consideration.[6]

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[2] 16 U.S.C. §791(a)-825r, as amended by the Electric Consumers Protection Act of 1986, Public Law 99-495 (1986) and the Energy Policy Act of 1992, Public Law 102-486 (1992).

[3] Public Law 95-91, 91 Stat. 556 (1977).

[4] 16 U.S.C. §803(a).

[5] 16 U.S.C. §803(g).

[6] 18 C.F.R. §385.206 (1987).

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
μg/L	micrograms per liter
μmhos/cm	micro-mhos per centimeter
ADA	Americans with Disabilities Act
APE	area of potential effects
Basin Plan	Central Valley Regional Water Quality Control Board's Water Quality Control Plan
Berry Creek Rancheria	Berry Creek Rancheria of Maidu Indians of California
BLM	U.S. Bureau of Land Management
CDF	California Department of Forestry and Fire Protection
CEQA	California Environmental Quality Act
cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
Corps	U.S. Army Corps of Engineers
DBW	California Department of Boating and Waterways
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DO	dissolved oxygen
DPR	California Department of Parks and Recreation
DPS	Distinct Population Segment
DWR	California Department of Water Resources
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESU	evolutionarily significant unit
FERC	Federal Energy Regulatory Commission
Forest Service	U.S. Department of Agriculture, Forest Service
FPA	Federal Power Act
FR	Federal Register
FWS	U.S. Fish and Wildlife Service
HPMP	Historic Properties Management Plan
IHN	Infectious Hematopoietic Necrosis
kV	kilovolt
kWh	kilowatt-hour
LWD	large woody debris
MCL	maximum contaminant level
mg/L	milligrams per liter
mL	milliliter
Mooretown Rancheria	Mooretown Rancheria of Maidu Indians of California
msl	mean sea level

MTBE	methyl tertiary butyl ether
MW	megawatt
MWh	megawatt-hour
National Register	National Register of Historic Places
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
O&M	operations and maintenance
OEHHA	California/EPA Office of Environmental Health Hazard Assessment
OHV	off-highway vehicle
ORCA	Oroville Recreation Coordination Agencies
OWA	Oroville Wildlife Area
PG&E	Pacific Gas and Electric Company
Regional Board	Central Valley Regional Water Quality Control Board
RM	river mile
RV	recreational vehicle
SHPO	State Historic Preservation Officer
USGS	U.S. Geological Survey
Water Board	State Water Resources Control Board

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EXECUTIVE SUMMARY

On January 11, 2001, the Federal Energy Regulatory Commission (Commission or FERC) issued a letter order approving the California Department of Water Resources' (DWR) request to use the alternative licensing process defined in 18 CFR §4.34(i), for relicensing the Oroville Facilities (FERC Project No. 2100).

DWR filed a license application with the Commission for a major new license to continue to own, operate, and maintain the Oroville Facilities on January 26, 2005. The 762-megawatt project is located on the Feather River in Butte County, California, and occupies 1,620 acres of federal lands managed by the U.S. Department of Agriculture, Forest Service, within the Plumas and Lassen National Forests and 4,620 acres managed by the U.S. Bureau of Land Management. The 2005 application included a preliminary draft environmental assessment.

DWR's license application outlined its proposal to continue operating the Oroville Facilities in accordance with certain existing and interim operational and environmental measures. DWR filed a comprehensive Offer of Settlement (Settlement Agreement) with the Commission on March 24, 2006, which replaces the Proposed Action outlined in the license application. The terms of the Settlement Agreement[7] include a wide range of measures described in Proposed Articles A100 through A135. The agreement also includes a set of measures that DWR proposes to implement outside of the project license.

Under the Proposed Action, DWR would implement six programs designed to enhance habitats for coldwater fisheries to benefit the threatened and endangered Central Valley spring-run Chinook salmon and Central Valley steelhead in the Feather River and warmwater fisheries in Lake Oroville. The Proposed Action includes a comprehensive program to monitor water quality and bacteria levels at project waters for the benefit of both fisheries and visitors using the project's swimming areas. Wildlife would be enhanced through proposed measures to manage the Oroville Wildlife Area. These measures include protecting nesting grebes and vernal pool habitat; minimizing disturbance to nesting bald eagles; protecting threatened and endangered species, including the giant garter snake, California red-legged frog, and valley elderberry longhorn beetles; providing upland food and nesting cover for waterfowl; and managing invasive plants. The substantial recreational opportunities of the Oroville Facilities would be enhanced and expanded through the implementation of the Recreation Management Plan, which includes upgrades to existing facilities, construction of new facilities, and comprehensive monitoring of recreation use over the term of any license issued for the project. Finally, the Proposed Action includes the implementation of a Historic Properties Management Plan and specific measures to address conflicts between recreation use and the protection of cultural resources. These environmental measures are described in detail in section 2.2.3, *Proposed Environmental Measures* of this environmental impact statement (EIS).

Staff revised some of the applicant-proposed project-related environmental measures to increase monitoring activities or accelerate the implementation schedules. We recommend including measures that would address concerns and recommendations made by the U.S. Department of Agriculture, Forest Service, Butte County, Native American Tribes, and visitors who use the extensive project-related trails. These include measures to (1) develop a fuel management plan on National Forest System lands; (2) prepare biological evaluations of any proposed new construction on National Forest System lands; (3) revise the Recreation Management Plan to include maintenance standards, the completion of a trail condition inventory

[7] The Settlement Agreement is available on the Commission's web site from the eLibrary feature at http://www.ferc.gov/docs-filing/elibrary.asp. Accession number 20060330-0215.

prior to recommending any redesignation of trail use, and the inclusion of trail users in the recreational monitoring program; (4) develop a threatened and endangered species implementation plan; and (5) close Foreman Creek to recreational use until DWR develops a plan to protect cultural resources and install recreation facilities. Staff's revised and additional recommended measures are described in section 2.3.5, *Staff Alternative,* of this EIS.

In this EIS, we analyze and evaluate the environmental effects associated with the issuance of a new license for the existing hydropower project and recommend conditions for inclusion in any license issued. For any license issued, the Commission must determine that the project adopted will be best adapted to a comprehensive plan for improving or developing the waterway. In addition to the power and development purposes for which licenses are issued, the Commission must give equal consideration to energy conservation and the protection and enhancement of fish and wildlife, aesthetics, cultural resources, and recreational opportunities. This EIS for the Oroville Facilities reflects the staff's consideration of these factors.

Overall, the measures proposed by DWR under the terms of the Settlement Agreement, along with additional staff-recommended and revised measures, would protect and enhance existing water use, water quality, fish and wildlife, land use, aesthetics, recreational, and cultural resources. In addition, the project would continue to provide a large portion of the electricity needed to pump water through the California State Water Project at a lower cost than potential replacement power sources.

New environmental and recreation measures as proposed by the applicant would cost $13,371,800. The Staff Alternative would cost $13,075,700 or about $296,100 less than DWR's Proposal. Generation would decrease 43,500 megawatt-hours under both DWR's Proposal and the Staff Alternative compared to the No-action Alternative, and this would reduce power benefits by about $1,480,000, although the annual cost of pump-back energy would drop by $35,000.

Based on our independent analysis of the Oroville Facilities, including our consideration of all relevant economic and environmental concerns, we conclude that issuing a new license for the project as proposed by DWR, along with staff's modification and additions to those proposals, would be best adapted to a comprehensive plan for the proper use, conservation, and development of the Feather River.

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Section 1
Purpose of Action and Need for Power
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1.0 PURPOSE OF ACTION AND NEED FOR POWER

On January 26, 2005, the California Department of Water Resources (DWR) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a new major license for the existing Oroville Facilities (FERC Project No. 2100). The 762-megawatt (MW) project is located on the Feather River, in Butte County, California, near the community of Oroville (figure 1). The Oroville Facilities are located at river mile (RM) 59 from the Feather River's confluence with the Sacramento River. The site is located in central California about 130 miles northeast of San Francisco, California. The project occupies 41,540 acres including 1,620 acres of federal lands managed by the U.S. Department of Agriculture, Forest Service (Forest Service; within the Plumas and Lassen National Forests) and the U.S. Bureau of Land Management (BLM; 4,620 acres).[8] The project would be expected to generate an average of 2,382,000 megawatt-hours (MWh) annually under current conditions. DWR does not propose any modifications to the Oroville Facilities that would either add new generation equipment or increase the generating capability of the existing three power plants. However, DWR does propose continuing to operate and maintain the Oroville Facilities with new environmental and recreational measures. These measures could be either structural or operational improvements that could affect future project costs and the amount of annual generation.

1.1 PURPOSE OF ACTION

The Commission must decide whether to issue a new license to DWR for the Oroville Facilities and what conditions, if any, should be placed on that license. Issuing a license would allow DWR to continue generating electricity for the term of that license, making electric power from a renewable source available to its customers the State Water Project.

In this environmental impact statement (EIS), we assess the effects associated with the operation of the project as well as alternatives to the proposed project; make recommendations to the Commission about whether to issue a new license; and if so, recommend terms and conditions to become part of any license issued. In deciding whether to issue any license, the Commission must determine that the project would be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (e.g., flood control, irrigation, and water supply), the Commission must give equal consideration to the purposes of energy conservation; protection of, mitigation of damage to, and enhancement of fish and wildlife (including related spawning grounds and habitat); protection of recreational opportunities; and the preservation of other aspects of environmental quality. In this EIS, we analyze and evaluate the environmental and economic effects of continuing to operate the project as it now operates and operating it (1) as presented in the Settlement Agreement (DWR, 2006a) and (2) with staff-recommended measures (Staff Alternative).

Four major issues for this project include flow releases into the Feather River, recreational trails, socioeconomic effects, and cultural resource protection. Project flow releases are important because they directly affect the quality of habitat for aquatic species, including anadromous fish by influencing water temperature and creating spawning habitat for fish. Project flow releases are also important because water released into the Feather River at each of the diversions affects the generation capacity and operational flexibility of the project.

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[8] We note there are inconsistencies within the license application regarding the acreage of public land within the project boundary. The preliminary draft environmental assessment states that BLM and Forest Service manage 3,900 and 2,000 acres of land, respectively. Exhibit G states that BLM and Forest Service manage 4,602.93 and 1,571.99 acres of land, respectively. Final Land Management Report (L-2) states that BLM and Forest Service manage 3,852 and 2,039 acres of land, respectively. DWR in its comments on the draft EIS states that BLM manages 4,620 acres and Forest Service manages 1,620 acres of federal lands.

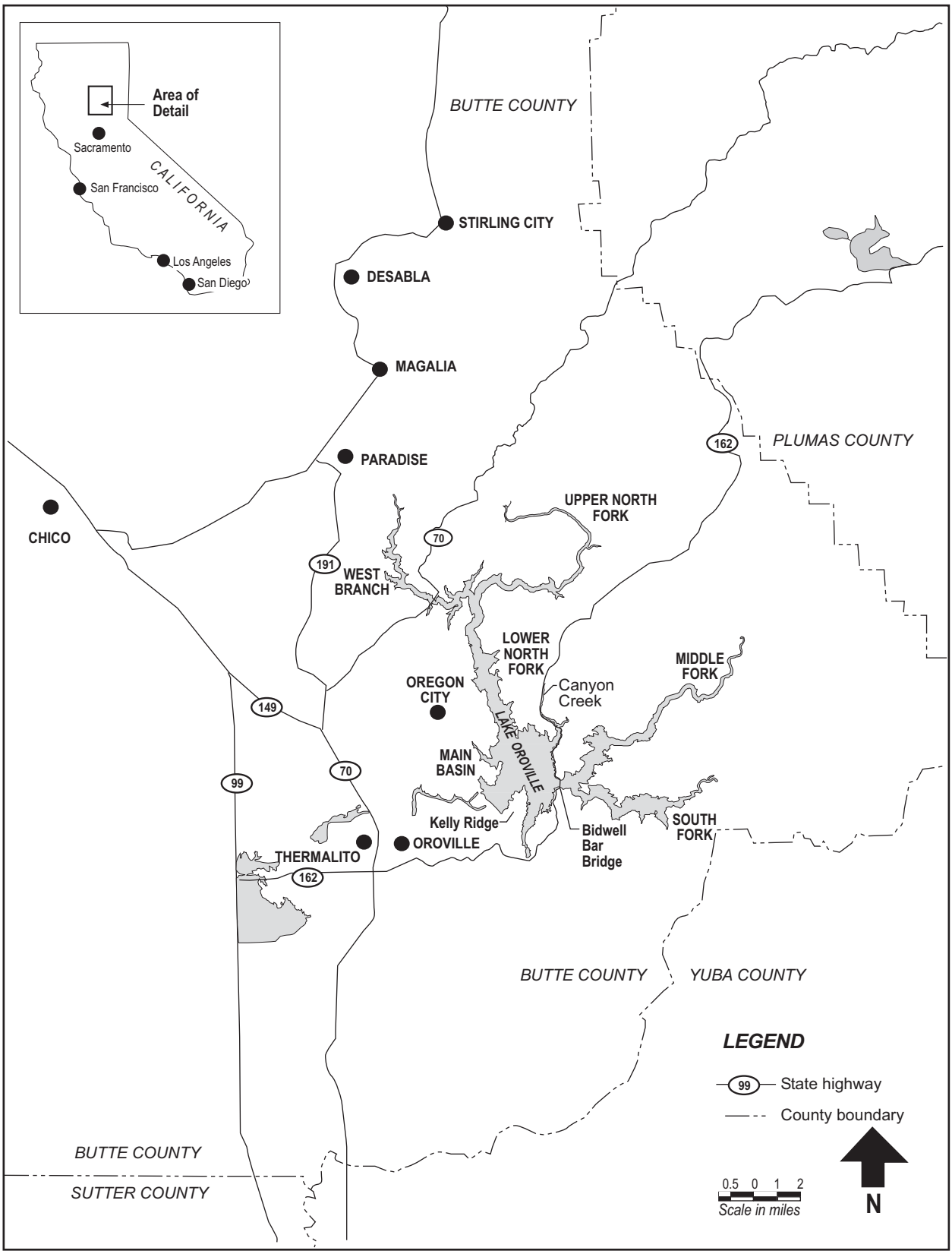

Figure 1. Oroville Facilities location. (Source: DWR, 2005a)

The project provides approximately 90 miles of trails that provide access to project lands and waters. Each trail is designated for specific uses whereby some trails are open to all forms of non-motorized uses and some forms of trail use, such as bicycling, are not allowed. At issue is the proper mix of designated uses that should be provided on the project recreational trails. Specifically, changing trails designated as equestrian/hiker-only to multiple-use trails would diminish the opportunity for equestrians to ride on trails where they would not encounter bicycles. In determining trail use designations, there is a trade-off between preserving the quality and safety of recreational experiences and providing abundant trail access for the public.

The project is located in the greater Oroville area where agriculture (primarily orchard and rice production), local and state government, and recreation and tourism–serving businesses dominate the local economy. The project attracts considerable recreational visitation that provides economic benefits and creates needs for public services such as search and rescue, road maintenance, and law enforcement. Because the project is located on public land, the lands are not subject to local taxes. Butte County, the main provider for these services, funds these services without direct funding support from the project. Additionally, Butte County asserts that its Emergency Operations Center could be inundated by a flood event.

The project recreation site at Foreman Creek contains cultural resources. Local tribes identify the importance of this area and believe DWR's proposed recreation development and any continued recreation use at the site would compromise cultural resources.

1.2 NEED FOR POWER

1.2.1 Regional Power Considerations

The Oroville Facilities has an installed capacity of 762 MW and an average annual generation of 2.4 million MWh[9] per year of energy from its three power plants. It plays an important part in meeting the capacity requirements of DWR and is a significant power resource to the state of California and within the Western Electricity Coordinating Council that includes the states west of the Rockies; portions of Texas, Nebraska, and Kansas; Alberta and British Columbia, Canada; and a portion of North Baja California.

Because the project is located in the California-Mexico Power area of the Western Electricity Coordinating Council, we looked at the regional need for power as reported by the Western Electricity Coordinating Council (WECC, 2005) to anticipate how the demand for electricity is expected to change in the region.

The California-Mexico Power area, which encompasses most of California and a part of Baja California in Mexico, has a significant summer peak demand. For the period from 2005 through 2014, the Western Electricity Coordinating Council forecasts peak demand and annual energy requirements in the area to grow at annual compound rates of 2.4 and 2.6 percent, respectively. Severe weather conditions in 1998 and 2000 affected the area, resulting in numerous curtailments of service to interruptible customers. Even with assumptions about future generation and transmission extension projects, short-term statewide and local reliability problems exist. Resource capacity margins for the California-Mexico Power area range between 13.2 and 14.8 percent of firm peak summer demand for the next 10 years, including allowances for projected new capacity. Winter reserves are expected to fall from 31.3 percent in 2005 to 2006 to 15.1 percent in 2014 to 2015. Available reserves in the California-Mexico Power area are projected to decrease below generally accepted values of 15 to 18 percent. Therefore, maintaining the capacity from the Oroville Facilities could have a significant positive effect on the ability of the area to meet regional requirements for generation in both summer and winter. The

[9] This value is the average generation from 1982 to 2001 (DWR, 2005b, exhibit B).

Western Electricity Coordinating Council anticipates that 6,783 MW of new capacity would come on line within the next 10 years in the California-Mexico Power region of the Western Electricity Coordinating Council region.

1.2.2 DWR Power Considerations

The project's power capacity and generation are vital to the state of California. The project provides a large portion of the electricity needed to pump water through the California State Water Project at a lower cost than potential replacement power sources.

Oroville Facilities operations are planned and scheduled in concert with other State Water Project and U.S. Bureau of Reclamation Central Valley Project's water storage, pumping, and conveyance facilities. The primary operating function of the Oroville Facilities power plants is to provide electricity to State Water Project pumps that move water through the State Water Project system. Overall, the State Water Project uses more energy than it produces. Thus, any decrease in power generation at the Oroville Facilities would need to be offset by increased purchases of energy from other resources and/or by construction of new power generating facilities. In 2000, the State Water Project required 9,190,000 MWh of generation to meet pumping requirements and station service usage. In the same year, the Oroville Facilities generated roughly 2,760,000 MWh of that total, which amounts to about 30 percent of the system's total requirements. The year 2000 was somewhat above average in terms of the annual generation at the Oroville Facilities as compared to the long-term average of 2,400,000 MWh. The year 2001 was a drier year in which Oroville Facilities only generated about 1,235,000 MWh (only half of the long-term average). During that same year, the State Water Project required about 6,656,000 MWh. Under those conditions, Oroville Facilities provided about 18.5 percent of the State Water Project needs. We present further analysis of the relationship between State Water Project energy usage and Oroville energy production in section 4.0, *Developmental Analysis*.

If the project's license is issued, the Oroville Facilities would continue to contribute to a diversified generation mix and help meet power needs within and beyond the region. Regional power benefits from the Oroville Facilities[10] include those often referred to as ancillary system benefits, including spinning reserves, non-spinning reserves, peaking capacity, and grid stability. The project would also reduce the need for fossil-fueled electric power generation thereby conserving non-renewable fossil fuels and reducing the emission of noxious byproducts that would be caused by fossil fuel combustion. We conclude that the project power contributes to a diversified generation mix and helps meet a need for power in the region.

1.3 SCOPING PROCESS

On January 11, 2001, the Commission issued a letter approving DWR's request to use the alternative licensing process for relicensing the Oroville Facilities. In accordance with the Commission's regulations, this includes a scoping process and preparing a preliminary draft environmental assessment as a substitute for exhibit E of the license application, which describes DWR's scoping process; includes information about potential resource effects and protection, mitigation, and enhancement proposals; and includes copies of comments received by DWR and the Commission on the proposed project.

The National Environmental Policy Act (NEPA) scoping process was completed as part of the alternative licensing process, and the Commission and DWR formally initiated public scoping on September 27, 2001, with the release of Scoping Document 1. Public scoping meetings were held in the cities of Oroville and Sacramento, California, on October 29 and 30, 2001, respectively, to receive oral comments on the project. At those meetings, a court reporter recorded all comments and the transcripts

[10] Two of the three hydroelectric developments, Hyatt pumping-generating plant and Thermalito pumping-generating plant have a pumped storage capability, thereby enhancing ancillary benefits.

are a part of the public record for the project. Any person who was unable to attend a public scoping meeting or desired to provide further comment was encouraged to submit written comments and information to DWR and the Commission by November 26, 2001.

Based on the comments received, a final Scoping Document 1 was issued on September 20, 2002. Subsequently, Scoping Document 2 was issued on February 21, 2003, for the purpose of supporting the development of an environmental document that would fulfill the requirements of NEPA. The notice solicited additional comments to be submitted by April 28, 2003. The following entities provided written comments throughout the scoping process. During the scoping meetings, three entities also provided oral comments, which are included in the meeting transcripts.

Commenting Entity	**Date of Comment**
National Marine Fisheries Services (NMFS)	October 11, 2001, May 28, 2003
Butte County	October 29, 2001, April 27, 2003
Catherine H. Hodges	October 29, 2001, April 28, 2003
Feather River Diverters (Joint Water Districts and Western Canal Water Districts)	October 29, 2001, April 28, 2003
Oroville Foundation of Flight	October 29, 2001
Ron Davis	October 29, 2001, April 27, 2003
Alameda County Flood Control & Water Conservation District	October 30, 2001
Association of California Water Agencies	October 30, 2001
California Business Properties Association	October 30, 2001,
California Chamber of Commerce	October 30, 2001
California Independent System Operator	October 30, 2001
Castaic Lake Water Agency	October 30, 2001
Kern County Water Agency	October 30, 2001
Southern California Water Committee	October 30, 2001
State of California Electricity Oversight Board	October 30, 2001
State Water Contractors Inc.	October 30, 2001, April 28, 2003
Plumas National Forest	November 14, 2001
Civil Engineering Services, F.D. Pursell	November 16, 2001
National Park Service	November 16, 2001
California State Department of Fish & Game	November 21, 2001, April 28, 2003
State Water Resources Control Board	November 21, 2001
Metropolitan Water District of Southern California	November 26, 2001
Paleo Resource Consultants, F&F Geo Resources Associates Inc.	November 26, 2001
Santa Clara County Water District	November 26, 2001

Commenting Entity	Date of Comment
United States Fish and Wildlife Service	Undated[11]
California State Department of Forestry and Fire Protection	April 11, 2003
The Baiocchi Family	April 15, 2003
Pacific Cherokee Tribal Council	April 21, 2003
County of Sutter, Board of Supervisors	April 22, 2003
Northern California Water Association	April 28, 2003

1.4 AGENCY CONSULTATION AND PUBLIC INVOLVEMENT

1.4.1 Alternative Licensing Process

An integral part of the alternative licensing process, significant opportunities for public involvement were integrated into the relicensing process. Opportunities began late in 1999 when DWR distributed a notice to government agencies, federally recognized Indian tribes, and other interested parties and organizations to develop a list of potential stakeholders. The alternative licensing process consisted of opportunities for agencies and individuals to participate in one of five resource-specific work groups to identify resource issues, develop study plans, consider existing and new information and recommend measures to the plenary group. Meetings of the Environmental; Recreation and Socioeconomic; Cultural Resources; Land Use, Land Management and Aesthetics; and Engineering and Operations Work Groups and the Plenary Group occurred from 2000 to 2004. All meetings were documented in meeting summaries, including decisions and action items, and placed on the applicant's web site.[12] These meetings gave interested members of the public the opportunity to provide input on the type and scope of resource study plans and the ability to comment on the results of the studies.

Over the course of this relicensing proceeding, the Commission received numerous filings for this project. Most of the filings were in response to (1) DWR's application filing, (2) the Commission's notice accepting the license application that solicits interventions and terms, conditions, and recommendations from agencies, and (3) DWR's filing of the Settlement Agreement. These filings are on the project record and can be found on the Commission's web site by using the eLibrary feature.

1.4.2 Interventions and Comments

On September 12, 2005, the Commission issued a notice accepting DWR's application and set a deadline of March 31, 2006, for filing protests, motions to intervene, and agency terms and conditions. The following table lists entities that filed motions to intervene and agency letters providing comments, recommendations, terms, and conditions for this relicensing proceeding.

Intervenor	Date of Filing
County of Butte, California	April 21, 2005, and March 30, 2006
Enterprise Rancheria	June 8, 2005

[11] This letter was not dated, but it appears as a scoping comment letter titled Fish and Wildlife Service's Comments on NEPA Scoping Document 2 and Amended CEQA Notice of Preparation—Oroville FERC Relicensing**,** dated February 25, 2003. It is available on DWR's web site at http://orovillerelicensing.water.ca.gov/pdf_docs/sd2_comments_fws.pdf.

[12] The applicant's web site is available on the Internet at http://orovillerelicensing.water.ca.gov.

Intervenor	Date of Filing
Friends of the River, Sierra Club and South Yuba River Citizens League	October 17, 2005
Michael Kelley	November 10, 2005
Pacific Gas and Electric Company	November 16, 2005
Kern County Water Agency	November 16, 2005
The Anglers Committee, The Baiocchi Family, Butte Sailing Club, Butte County Taxpayers for Fair Government, Butte County Taxpayers Association and Lake Oroville Fish Enhancement Committee	December 16, 2005, and April 20, 2006
Tyme Maidu Tribe of the Berry Creek Rancheria	January 30, 2006
Mojave Water Agency	January 30, 2006
Cathy Hodges	February 7, 2006
Western Canal Water District, Richvale Irrigation District, Butte Water District, Biggs-West Gridley Water District, Sutter Extension Water District	February 13, 2006
State Water Contractors[13]	February 3, 2006, and March 30, 2006
Lake Oroville Bicycle Organization	February 22, 2006, and March 31, 2006
Plumas County	March 16, 2006
California State Water Resources Control Board	March 16, 2006
Sutter County, Yuba City, Levee District No. 1 of Sutter County	March 27, 2006
Metropolitan Water District of Southern California	March 28, 2006
U.S. Department of Agriculture, Forest Service	March 29, 2006
National Marine Fisheries Service	March 29, 2006
California Department of Fish and Game	March 29, 2006
Mooretown Rancheria of Maidu Indians of California	March 30, 2006
Ronald Davis	March 31, 2006
California State Horsemen's Association	March 31, 2006
American Rivers, American Whitewater, Chico Paddleheads	March 31, 2006
Action Coalition for Equestrians et al.[14]	March 31, 2006

[13] Filed on behalf of Alameda County Flood Control and Water Conservation District, Zone 7; Alameda County Water District; Antelope Valley-East Kern Water Agency; Castaic Lake Water Agency; Central Coast Water Authority; Coachella Valley Water District; County of Kings; Crestline-Lake Arrowhead Water Agency; Desert Water Agency; Dudley Ridge Water District; Empire West Side Irrigation District; Littlerock Creek Irrigation District; Oak Flat Water District; Palmdale Water District; San Bernardino Valley Municipal Water District; San Gabriel Valley Metropolitan Water District; San Gorgonio Pass Water Agency; Santa Clara Valley Water District; Solano County Water Agency; and Tulare Lake Basin Water Supply District.

Intervenor	Date of Filing
George Weir, Vicki Hittson-Weir and Pathfinder Quarter Horses	March 31, 2006
California State Horsemen's Association, Region II	March 31, 2006
Mechoopda Indian Tribe of Chico Rancheria	March 31, 2006
KonKow Valley Band of Maidu	March 31, 2006
International Mountain Bicycling Association	March 31, 2006
United Water Conservation District and City of San Buenaventura	March 31, 2006
U.S. Department of the Interior	March 31, 2006
City of Oroville	April 20, 2006
Feather River Recreation and Park District	May 11, 2006

1.4.3 Settlement Agreement

Early in 2004, DWR initiated settlement negotiations with agencies, tribes, non-governmental organizations, and other interested parties (Settlement Negotiations Group) to develop an alternative that would be supported by these participants. Settlement negotiations continued into March 2006, and DWR filed a Settlement Agreement with an explanatory statement on March 24, 2006. The Settlement Agreement was signed by representatives of 51 federal, state, and local agencies; the KonKow Valley Band of Maidu; non-governmental organizations; and two individuals. In the cover letter transmitting the Settlement Agreement to the Commission, DWR requested that the proposed articles included in the Settlement Agreement replace the preferred alternative identified in the project application, which was filed on January 26, 2005.[15] Accordingly, we consider the Settlement Agreement to represent the Proposed Action for this project.

Signatories to the Settlement Agreement include the following entities:

Agencies

- National Marine Fisheries Service
- United States Department of the Interior
- California Department of Boating and Waterways
- California Department of Fish and Game
- California Department of Parks and Recreation
- California Department of Water Resources

[14] Filed on behalf of Action Coalition of Equestrians, Back Country Horsemen of California, California Equestrian Trails & Lands Coalition, Chico Equestrian Association, Equestrian Trail Riders, Equestrian Trails, Inc., Golden Feather Riders, Inc., Oroville Pageant Riders, Paradise Horsemen's Association and concerned individuals.

[15] Appendix A of the Settlement Agreement includes proposed articles to be included in the license and Appendix B of the Settlement Agreement includes measures the Settlement parties agreed to, but DWR proposes to be outside of the terms and conditions associated with a new license for the project.

Indian Tribes

- KonKow Valley Band of Maidu

Other Governmental Entities

- Alameda County Flood Control & Water Conservation District, Zone 7
- Alameda County Water District
- Antelope Valley – East Kern Water Agency City of Oroville
- Castaic Lake Water Agency
- Central Coast Water Authority
- City of Oroville
- Coachella Valley Water District
- County of Kings
- Crestline – Lake Arrowhead Water Agency
- Desert Water Agency
- Empire West Side Irrigation District
- Feather River Recreation and Parks District
- Kern County Water Agency
- Littlerock Creek Irrigation District
- Metropolitan Water District of Southern California
- Mojave Water Agency
- Napa County Flood Control and Water Conservation District
- Oak Flat Water District
- Oroville Parks Commission
- Oroville Redevelopment Agency
- Palmdale Water District
- San Bernardino Valley Municipal Water District
- San Gabriel Valley Municipal Water District
- San Gorgonio Pass Water Agency
- Santa Clara Valley Water District
- Solano County Water Agency
- Town of Paradise
- Tulare Lake Basin Water Storage District

Non-governmental Entities

- Berry Creek Citizens Association
- California State Horsemen's Association
- California State Horsemen's Association Region II
- Chico Paddleheads
- Feather River Low Flow Alliance
- International Mountain Bicycling Association
- Lake Oroville Bicyclist Organization
- Oroville Area Chamber of Commerce
- Oroville Downtown Business Association
- Oroville Economic Development Corporation
- Oroville Recreation Advisory Committee
- Oroville Rotary Club
- State Water Contractors, Inc.

Conservation Groups

- American Rivers
- American Whitewater
- Citizens for Fair and Equitable Recreation

Several entities filed comment letters in response to the Settlement Agreement filing. Signatories to the agreement and some of their constituents filed letters and petitions in support of the agreement. Most of these filings supported the proposed changes to the trail designations stating that the planned changes represent a collaborative-based compromise between equestrians and bicyclists that would provide the best use of limited natural resources that ensures maximum trail-use opportunities for hikers, bicyclists, and equestrians.

However, there were also several comments filed in opposition to the agreement. Most of these filings were from equestrians, Native Americans, and Butte County. The following sections describe some of the comments filed in response to the Settlement Agreement.

1.4.3.1 Comments by Equestrians in Opposition to the Settlement Agreement

The comment letters from equestrians stated several concerns with the proposed trail-use designations focusing on safety, resource damage and user conflicts. They cite concerns with bicyclists spooking horses, potentially causing accidents, and potential trail damage (e.g., erosion and vegetation damage) associated with bicycle use. Equestrians believe the terms of the Settlement Agreement do not properly address trail safety concerns and that trail maintenance funding could be insufficient to maintain the trails. They would also like to preserve the existing equestrian/hiker-only designated trails because regionally there are only a few trails where equestrians can ride without encountering bicycles.

Equestrians who oppose the Settlement Agreement also state concerns with the process and information DWR used to develop the proposed trail designations. Although DWR convened a trails

focus group that consisted of various user group representatives, some individuals claim DWR discouraged them from participating in the process because of their opposition to changing the trail designations. They also assert that DWR used flawed or insufficient data to develop their proposed changes. They point out that trails were not being managed under their approved uses in 2002 when the user surveys were conducted, invalidating the survey results, and that DWR did not properly investigate potential user conflicts. They also point out that DWR developed the proposed changes without knowing the existing trail conditions since DWR has not completed a trail condition inventory. Consequently, the equestrians opposed to the Settlement Agreement do not believe that DWR has provided a scientific or environmental reason for changing the trail designations.

1.4.3.2 Comments by Native Americans in Opposition to the Settlement Agreement

Comment letters filed by Berry Creek Rancheria of Maidu Indians of California (Berry Creek Rancheria) and Mooretown Rancheria of Maidu Indians of California (Mooretown Rancheria) state concerns with proposed development and continued recreation use at Foreman Creek. They believe the Settlement Agreement terms fail to address their concerns at this site and would allow further desecration of cultural resources. They would like to see public access prohibited at the site except for local, federally recognized Tribes.

1.4.3.3 Comments by Butte County in Opposition to the Settlement Agreement

Butte County opposes the Settlement Agreement because, in their opinion, it (1) fails to include essential stakeholders in the license implementation and monitoring process, thereby limiting public participation; (2) fails to resolve important relicensing issues and project effects (e.g., socioeconomic, recreational, natural resources and emergency project operations); (3) imposes fundamental impediments to the Commission's ability to monitor the license implementation and compliance; and (4) fails to protect public safety and the public interest. Butte County believes that Settlement Agreement terms are based on inadequate studies and analysis and that it has not had the opportunity to challenge the key facts and assumptions relied on by DWR to develop the agreement. Further they believe the procedures outlined in the agreement shelter DWR from community monitoring making it difficult for stakeholders to bring compliance problems before the Commission.

1.4.4 Comments on the Draft Environmental Impact Statement

On September 29, 2006, the Commission staff issued the draft EIS for the relicensing of the Oroville Facilities. Comments on the draft EIS were due on November 28, 2006.[16]

On November 8, 2006, Commission staff held a public meeting in Oroville, California, for the purpose of summarizing staff's recommendation in the draft EIS and discussing and receiving comments on the draft EIS. The meeting was transcribed and is part of the public record. In addition, 57 people commented at the public meeting.

[16] The U.S. Environmental Protection Agency issued a notice of availability for the draft EIS in the Federal Register on October 6, 2006 (71 FR 59106)

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COVER SHEET

FEDERAL ENERGY REGULATORY COMMISSION
FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE OROVILLE FACILITIES PROJECT
Docket No. P-2100-052

Section 2
Proposed Action and Alternatives
Pages 13 to 42
FEIS

2.0 PROPOSED ACTION AND ALTERNATIVES

This section describes each of the alternatives analyzed in detail in this EIS and summarizes the alternatives considered but eliminated from detailed study. The three alternatives analyzed in detail include DWR's Proposal as described in the Settlement Agreement (Proposed Action), DWR's Proposal with additional Staff-Recommended Measures (Staff Alternative), and the No-action Alternative, which is the baseline against which the other alternatives are compared.

In this section, we briefly describe the Proposed Action and the No-action Alternative. In section 3, we provide a detailed evaluation of the proposed measures for each resource. In section 4, we compare the costs of the measures, and in section 5, we explain our rationale for adopting our preferred alternative.

2.1 NO-ACTION ALTERNATIVE

The No-action Alternative includes existing project facilities, conditions of the existing license, environmental commitments such as those associated with DWR's water rights, recreation programs, and other agreements that affect current operations. Accordingly, the No-action Alternative also includes the following: (1) interim projects implemented by DWR during the relicensing effort, (2) measures continued under the 1983 Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife, and (3) measures identified during informal consultation with U.S. Fish and Wildlife Service (FWS) to resolve terrestrial listed species issues prior to the initiation of formal consultation to be conducted after license application filing. We use this alternative to establish baseline environmental conditions for comparison with other alternatives and to judge the benefits and costs of any measures that might be required under a new license. The effects of the No-action Alternative contribute to the character of existing environmental conditions, and we describe them in our discussion of the affected environment (see section 3).

2.1.1 Existing Project Facilities

The Oroville Facilities are located on the Feather River in the foothills of the Sierra Nevada and Sacramento Valley[17] in Butte County, California. Oroville dam is located 5 miles east of the city of Oroville and about 130 miles northeast of San Francisco. The location of the project and the project features are shown on figure 2, a flow diagram for the Oroville Facilities is presented on figure 3, and the public land within the project boundary is shown on figure 19 (see section 3.3.6, *Recreational Resources*). For ease of reference and consistency, we use the terminology presented in table 1 throughout this EIS to discuss various locations relative to the project.

The Oroville Facilities were developed as part of the State Water Project, a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the State Water Project is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, water quality improvement in the Sacramento-San Joaquin Delta (Delta), and recreation and fish and wildlife enhancement.

[17] The Central Valley is a 400-mile-long and 40- to 60-mile-wide valley in California extending from Redding in the north to Bakersfield in the south. The portion of the valley north of Sacramento is known as the Sacramento Valley and the southern portion of the valley is known as the San Joaquin Valley.

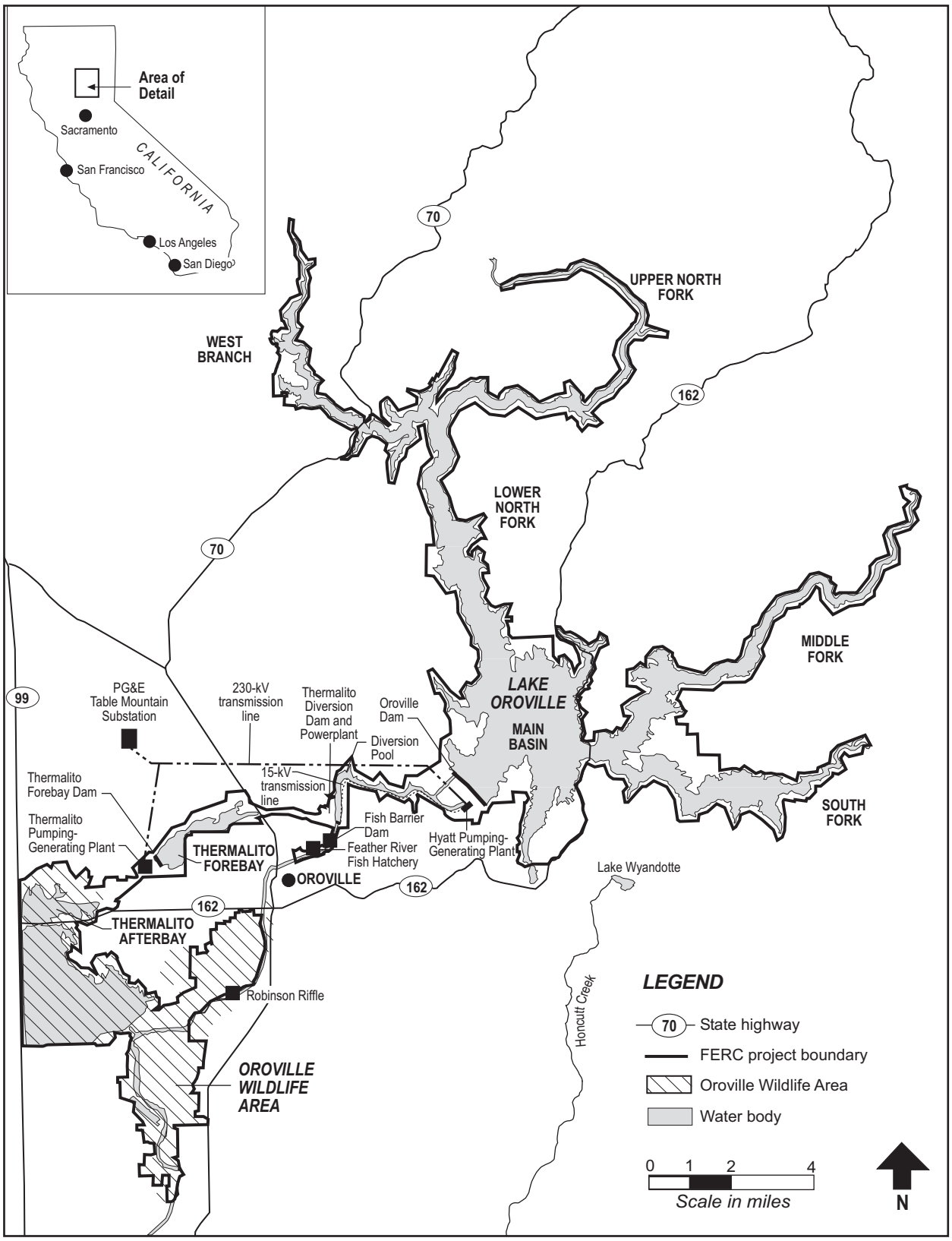

Figure 2. Oroville Facilities features. (Source: DWR, 2005a)

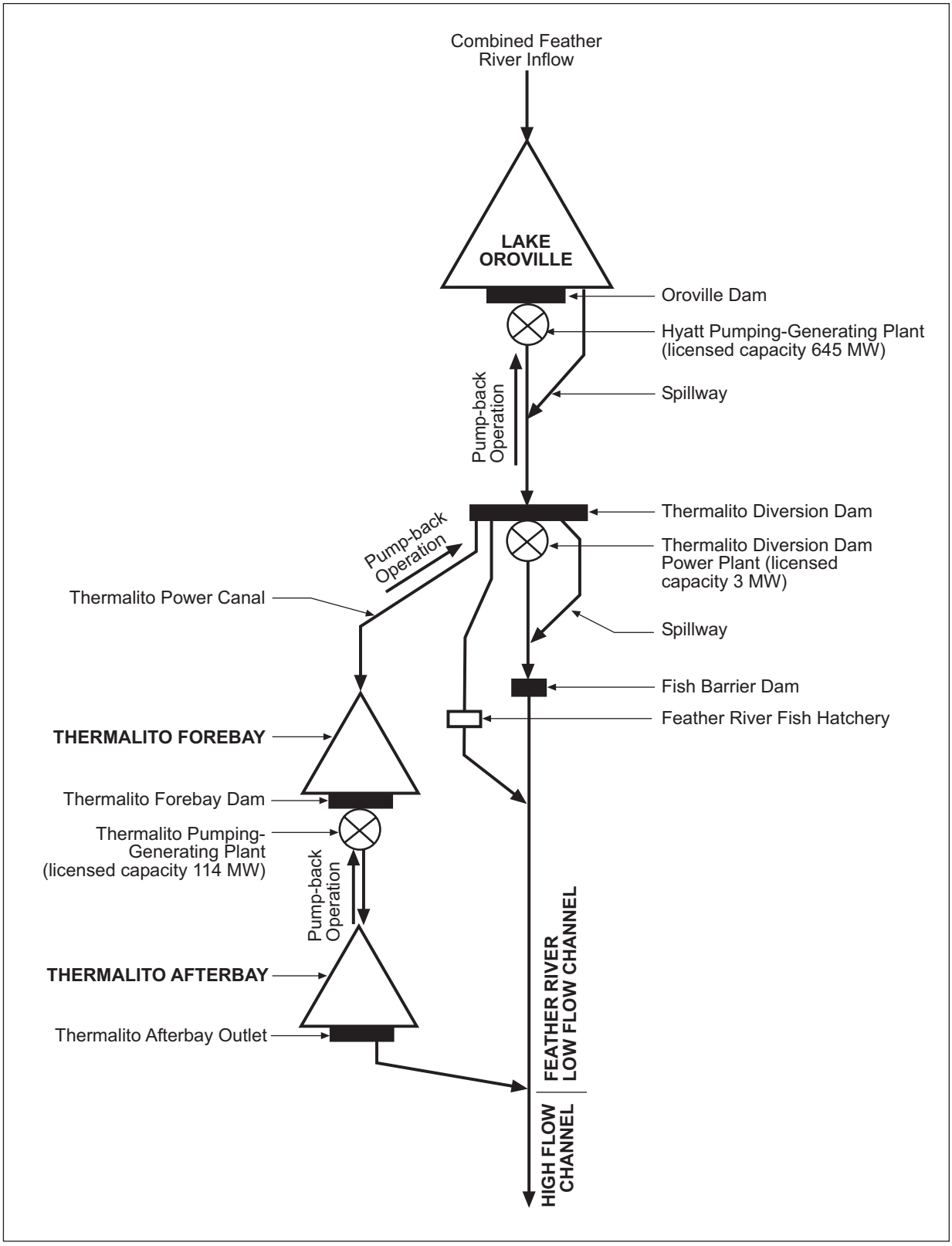

Figure 3. Oroville Facilities flow diagram. (Source: DWR, 2005b, exhibit B)

Table 1. Terminology used in the EIS to describe project-related geographic areas. (Source: Staff)

Terminology Used in EIS	Description of Area Referenced by the Term
Lake Oroville	
Upper North Fork arm	North Fork of the Feather River from the project boundary in the vicinity of Big Bend dam (non-project) to the confluence with the West Branch of the North Fork of the Feather River
West Branch arm	West Branch of the North Fork of the Feather River from the project boundary in the vicinity of Concow Creek to the confluence with the Upper North Fork arm
Lower North Fork arm	North Fork of the Feather River downstream of the West Branch arm/Upper North Fork arm confluence to the Main Basin of Lake Oroville
Middle Fork arm	Middle Fork of the Feather River from the project boundary in the vicinity of Feather Falls to the Main Basin of Lake Oroville
South Fork arm	South Fork of the Feather River from the project boundary in the vicinity of Ponderosa dam (non-project) to the Main Basin of Lake Oroville
Main Basin	Central body of water formed at the confluence of the Lower North, Middle and South Fork arms
Waterbodies, Water Courses, and Watersheds	
North Fork	North Fork of the Feather River
West Branch	West Branch of the North Fork of the Feather River
Middle Fork	Middle Fork of the Feather River
South Fork	South Fork of the Feather River
Feather River	Feather River downstream of fish barrier dam
High flow channel	Feather River downstream of the Thermalito afterbay outlet to the project boundary
Low flow channel	Feather River between the fish barrier dam and the Thermalito afterbay outlet
North forebay	Portion of Thermalito forebay located north of Nelson Avenue
South forebay	Portion of Thermalito forebay located south of Nelson Avenue
Thermalito Complex	Project features and lands associated with the Thermalito forebay and Thermalito afterbay

The project encompasses 41,540 acres (figure 2) and includes Oroville dam and reservoir, Hyatt pumping-generating plant, Thermalito diversion dam power plant and the Thermalito pumping-generating plant. Other project features include the Thermalito diversion dam, the Feather River Fish Hatchery and fish barrier dam, Thermalito power canal, Oroville Wildlife Area (OWA), Thermalito forebay and forebay dam, Thermalito afterbay and afterbay dam, transmission lines, and a number of recreational facilities.

Oroville dam, along with two small saddle dams, impounds Lake Oroville, a 3.5 million acre-feet capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level (at

elevation 900 feet mean sea level [msl]).[18] Oroville dam is 770 feet high from the base of the dam with a crest length of 6,920 feet. Bidwell Canyon Saddle dam is 47 feet high from the base of the dam with a crest length of 2,270 feet. Parish Camp Saddle dam is 27 feet high from the base of the dam with a crest length of 280 feet.

The Hyatt pumping-generating plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels to the Feather River just downstream of Oroville dam. The plant has a generating and pumping flow capacity of 16,950 cubic feet per second (cfs) and 5,610 cfs, respectively. The Thermalito diversion dam power plant and the Thermalito pumping-generating plant have generation capacities of 3 MW and 114 MW, respectively.

The Thermalito diversion dam, located 4 miles downstream of the Oroville dam, creates a tailwater pool for the Hyatt pumping-generating plant and is used to divert water to the Thermalito power canal. The Thermalito diversion dam is 143 feet high from the base of the dam with a crest length of 1,300 feet. The crest of the dam is at 233 feet msl. The diversion dam impounds the Thermalito diversion pool, which has storage capacity of 13,350 acre-feet with a maximum water surface area of 320 acres at the maximum water surface elevation of 225 feet msl. The Thermalito diversion dam power plant is a 3-MW power plant located below the left abutment of the diversion dam. The power plant releases a maximum of 615 cfs of water in the river through a single turbine.

The Thermalito power canal is a 10,000-foot-long channel designed to convey generating flows up to 16,900 cfs to the Thermalito forebay for use in the Thermalito pumping-generating plant. It also conveys pump-back flows of up to 9,000 cfs from the Thermalito forebay to the Thermalito diversion pool, which in turn acts as a forebay to provide flow to the Hyatt pumping-generating plant when it is operating in a pump mode. The Thermalito forebay is an off-stream regulating reservoir for the Thermalito pumping-generating plant. The Thermalito forebay dam is 91 feet high from the base of the dam with a crest length of 15,900 feet. The crest of the dam is at 231 feet msl. The dam impounds the Thermalito forebay, which has storage capacity of 11,768 acre-feet with a maximum water surface area of 630 acres at the maximum water surface elevation of 225 feet msl.

The Thermalito pumping-generating plant is designed to operate in tandem with the Hyatt pumping-generating plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in a generating mode, the Thermalito pumping-generating plant discharges into the Thermalito afterbay, which is impounded by a 42,000-foot-long earthfill dam. The Thermalito afterbay dam is 39 feet high from the base of the dam. Thermalito afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. The Thermalito afterbay has a storage capacity of 57,040 acre-feet with a maximum water surface elevation area of 4,300 acres at the maximum water surface elevation of 136.5 feet msl. Several local irrigation districts receive water from the Thermalito afterbay.

Major transmission lines include two separate transmission lines that meet the Commission's criteria for being primary transmission lines.[19] Two sets of double circuit towers carrying three 230-

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[18] Although Lake Oroville has a nominal maximum surface elevation of 900 feet msl, DWR tries to hold the maximum elevation closer to 899 feet msl. The lake may exceed 900 feet msl during flood conditions. Note that our use of feel msl throughout this document is based on the National Geodetic Vertical Datum 1929.

[19] DWR did not apply to modify the existing license with respect to transmission lines. Both transmission lines are required to get project power to market dependably and since the lines continued existence appears to depend on a Commission license, these transmission lines are properly classified as primary transmission lines.

kilovolt (kV) circuits within a 300-foot-wide corridor extend about 9 miles from the Hyatt pumping-generating plant's switchyard to the Table Mountain switchyard. One set of double circuit towers extends about 2.3 miles within a 125-foot-wide corridor from the Thermalito pumping-generating plant switchyard to the Table Mountain switchyard. Two underground powerlines provide electricity to the Thermalito diversion dam and the Feather River Fish Hatchery. A 3.9-mile underground 15-kV powerline, also a primary transmission line, extends from the Hyatt pumping-generating switchyard to the Thermalito diversion dam power plant switchyard. A second underground 15-kV powerline, which is not a primary transmission line, connects the Thermalito diversion dam power plant with the Feather River Fish Hatchery.

The project boundary also includes the Feather River fish barrier dam, which is downstream of the Thermalito diversion dam and immediately upstream of the Feather River Fish Hatchery, an anadromous fish hatchery. The Feather River fish barrier dam is 91 feet high from the base of the dam with a crest length of 600 feet. The crest of the dam is at elevation 181 feet msl. The flow over the fish barrier dam maintains fish habitat in the Feather River between the dam and the Thermalito afterbay outlet and provides attraction flow for the hatchery. The Feather River Fish Hatchery receives returning salmon and steelhead and accommodates more than 20,000 adult fish and 15 million young, annually. The Thermalito fish rearing facility is located immediately adjacent to the dam on the west side of the Thermalito afterbay. This facility consists of a set of fish rearing ponds used to raise as many as 2.5 million fingerlings.

The following recreational facilities are located in the project boundary, unless otherwise noted:

Location/Type	Recreational Facility	
Lake Oroville	Nelson Bar boat launch	Craig Saddle boat-in campground
	Lime Saddle Complex (campground, group campground day-use area and boat launch	Goat Ranch boat-in campground
	Bidwell Canyon campground, day-use area, boat launch)	10 floating campsites on Lake Oroville
	Bidwell Canyon day-use area and boat launch	Lake Oroville Visitor Center
	Loafer Creek campground	Feather River Fish Hatchery day-use area
	Loafer Creek group campground	Lake Oroville scenic overlook
	Loafer Creek equestrian campground	Dark Canyon boat launch
	Loafer Creek day-use area (swimming beach, boat launch)	Foreman Creek (campground and day-use area)
	Spillway day-use area (boat launch, swimming area)	Vinton Gulch boat launch
	Spillway RV campground	Enterprise boat launch
	Oroville dam overlook day-use area	Stringtown boat launch
	Bloomer boat-in campground	Feather River Nature Center[a] and day-use area
Thermalito Complex	North Thermalito forebay (day-use area, aquatic center, campground)	Monument Hill day-use area (boat launch, swimming area)

Location/Type	Recreational Facility	
	North Thermalito forebay day-use area (swimming area, aquatic center, boat launches)	Model aircraft flying facility
	North Thermalito forebay RV campground	Shoreline hunting blinds at Thermalito afterbay
	Thermalito diversion pool (day-use area)	Wilbur Road boat launch
	South Thermalito forebay day-use area (boat launch, swimming area)	Larkin Road boat launch
	Thermalito afterbay outlet camping area and informal boat launch	
Trailheads	East Hamilton Road Trailhead	Lakeland Boulevard Trailhead
	Toland Road Trailhead	Saddle Dam Trailhead
	Tres Vias Road Trailhead	
Trails	Bidwell Canyon Trail	Sewim Bo Trail
	Brad B. Freeman Trail[b]	OWA trails
	Dan Beebe Trail[b]	Potter's Ravine Trail[b]
	Loafer Creek Day-use /campground Trail	Roy Rogers Trail
	Loafer Creek Loop Trail	Wyk Island Trail

[a] The Feather River Nature Center is owned by the City of Oroville and operated by the Feather River Recreation and Park District. The day-use facilities along the river are provided and maintained by DWR.

[b] Portions of the trail are outside of the project boundary.

2.1.2 Project Boundary

At Lake Oroville, the project boundary generally follows an elevational contour about 200 to 600 feet from the maximum pool level (900 feet msl) and includes the entire reservoir. In the vicinity of Oroville dam, Bloomer Hill, Foreman Creek, Loafer Creek, and Bidwell Canyon, the project boundary extends upslope as much as 4,900 feet to include lands where there are project features and recreation facilities; the project boundary at these locations does not follow an elevational contour. At the Thermalito diversion pool and power canal, the project boundary generally follows an elevational contour about 200 to 500 feet from the maximum pool level (225 feet msl) except near the Thermalito diversion dam where it extends upslope up to 2,000 feet to include land where the powerhouse and the facilities to operate the dam are located. The project boundary also extends downstream of the Thermalito dam on the Feather River to include the fish barrier dam, fish hatchery, and its components. The project boundary in this area includes both sides of the river, generally following an elevational contour about 100 to 500 feet from the river shoreline from the dam to just downstream of the fish hatchery. At the Thermalito forebay and afterbay, the project boundary generally follows the shoreline of the reservoirs extending upslope about 200 to 3,000 feet to include project features and recreation facilities. South of the Thermalito afterbay, the project boundary generally follows the boundary of the OWA, which was the site excavated for material to build the Oroville dam. In this area, the project boundary is between 300 and 8,000 feet from the Feather River and includes the Thermalito afterbay outlet. The project boundary includes two separate transmission lines which are 9 and 2.3 miles in length with corridor widths of about 300 and 125 feet, respectively. The project boundary encompasses about 11,200 acres of the 12,000-acre OWA.

The project boundary includes two separate transmission lines which are 9 and 2.3 miles in length with corridor widths of about 300 and 125 feet, respectively. We describe these two lines in section 2.1.1, *Existing Project Facilities*. DWR did not apply to modify the existing license with respect to transmission lines and both of these lines meet the Commission's criteria for primary transmission line. This is because these transmission lines are required to dependably deliver project power to market and the lines continued existence appears to depend on a Commission license. There are also two 15 kV powerlines within the project boundary. The 3.9-mile underground 15-kV powerline between the Hyatt pumping-generating switchyard and Thermalito diversion dam power plant switchyard also appears to meet the definition of primary transmission line. A second underground 15-kV powerline connecting the Thermalito diversion dam power plant with the Feather River Fish Hatchery does not appear to be a primary transmission line; nonetheless, it is a project transmission facility.

2.1.3 Existing Project Operations

2.1.3.1 Overall Project Operations

Winter and spring runoff is stored in Lake Oroville for release to the Feather River, as necessary, to meet downstream water demands and minimum instream flow requirements. Annual planning for operations is conducted for multi-year carryover, during which half the Lake Oroville storage above the minimum pool is assumed available for subsequent years. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Water can also be stored in Lake Oroville and the other project impoundments over a shorter time-frame (over days or hours) to meet power objectives as described below.

As shown in figure 3, the project offers flexibility with respect to energy generation and flow release. Specific technical information about the various flow, storage, and generating capacity is provided for each project facility in the following sections. Conceptually, water can be released from Lake Oroville through the Hyatt pumping-generating plant during peak hours. That water can either be (1) temporarily stored in the Thermalito diversion pool for pumping back to Lake Oroville during off-peak hours, (2) released through the Thermalito diversion dam power plant to produce electricity and provide instream flow to the low flow channel; or (3) passed down the Thermalito power canal to the Thermalito forebay. Water passed through the Thermalito power canal can be stored in the Thermalito forebay or passed through Thermalito pumping-generating plant to produce electricity and then either stored in the Thermalito afterbay or passed through the Thermalito afterbay outlet to the high flow channel. Water stored in the Thermalito afterbay can also be temporarily stored and later pumped upstream during off-peak hours to the Thermalito forebay. Once back in the Thermalito forebay, water can be sent in either direction, provided the hydraulics would permit open channel flow[20] back to the Thermalito diversion pool.

2.1.3.2 Lake Oroville

Typically under normal and wetter conditions, Lake Oroville is filled to its normal maximum annual level of elevation 900 feet msl in June and then can be lowered as necessary to meet downstream requirements to its minimum level in December or January. During and following dry years, the reservoir may be drawn down more and may not fill to desired levels the following spring. During wetter hydrologic conditions, Lake Oroville is managed to control downstream flooding. The U.S. Army Corps of Engineers (Corps) requires Lake Oroville to be operated to maintain up to 750 thousand acre-feet of

[20] Open channel flow is characterized as having the top surface exposed to the atmosphere unlike closed conduit flow which operates under pressure. The elevation in the Thermalito afterbay must be higher than the elevation of the water in the Thermalito diversion pool in order for water to flow in that direction.

storage space to capture significant inflows for flood control. In general, operations usually result in the following: (1) lower reservoir levels in the late winter and early spring for flood control purposes, (2) higher levels in the late spring and early summer when higher flows may be captured without affecting flood protection, and (3) declining reservoir levels in the late summer and fall as the stored water is used. Lake Oroville daily water surface elevations for various hydrologic conditions are summarized on figure 4.

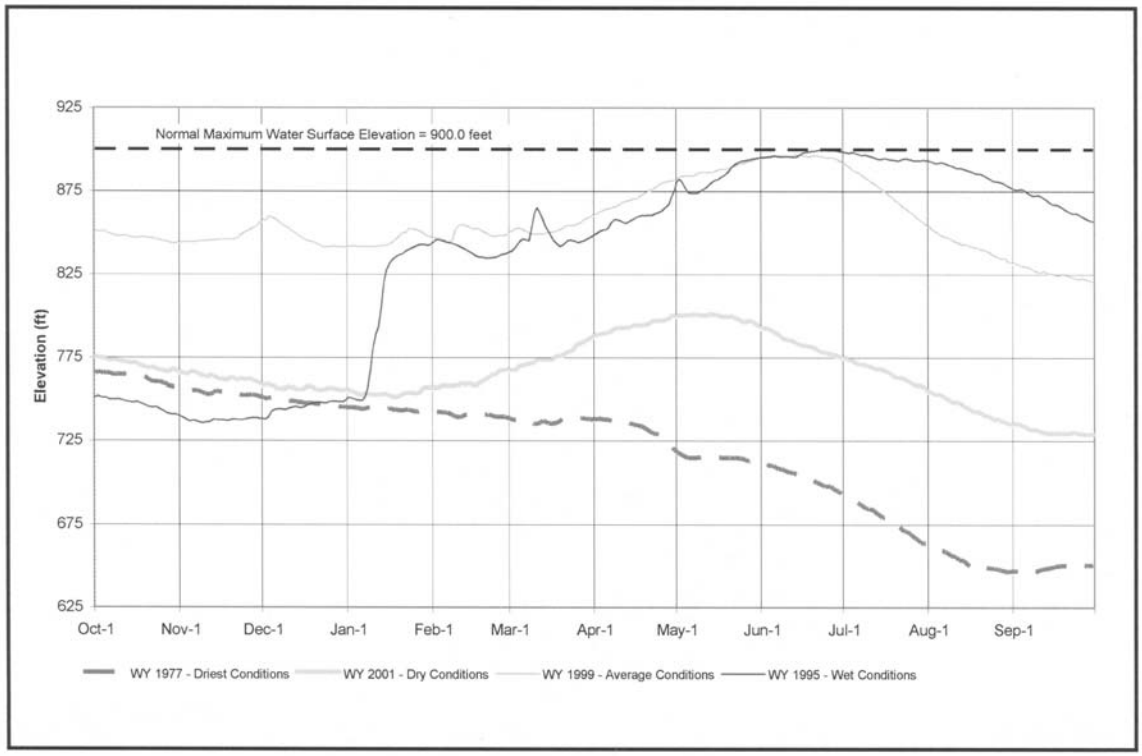

Figure 4. Lake Oroville daily elevations under various water conditions. (Source: DWR, 2005b)

The project is also designed to use water that is in excess of the downstream flow requirement for pumping water back into the Thermalito forebay and then into Lake Oroville during off-peak hours. This water is then released again during on-peak hours when power values increase. The project operates in a pump-back mode year-round, and this operation can cause Lake Oroville to fluctuate 1 to 2 feet on a daily basis. Weekly fluctuations range from 2 to 6 feet and may be as great as 9 to 11 feet over a several week period (DWR, 2005c).

Since storage at the project began in 1967, the minimum elevation of Lake Oroville occurred on September 7, 1977, when the reservoir was at 645.11 feet msl corresponding to a reservoir content of 882,395 acre-feet. The maximum reservoir elevation occurred on June 4, 1973, when the reservoir was at 899.88 feet msl corresponding to a reservoir content of 3,536,000 acre-feet. Start-of-month elevations for Lake Oroville are summarized in figure 5. Looking at start-of-month elevations since water year 1971, the October 1 (beginning of the water year) Lake Oroville levels ranged from elevation 648 feet msl to 850 feet msl and averaged 793 feet msl.

2.1.3.3 Thermalito Forebay, Diversion Pool, and Power Canal

Because the Thermalito forebay and diversion pool and the power canal are all designed to share the same operating water level and are essentially the same hydraulic system, the water levels in each of

these facilities rise and subside in unison. The system does not fluctuate much on a daily basis. During the summer, it is generally cycled down 2 to 4 feet during the middle of the week and then refilled by the weekend. During the winter, it may fluctuate more.

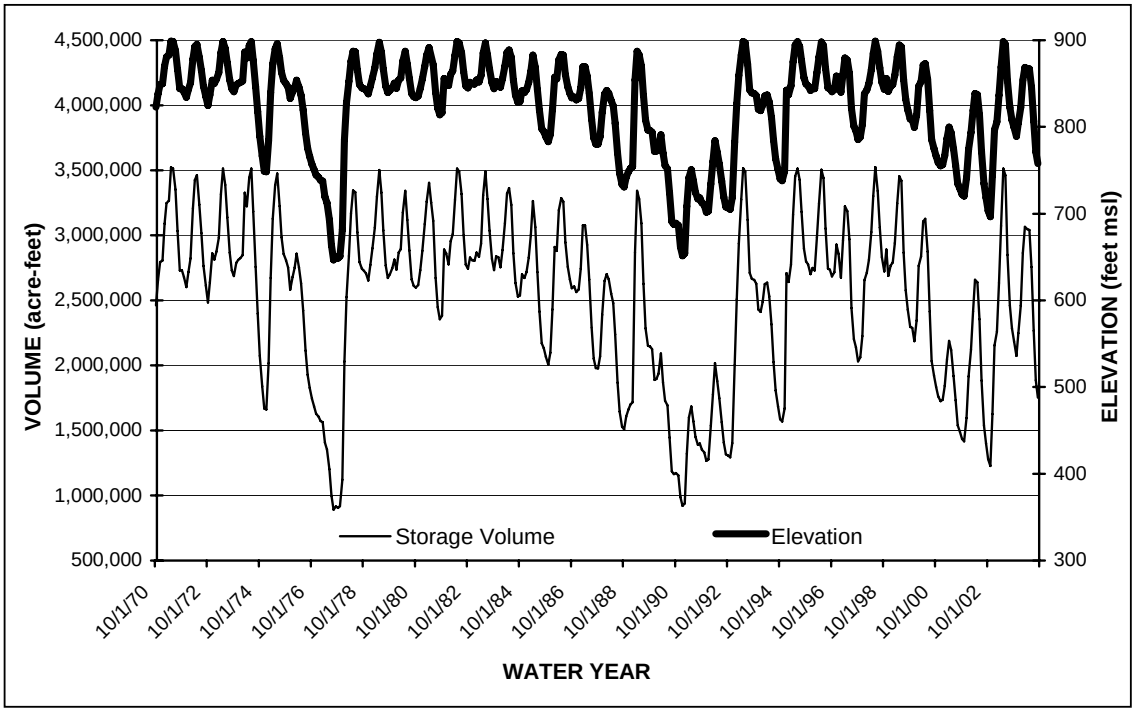

Figure 5. Lake Oroville historic storage volume and water surface elevations, water year 1971–2004. (Source: DWR, 2005d)

2.1.3.4 Thermalito Afterbay

Thermalito afterbay is operated to meet multiple requirements, including regulating inflow from the Thermalito pumping-generating plant, providing water for withdrawal during pump-back operation, and releasing water through the Thermalito afterbay outlet to the Feather River. Thermalito afterbay is also the location where diversions are made to meet the Feather River service area irrigation entitlements. To successfully meet each requirement, operational flexibility is required at Thermalito afterbay.

Natural hydrologic conditions do not affect the Thermalito afterbay operation; it is primarily affected by operational requirements. Generally, the Thermalito afterbay does not have seasonal differences in the operation, and the water surface elevation varies from about 124 to 136 feet msl throughout the year. DWR schedules hourly releases through the Edward Hyatt and Thermalito pumping generating plants to maximize the amount of energy produced when power values are highest. Because the downstream water supply is not dependent on hourly releases, and pumping of SWP water can occur at off-peak times; energy prices primarily dictate hourly operations for the power generation facilities. Storage in Thermalito forebay and afterbay helps to maximize the value of Project energy and maintain uniform flows in the Feather River downstream from the Oroville facilities. The Thermalito afterbay also provides storage for pump-back operations, which are designed to maximize profit from the power generation facilities. DWR releases water from Lake Oroville when power prices are high, then pumps water not needed to meet downstream requirements back into Lake Oroville from Thermalito forebay and afterbay when power prices are low. Because DWR operates the power plants to maximize weekday generation when power prices are highest, storage is usually higher in the afterbay at the end of each

week than at the beginning. Downstream releases during the weekend or pumpback to Lake Oroville (to prepare for the following week's operation) lower the water in the afterbay (DWR, 2003).

A common refill pattern is that Thermalito afterbay is at its low point on Monday and builds storage over the week to reach a maximum elevation on Saturday. After a maximum is reached on Saturday, Thermalito afterbay is often decreased through the first part of Monday and the cycle frequently starts over. The weekly fluctuations usually range from 2 to 6 feet, although there are times during the year when the elevation is allowed to be higher or lower as a response to systemwide operations or energy prices. Fluctuations of about 9 to 11 feet sometimes occur during a several week period and are most likely to occur in the winter. This type of operation is illustrated in figure 6. As can be seen from figure 6, pump-back operations occur on a year-round basis.

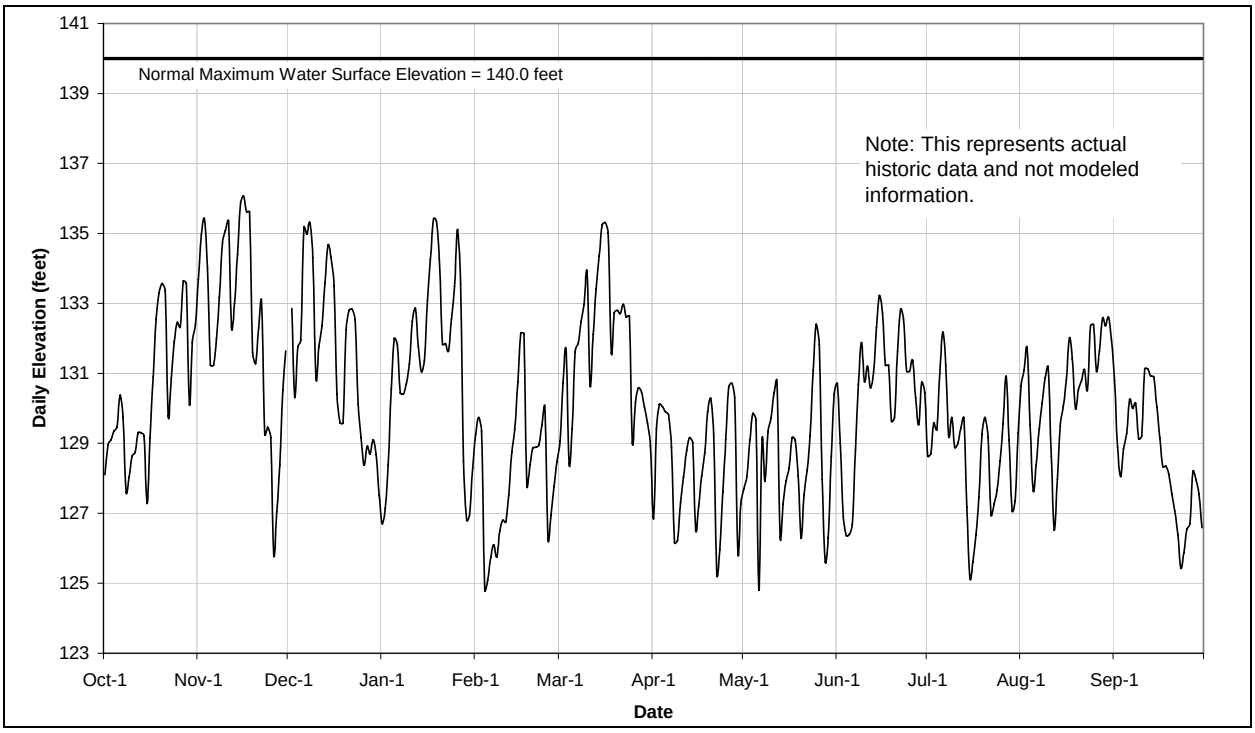

Figure 6. Thermalito afterbay historical water surface elevations, water year 2001. (Source: DWR, 2005e)

2.1.3.5 Minimum Instream Flows and Water Temperature

Minimum Instream Flows

Minimum flows in the Feather River originally were set by an agreement between DWR and the California Department of Fish and Game (DFG) (DWR, 1983). The agreement, titled *Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife,* established criteria for flow and water temperature in the low flow channel and the reach of the Feather River downstream of the Thermalito afterbay outlet to the confluence with the Sacramento River to preserve salmon spawning and rearing habitat. The agreement specifies a minimum release of 600 cfs into the Feather River from the Thermalito diversion dam for fisheries purposes when surface elevations of Lake Oroville are below 733 feet msl. (This is the total volume of flows from the diversion dam outlet, the diversion dam power plant, and the Feather River Fish Hatchery outlet.) For a Lake Oroville surface elevation greater than 733 feet, the minimum instream flow requirements on the Feather River

downstream of the Thermalito afterbay outlet are listed in table 2 (DWR, 1983). These flows are requirements in the existing project license.

Table 2. Minimum instream flow requirements on the Feather River at Lake Oroville surface elevation greater than 733 feet msl. (Source: DWR, 2005a)

Normal Runoff (%)[a]	October–February (cfs)	March (cfs)	April–September (cfs)
>55	1,700	1,700	1,000
<55	1,200	1,000	1,000

[a] Normal runoff is defined as 1,942,000 acre-feet, which is the mean (1911 to 1960) April through July unimpaired runoff near Oroville. If the April 1, runoff forecast in a given water year indicates that, under normal operation of the project, Oroville reservoir will be drawn to elevation 733 feet (approximately 1,500,000 acre-feet), minimum flows in the high flow channel may be diminished on a monthly average basis, in the same proportion as the respective monthly deficiencies imposed upon deliveries for agricultural use from the project; however, in no case shall the minimum flow releases be reduced by more than 25 percent.

Under the agreement, if the hourly flow were to exceed 2,500 cfs anytime between October 15 and November 30, DWR must maintain a flow equal to that hourly flow amount less 500 cfs until the following March unless the high flow was a result of flood management operations or mechanical problems.[21] This requirement ensures flow levels are high enough to keep the overbank areas submerged to protect any fish spawning that could occur. In practice, the flows are maintained below 2,500 cfs from October 15 to November 30 to prevent fish from spawning in the overbank areas.

Ramping Rates

The 2002 biological opinion (NMFS, 2002) specifies down-ramping rates for releases into the low flow channel (table 3). The ramping rates were slightly modified in 2004. Because instream flows and ramping rates primarily affect aquatic resources, these topics are further discussed in section 3.3.3, *Aquatic Resources*. These down-ramping rates are not required by the existing project license.

Table 3. National Marine Fisheries Service 2002 biological opinion required ramping rates. (Source: NMFS, 2004)

Feather River Low Flow Channel Releases (cfs)	Rate of Decrease (cfs)
5,000 to 3,501	1,000 per 24 hours
3,500 to 2,501	500 per 24 hours
2,500 to 600	200 per 24 hours[a]

[a] DWR (2005a, appendix B1, table B1-1) indicates this value is 300 cfs per 24 hours. We assumed the biological opinion is correct.

Additionally, ramping criteria for changing the flows in the Feather River (table 4) have been established. These ramping criteria are flow rate dependent to protect the fishery habitat from rapid dewatering and to protect the river channel from erosion and scour resulting from high flow fluctuation. For increasing flow, the hourly limit is 5,000 cfs regardless of flow during the previous hour. This

[21] For example, if the hourly flow reached 3,500 cfs on October 20, DWR would be obligated to maintain a minimum flow of 3,000 cfs until the following March.

ramping criterion for increasing flow is suspended when the storage of Lake Oroville is above 2,780,000 acre-feet (i.e., flooding conditions).[22]

Table 4. Feather River ramping criteria for reducing flow. (Source: DWR, 2006)

Feather River Low Flow Channel Releases (cfs)	Rate of Decrease (cfs reduction per 24 hours)
Less than 2,500	200
2,500 to 3,500	500
3,500 to 6,500	1,000
Greater than 6,500	2,000

Temperature

The project is operated to meet water temperature objectives at the Feather River Fish Hatchery. The existing maximum temperature objectives are listed in table 5. These temperature objectives are not required by the existing project license.

Table 5. Existing temperature objectives at the Feather River Fish Hatchery.

Period	Temperature (+/– 4ºF)	Period	Temperature (+/– 4ºF)	Period	Temperature (+/– 4ºF)
April 1–May 15	51º	June 16–August 15	60º	October 1–November 30	51º
May 16–May 31	55º	August 16–31	58º	December 1–March 31	No greater than 55º
June 1–June 15	56º	September 1–30	52º		

2.1.4 Existing Environmental Measures

Currently, DWR provides facilities and programs related to fisheries, wildlife, and recreation at the project. See sections 3.3.3.1, *Aquatic Resources*, 3.3.4.1, *Terrestrial Resources*, and 3.3.6.1, *Recreational Resources*, respectively, for discussion of these facilities and programs.

2.1.5 Project Safety

The project has been operating for more than 37 years under the existing license, and during this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance. As part of the relicensing process, Commission staff would evaluate the continued adequacy of the proposed project facilities under a new license. Special articles would be included in any license issued, as appropriate. Commission staff would continue to inspect the project during the new license term to assure continued adherence to Commission-approved plans and specifications, special license articles relating to construction (if any), operation and maintenance, and accepted engineering practices and procedures.

[22] Although the agreement that outlined this ramping criteria was superseded by the 1983 Agreement, and the 1983 Agreement only specifies criteria for low flow channel releases less than 2,500 cfs, DWR still maintains this criteria in its operations procedures.

2.2 DWR'S PROPOSAL (PROPOSED ACTION)

Under the Proposed Action, the project would continue to be operated for the purposes described in section 2.1. Measures included in the Settlement Agreement would modify flow releases and provide various other environmental protection, mitigation, and enhancement measures.

2.2.1 Proposed Project Facilities

DWR does not propose to construct any additional project facilities; however, under Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*, DWR would conduct studies to investigate the potential for making facility modifications to improve temperature conditions for anadromous fish in the low flow and high flow channels. If implemented, modifications would be completed within 10 years of license issuance.

2.2.2 Proposed Project Operations

DWR proposes to operate the project similar to its current operation with the following changes (DWR, 2006a):

- **Low flow channel—instream flow:** The minimum instream flow requirement in the low flow channel would be 700 cfs except between September 9 and March 31 when it would be 800 cfs (Proposed Article A108, *Flow/temperature to Support Anadromous Fish*). Minimum instream flow requirements in the high flow channel would be the same as the existing minimum instream flow requirements (see section 2.1.2).
- **Fish hatchery—temperature:** Prior to implementing any facility modifications, DWR would attempt to meet the following temperature objectives at the Feather River Fish Hatchery by modifying at least 3 specific operations[23] listed in Proposed Article A107.2, *Feather River Fish Hatchery Improvement Program*.

Period	Minimum Temperature Requirement (ºF)	Proposed Maximum Temperature Objective[a] (ºF)	Not-to-Exceed Temperature (ºF)
April 1–May 15	51	55	55
May 16–May 31	51	55	59
June 1–June 15	None	60	60
June 16–August 15	None	60	64
August 16–August 31	None	60	62
September 1–September 30	None	56	56
October 1–November 30	None	55	55
December 1–March 31	None	55	55

[23] The proposed article states, "The licensee shall seek to not exceed these maximum mean daily temperatures through operational changes including but not limited to: (1) curtailing pump-back operation; (2) removing shutters on Hyatt intake; and (3) after river valve refurbishment, DWR will consider the use of the river valve up to a maximum of 1,500 cfs; provided however these flows need not exceed the actual flows in the high flow channel, but in no event would the high flow channel flows be less than 2,500 cfs as specified in A108.2."

[a] The temperature objective would be a target between the time the license is issued and either facility modifications are completed or 10 years, whichever occurs first, after which meeting the objectives would be a license requirement. The temperature objectives also would be subject to conference year and uncontrollable forces provisions, as defined in Proposed Article 108.6 and 108.7. Under Proposed Article A107.2, *Feather River Fish Hatchery Improvement Program*, new temperature objectives at least as protective as the proposed objectives could be developed for Commission approval after facility modifications are completed.

- **Low flow and high flow channels—temperature:** Prior to implementing any facility modifications, DWR would attempt to meet the following temperatures in the low flow channel by modifying up to three specific operations listed in Proposed Article 108, *Flow/temperature to Support Anadromous Fish*. After implementing any facility modifications, the temperature objectives in the low flow channel would become requirements, and temperature objectives in the high flow channel would be evaluated and modified.

Maximum Temperature for the Low Flow Channel		**Maximum Temperature for the High Flow Channel**	
Period	**Temperature (ºF)**	**Period**	**Temperature (ºF)**
January–March	56	January–March	56
April	56	April	61
May 1–15	56–63[a]	May 1–15	64
May 16–31	63	May 16–31	64
June–August	63	June–August	64
September 1–8	63–58[a]	September 1–8	61
September 9–30	58	September 9–30	61
October	56	October	60
November–December	56	November–December	56

[a] Indicates a period of transition from the first temperature to the second temperature.

2.2.3 Proposed Environmental Measures

Table 6 lists DWR's proposed measures, which are included in appendix A of the Settlement Agreement, to protect and enhance environmental resources that may be affected by the project.[24] These measures are listed in table 6.

[24] The precise wording of this summarization of the Settlement Agreement measures may differ from the specific language of the Settlement Agreement. Individual articles include programmatic elements for scheduling and developing plans, monitoring, evaluation and reporting that are not listed in this table. Characterizations of these measures are primarily the result of our attempt to provide a concise summary of the measures for this draft EIS and are not intended to modify any of the terms of the Settlement Agreement.

Table 6. Proposed articles included in appendix A of the Settlement Agreement. (Source: DWR, 2006a, as modified by staff)

Article	Measure	Elements
Aquatic Resources		
A102	Gravel Supplementation and Improvement Program	Conduct physical assessment of spawning riffles between RM 54.2–67.2 and supplement spawning gravels in low flow channel or high flow channel.
A103	Channel Improvement Program	Implement and maintain modifications to Moe's Ditch and Hatchery Ditch and five additional side channel improvements (totaling 2,460 feet) to support spawning and rearing.
A104	Structural Habitat Supplementation and Improvement Program Plan	Map existing and potential large woody debris (LWD) sources and riparian habitat between the fish barrier dam to the downstream limit of the project boundary in the Feather River. Plan, install, maintain and replace habitat structures using LWD and boulders in the Feather River
A105	Fish Weir Program	Develop Phase 1 Plan within 1 year to schedule, install, and operate a monitoring fish weir upstream of Thermalito afterbay for implementation within 3 years. Develop Phase 2 plan within 8 years to schedule, install, and operate a segregation fish weir upstream of Thermalito afterbay for implementation within 12 years. Evaluate and potentially install an egg-taking station for fall-run Chinook to transport to Feather River Fish Hatchery.
A107	Feather River Fish Hatchery Improvement Program	Operate Feather River Fish Hatchery in cooperation with DFG to produce salmonids. Operate to achieve temperature objectives for the intake with contingencies for modifying them upon completing facility modifications. Develop and file within 2 years a multi-faceted hatchery management plan that outlines hatchery practices that would respond to changing conditions. In addition to facility management, the plan would also address genetics, operational protocols, tagging, and disease management. Install water disinfection system for Feather River Fish Hatchery, if fish are passed upstream of hatchery. Conduct facility assessment of the Feather River Fish Hatchery with DFG and report findings within 2 years. Conduct assessment and report again every 5 years for term of license.
A108	Flow/Temperature to Support Anadromous Fish	**Minimum flows in low flow channel:** • April 1 to September 8—700 cfs • September 9 to March 31—800 cfs unless otherwise notified by NMFS, FWS, and DFG that lower flows substantially meet needs of anadromous fish. Operate to achieve temperature objectives for the low flow channel (Robinson Riffle) with contingencies for modifying them upon completing facility modifications.

Article	Measure	Elements
		Minimum flows in high flow channel: Provide minimum instream flows in the high flow channel, based on preceding April to July unimpaired runoff > or = 55%: • October 1 to March 31—1,700 cfs • April 1 to September 30—1,000 cfs preceding April to July unimpaired runoff < 55%: • October 1 to February 28/29—1,200 cfs • March 1 to September 30—1,000 cfs Reduce monthly average minimum instream flows in the high flow channel by not more than 25% if forecast indicates that Lake Oroville will be drawn down to 733 feet. Operate to maintain minimum instream flows within 500 cfs of inflows exceeding 2,500 cfs between October 15 and November 30 unless flows result from flood flows, inadvertent equipment failure or malfunction. **Facility Modifications:** Study and possibly implement options for facility modifications to improve temperature conditions for anadromous fish in the high and low flow channels and the Feather River Fish Hatchery. Implement approved facility modification(s) and test for 5 years.
A109	Reservation of Section 18 Authority	NMFS and Interior reserve authority to prescribe fish passage at Lake Oroville as provided in draft Habitat Expansion Agreement
A110	Lake Oroville Warm Water Fishery Habitat Improvement Program	Plan and implement projects to benefit warmwater fishery spawning and rearing habitat in 7-year cycles. Provide $40,000 per year for constructing 15 habitat units (i.e., a habitat unit is defined in the settlement agreement as a project constructed with $2,000 of labor and materials).
A111	Lake Oroville Cold Water Fishery Habitat Improvement Program	Develop and implement a coldwater fishery habitat improvement plan to stock 170,000 yearling salmon or equivalents per year (+/– 10%) in Lake Oroville and provide funding for stocking not to exceed $75,000 per year.
Geology and Soil Resources		
A106	Riparian and Floodplain Improvement Program	Identify and implement riparian/floodplain improvement projects and identify areas where gravel extraction may take place in anticipation of improving terrestrial and aquatic habitat. Analyze and select recommended alternatives for riparian/floodplain improvement in two phases. Implement Phase 1 within 15 years and implement Phase 3 improvements within 25 years. Provide funding not to exceed $5 million (excluding profits from gravel sales) for this program.

Article	Measure	Elements
Water Quality		
A112	Comprehensive Water Quality Monitoring Program	Develop and implement a comprehensive water quality monitoring program that includes sampling of and reporting on water chemistry; fish tissue bioaccumulation; pathogens, petroleum product concentrations, and erosion at recreation sites; water temperature; bioassays; and aquatic macro invertebrates.
A113	Monitor Bacteria Levels and Provide Public Education and Notification	Monitor bacterial levels from June 1 to September 30 at eight swim areas.
		Provide public information about potential sources of bacteria in the water.
		Provide funding for monitoring not to exceed $124,000 in first 5 years and $23,500 annually, thereafter.
A114	Public Education Regarding Risks of Fish Consumption	Provide public information about potential health issues related to contaminated fish consumption.
		Provide funding to Office of Environmental Health Hazard Assessment to publish public information.
		Provide funding for this program not to exceed $20,800 in first 5 years and $1,800 annually, thereafter.
Terrestrial Resources		
A115	OWA Management Plan	Develop and file plan within 2 years that includes wildlife, recreation, and fuel management; implementation schedule; agency management funding; monitoring and reporting requirements.
		Provide funding not to exceed $200,000 to develop the initial plan.
A116		Provide reasonable public access to OWA for hunting and fishing.
A117	Protection of Vernal Pools	Implement and, if necessary, modify conservation measures in FWS biological opinion to protect vernal pool invertebrate habitat.
		Maintain the same amount and quality, including hydrologic connectivity, of existing vernal pool habitat as established in DWR's 2004 baseline habitat maps (253 individual vernal pools or swales totaling about 18.3 acres).
		Conduct earth-moving activities so as not to alter the hydrology related to the 253 vernal pools and swales.
		Inspect fences around/at vernal pools at least monthly to ensure fences are intact and monitor for adverse uses. Make any necessary repairs or replacements within 30 days.
		Encourage California Department of Parks and Recreation (DPR) and DFG patrols and enforcement of restrictions at vernal pools.
		Apply gravel coverings to all seepage-pump access roads located along the south and west edges of the Thermalito afterbay by 2008.
		Prohibit disking within 100 feet of vernal pool edges.

Article	Measure	Elements
		Avoid, to the extent possible, herbicide use within 200 feet of vernal pools. If needed, use glyphosate-based rather than acetolactate synthase-inhibiting herbicides; limit use of surfactants.
		Evaluate and report on effectiveness of measures annually through 2010 and every other year after 2010.
A118	Minimization of Disturbances to Nesting Bald Eagles	Implement and, if necessary, modify bald eagle nesting territory management plans for existing nesting territories, conduct mid-winter bald eagle counts at least every 2 years, report and develop draft site-specific management plans for new territories in consultation with DFG and FWS, and install at least one fishery structure/cover element annually in Lake Oroville near foraging areas.
		Develop additional management plans or amend current plans if new nest territories are identified.
		Evaluate and report on effectiveness of measures annually.
A119	Protection of Giant Garter Snake	Implement and, if necessary, modify conservation measures in FWS biological opinion to maintain the same amount and quality, including connectivity, of existing giant garter snake wetlands habitat as established in DWR's 2004 baseline habitat maps.
		Consult with FWS prior to initiating any activities in area D of the OWA.
		Minimize activities (e.g., construction or maintenance of trails, roads, or other permanent recreational features) in upland habitat within 200 feet of giant garter snake wetland habitat.
		Prohibit rodent control activities in designated giant garter snake wetlands habitat or within 200 feet of the habitat, except as necessary for maintaining structural integrity of project features.
		Remove non-native vegetation or noxious weeds at Thermalito forebay and afterbay and the OWA only by hand, using hand tools or through individual plant treatment with appropriate herbicides.
		Provide that the structural components of giant garter snake habitat (e.g., LWD) that accrue or move through natural processes would not be removed or otherwise altered, unless necessary for project operations or public safety.
		Develop and implement a public education program to prevent giant garter snakes from being intentionally harmed or killed.
		Restrict dog-training field exercises in the Thermalito afterbay areas.
		Maintain and manage giant garter snake habitat around the Thermalito afterbay margins occurring in the waterfowl brood ponds.
		Restrict burning and disking wetland margins of the Thermalito afterbay drawdown zone to the inactive period of the year, November through March.
		Encourage gravel-mining lessees operating within the project boundary to implement habitat improvements.

Article	Measure	Elements
		Encourage agencies that maintain roads and structures along and under Highway 99 to avoid altering or degrading these structures. Promote improving, if possible, these structures to improve connectivity of giant garter snake habitat.
A120	Protection of Valley Elderberry Beetle	Implement and, if necessary, modify conservation measures in the FWS biological opinion to maintain the same amount and quality, including connectivity, of existing valley elderberry longhorn beetle habitat as established in DWR's 2004 baseline habitat maps.
		Avoid, to the extent possible, direct and indirect effects on existing elderberry shrubs.
		Meet compensation requirements for valley elderberry longhorn beetle, if necessary, using a conservation banking process.
		Implement best management practices and other measures as necessary to ensure elderberry plants are not inadvertently harmed.
A121	Protection of Red-Legged Frogs	Implement and, if necessary, modify conservation measures in the FWS biological opinion to protect red-legged frog habitat. The measures for red-legged frogs are the same as described for the giant garter snake in Proposed Article A119, *Protection of Giant Garter Snake.*
		Conduct protocol level surveys for the California red-legged frog and, if necessary, consult with the FWS before initiating any formal planning of actions within the project boundary.
A122	Construction and Recharge of Brood Ponds	Construct 4 ponds within 20 years with a specified schedule for maintaining their water surface elevation and monitoring.
		Provide funding not to exceed $920,000 to construct 4 brood ponds.
A123	Provision of Upland Food for Nesting Waterfowl	Prepare and plant 60–70 acres of upland cover/forage crops annually.
		Provide funding not to exceed $9,000 annually to implement.
A124	Provision of Nest Cover for Upland Waterfowl	Manage 240 acres to provide nest cover for upland waterfowl.
		Provide funding not to exceed $15,000 annually to implement.
A125	Installation of Wildlife Nesting Boxes	Install and maintain 100 nesting boxes in the OWA.
A126	Invasive Plant Management	Specify treatment areas and methods, best management practices, and monitoring, and address purple loosestrife, giant reed, tree of heaven, scarlet wisteria, parrot feather, Himalayan blackberry, aquatic primrose, yellow star thistle, Spanish broom, French broom, scotch broom, and skeleton weed specific species.
		Coordinate plan and ongoing actions with applicable agency.
		Provide funding not to exceed $450,000 to develop and implement plan in the first 5 years and $35,000 annually thereafter.

Article	Measure	Elements
Recreational and Aesthetic Resources		
A127	Recreation Management Plan	Implement the Recreation Management Plan filed with the Settlement Agreement which consists of 6 programs which provide: new and upgraded recreation facilities; operation and maintenance for project recreation facilities; monitoring recreation use at the project; interpretation and education program and; an administrative framework. **Nelson Bar Boat Launch:** Install a sign, barrier and/or gate at terminus of the boat launch for public safety during lowered reservoir elevations. **Lime Saddle:** Provide 10 additional recreational vehicle (RV) campsites at the Lime Saddle campground and a new RV group site (50 people at one time) at the Lime Saddle group campground. At the Lime Saddle day-use area, replace 13 tables and 7 shade structures and install pole stoves. Construct 60-space parking area adjacent to existing parking area. Provide Americans with Disabilities Act (ADA) accessibility at marina, boat ramp, and day-use picnic sites. Add an additional boarding dock to improve launching capacity. Conduct a feasibility study to determine if improved swimming opportunities can be provided at either Loafer Creek or Lime Saddle during the recreation season. **Dark Canyon Boat Launch:** Install a vault restroom and provide directional signs along the roadside to the site. **Foreman Creek Boat Launch:** Redirect recreational use to avoid effects on historic properties and culturally sensitive areas. Install vault restroom, trash receptacle, and 5 to 10 picnic tables with shade ramadas. **Enterprise Boat Launch and Day-Use Area:** Construct 10 day-use sites and extend the existing boat ramp to about 750 feet msl to provide boating access at low water elevations. Construct a gravel parking area near the end of the ramp if topography permits. Provide 1 new boarding dock. **Stringtown Boat Launch:** Maintain the ramp surface above 866 feet msl and install a sign, barrier, or gate for safety purposes at the unmaintained road in the inundation zone. Provide directional signs along the roadside to the site. **Lake Oroville Scenic Overlook:** Provide trash receptacles and minor trail enhancements at the overlook along State Route 162. **Saddle Dam Trailhead:** Provide 10 picnic tables, a stock watering trough, and sink. Construct a short, non-motorized trail to provide shoreline access. **Loafer Creek:** Construct two new group campsites with RV hook-ups and an associated shower building at the Loafer Creek group campground. Provide ADA accessibility at the Loafer Creek group and equestrian campgrounds. Provide a fish cleaning station near the boat ramp and install a vault restroom at Brooks Orchard. Improve an existing service road in the day-use area to provide an alternative launch when the Loafer Creek ramp is dewatered. Provide one additional or enlarge the existing boarding dock to improve launching capacity. Improve shoreline access and ADA accessibility to the day-use area, swimming beach, and cove. Conduct a feasibility study to determine if improved swimming opportunities can be provided at either Loafer Creek or Lime Saddle during the recreation season.

Article	Measure	Elements
		Bidwell Canyon: Construct a new campground loop with 30 to 38 campsites adjacent to the remaining loop at the Bidwell Canyon campground. At the Bidwell Canyon day-use area, create 215 additional parking spaces: 90 at Bidwell Marina (using a current campground loop), 80 at Bidwell boat ramp 2, and 45 at new Bidwell boat ramp 3. Extend three launch lanes from about 750 to 640 feet msl to provide boating access at low water elevations. Provide 1 or 2 floating docks. Implement ADA upgrades to improve accessibility within the complex.
		Lake Oroville Visitor Center: Provide a visitor information and education program and enhance the existing facilities.
		Lake Oroville Spillway: Determine the optimum boarding dock system configuration at the Spillway day-use area boat launch and provide an additional boarding dock, if feasible, to improve launching capacity.
		Oroville Dam Overlook Day-Use Area: Provide additional 100-space parking area, additional 4 to 5 tables with shade ramadas, and interpretive panels, modify existing parking spaces and restroom to make ADA accessible, and improve the surface of the walkway from the parking lot to the crest of the dam at the Oroville dam overlook day-use area.
		Lake Oroville: Install 3 additional floating campsites.
		Lake Oroville Area: Modify or construct seven trails in this area, including extending the Potter's Ravine North Fork Shoreline Trail, opening an access road near the Loafer Creek equestrian campground to bicycles, providing one or two short access trails at the Saddle Dam Trailhead access, relocating a segment of the Bidwell Canyon Trail, rerouting a segment of the Brad B. Freeman Trail near the Hyatt power plant switchyard for security purposes, and opening most of the Dan Beebe Trail to bicycles.
		Thermalito Diversion Pool: On the northwest shoreline of the Thermalito diversion pool (Burma Road), construct 10 concrete picnic tables with pole grills, improve existing graveled area used for launching, and possibly provide an ADA accessible fishing pier at the Diversion Pool day-use area.
		Thermalito Diversion Pool: On the southeast shoreline of the Thermalito diversion pool (Lakeland Boulevard), construct access road to railroad bridge crossing at the Thermalito diversion pool. Construct a new day-use area including a car-top boat launch, graveled parking area, vault restroom, picnic tables, pole grills, and foot trail access to the shoreline; install fencing to separate facilities from the railroad tracks. Install non-potable water trough.
		Thermalito Diversion Pool: Modify or construct four trails along the Thermalito diversion pool, including opening the Burma Road and adjacent portions of the Brad B. Freeman Trail to equestrian use, opening most of the Dan Beebe Trail to bicycle use, constructing a paved trail from the Feather River Fish Hatchery downstream to the project boundary, and evaluating the feasibility of both providing a trail crossing the diversion pool and a demonstration mountain bicycle trail originating from the Lakeland Boulevard Trailhead access.

Article	Measure	Elements
		Feather River Fish Hatchery: Improve a launch site for non-motorized boats and provide additional interpretive displays and paths.
		North Thermalito Forebay Day-Use Area: Provide a fish cleaning station and evaluate warmer water swimming options.
		South Thermalito Forebay: Install ADA-accessible fishing pier, 5 to 10 day-use sites, and paved parking areas. Provide sandy swimming beach with safety buoys, landscaping, and shade trees.
		Thermalito Forebay: Provide new non-motorized trails including short shoreline access trails and forebay area loop trails consistent with protecting federal and state endangered species.
		Wilbur Road Boat Launch: Provide directional signs along the roadside to the Wilbur Road boat launch.
		Larkin Road Boat Launch: Provide 5 to10 family picnic tables with pole stoves and shade structures, a sandy swimming beach with safety buoys and directional signs along the roadside to the Larkin Road boat launch.
		Thermalito Afterbay Outlet: Construct 20 campsites at the 40-acre parcel area north of the Thermalito afterbay outlet and designate 5 to 10 day-use sites with picnic tables south of the Thermalito afterbay outlet. Regravel existing access roads, revegetate disturbed areas, and provide one to two additional vault restrooms, if needed. Upgrade the boat ramp surfacing with concrete and pave the associated parking area and access road.
		Oroville Wildlife Area: Provide two ADA-accessible watchable wildlife sites, with additional trash receptacles and vehicle barriers, and implement site hardening and closure measures. Enhance 2 non-motorized boat launch sites/take-outs at the OWA and designate as access sites for the proposed River trail.
		Oroville Wildlife Area: Maintain and enhance public access for hunting and fishing.
		Programmatic: Provide for O&M at new and existing project recreation facilities.
		Programmatic: Establish a License Coordination Unit of appropriate DWR staff in Oroville to manage the terms and conditions of the new license.
		Programmatic: Establish Recreation Advisory Committee with specified membership criteria to advise on plan implementation, review monitoring data, and recommend modifications to the plan.
		Oroville Wildlife Area: Implement measures to resolve conflicts between wildlife management objectives and recreational use, including reducing boating speeds on Thermalito afterbay north of State Route 162.
		Lake Oroville: Provide annual funding for planning July 4th fireworks display.

Article	Measure	Elements
		Programmatic: Coordinate with Pacific Gas and Electric Company to provide daily flow release information from the upstream Poe Project via a web link and/or flow phone link.
		Programmatic: Prepare a Recreation Implementation Plan, in consultation with Recreation Advisory Committee, for first 12 years for FERC approval.
A132	Screening of Material Storage Area	Plant vegetation to screen material storage area within 1 year.
Cultural Resources		
A128	Historic Properties Management Plan	Implement the Historic Properties Management Plan (HPMP) that includes the following elements: • Data recovery and stabilization of historic properties subject to imminent loss. • Restricted public access at Goat Ranch and Bloomer boat-in campgrounds. • Eliminate motorized wheeled vehicles use in the Lake Oroville fluctuation zone. • Expand the existing Site Stewardship Program. • Identify and set aside areas for planting and harvesting traditionally used plants. • Develop and implement an interpretive and educational signage program. • Establish a curation facility for housing archaeological collections associated with the Oroville Facilities. • Develop and implement a plan to protect cultural resources at Foreman Creek through recreation management actions.
A129	Improve and Redirect Recreation Usage to Specific Areas at Foreman Creek	Develop plan to protect cultural resources at Foreman Creek while continuing to provide for recreation activity. Develop plan in consultation with four federally recognized Native American Tribes located in Butte County and Recreation Advisory Committee. Restrict existing car-top boat ramp use and develop facilities to encourage recreational use in designated areas. Review plan annually with tribes and Recreation Advisory Committee over first 5 years and as necessary thereafter to ensure plan is achieving stated goals.
General		
A100	Ecological Committee	Establish and convene an Ecological Committee to provide consultation and advice to DWR relative to the various resource management license articles. Include specific membership criteria.

Article	Measure	Elements
A101	Lower Feather River Habitat Improvement Plan	Develop comprehensive implementation and monitoring program and adaptive management summary report as required by other articles.
A130	Flood Control	Operate project as prescribed by Secretary of Army.
A131	Early Warning System	Develop an Early Warning Plan that outlines communication protocols emergency procedures to be implemented when there are greater than normal releases from Lake Oroville and during flood emergency events.
A133	Project Boundary Modifications	Revise exhibit G within 2 years to include all project features, recreational and environmental measures, access roads, transmission lines, and other necessary lands.
A134	Expenditures	Acknowledge that FERC reserves right to require measures regardless of expenditure limitations outlined in license articles.
A135	Procedural Requirements	Comply with procedural requirements provided in the Settlement Agreement (dispute resolution, reopener, license amendment).
		Direct that FERC not consider motions to reopen/amend the license by those who have not signed the Settlement Agreement or complied with procedural requirements specified in the Settlement Agreement for Dispute Resolution, Reopener and Amendment of New Project License.

2.3 MODIFICATIONS TO DWR'S PROPOSAL

2.3.1 Water Quality Certification

Section 401 of the Clean Water Act (33 U.S.C. §1341) requires that a license applicant obtain from the state a certification that project discharges will comply with applicable effluent limitations, or waiver of certification. Without a 401 certificate, the project cannot be licensed. On October 26, 2005, DWR applied to the State Water Resources Control Board (Water Board) for water quality certification for the Oroville Facilities as required by Section 401 of the Clean Water Act.[25] On October 16, 2006, DWR withdrew and re-applied for Water Quality Certification. The Water Board is required to take action within 1 year of the application filing date, which would be October 16, 2007.

2.3.2 Section 18 Fishway Prescriptions

Section 18 of the Federal Power Act (FPA) states that the Commission shall require the construction, maintenance, and operation by a licensee of such fishways as the Secretaries of the U.S. Departments of Commerce (through the National Marine Fisheries Service [NMFS]) and Interior (through FWS) may prescribe. NMFS, by letter dated March 28, 2006, and Interior, by letter dated March 29, 2006, reserved this authority, and they state that their preliminary terms and conditions under section 18 of the FPA are consistent with the relevant provisions of the Settlement Agreement. NMFS filed modified fishway prescriptions on February 17, 2007, that are also consistent with the Settlement Agreement. NMFS considers that the Settlement Agreement, including an agreement-in-principle on a Habitat Expansion Agreement, would provide better protection for fish resources than a prescription of fish passage at this time. However, if the Habitat Expansion Agreement is not completed or implemented as anticipated through the Settlement Agreement, NMFS continues to reserve its fishway prescription authority under section 18 to implement fish passage.

[25] For more information, refer to eLibrary filing titled *Filing of Application for Water Quality Certification of California Department of Water Resources for P-2100*, dated November 3, 2005, accession no. 20051103-5076.

2.3.3 Section 4(e) Federal Land Management Conditions

Section 4(e) of the FPA states that the Commission may issue a license for a project on a federal reservation only if it finds that the project license will not interfere or be inconsistent with the purpose for which the reservation was created or acquired. Section 4(e) of the FPA requires that a Commission license for a project located on a reservation include the conditions that the Secretary of the department under whose supervision the reservation falls deems necessary for the adequate protection and use of such reservation.

By letter dated March 29, 2006, the Forest Service filed, under section 4(e) of the FPA, preliminary terms and conditions that are consistent with the relevant provisions of the Settlement Agreement.[26] The Forest Service filed 19 preliminary conditions for the project. Conditions numbered 1 through 15 are standardized conditions included by the agency to meet applicable laws and regulations germane to the project. Because these conditions are administrative in nature, they are not discussed further in the EIS. The remaining conditions numbered 16 through 19 include:

- Condition no. 16, *Heritage Resources*—Prepare and file a Historic Properties Management Plan (HPMP) for protecting and interpreting heritage resources located on National Forest System lands. This preliminary 4(e) condition is identical to Proposed Article A128, *Historic Properties Management Plan*.
- Condition no. 17, *Protection of Forest Service Special Status Species*—Prepare a biological evaluation before taking actions to construct new project features on National Forest System lands;
- Condition no. 18, *Invasive Weed Management*—Prepare a plan to reduce invasive plant species on or affecting National Forest System lands. This preliminary 4(e) condition is identical to Proposed Article A126, *Invasive Plant Management*.
- Condition no. 19, *Development of a Fuel Management Plan*—Prepare a plan to identify and prioritize fuel management issues and recommend actions to address these issues on National Forest System lands.

In its transmittal letter, the Forest Service stated that it will issue final terms and conditions and supporting information within 60 days of the end of the comment period for the draft EIS, if the Forest Service determines that the draft EIS provides an adequate record to support the section 4(e) conditions. If the Forest Service determines that the record is incomplete at the draft EIS stage, the Forest Service will file final section 4(e) conditions within 60 days of publication of the final EIS.

2.3.4 Section 10(j) Recommendations

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the project.

Section 10(j) also states that, whenever the Commission believes that any fish and wildlife agency recommendation is inconsistent with the purpose and the requirements of the FPA or other applicable laws, the Commission and agency shall attempt to resolve any such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibility of the agency. We do not recommend the DFG 10(j) recommendation that corresponds to Proposed Article A116, because this

[26] The filing identified portions of the Settlement Agreement measures as section 10(a) recommendations where the text is not directly applicable to or affecting National Forest System lands.

recommendation is not a specific measure to protect fish and wildlife resources and therefore is not within the scope of section 10(j).

In response to the Commission's Ready for Environmental Analysis (REA) notice dated September 12, 2005, NMFS, Interior (on behalf of FWS), and DFG filed letters of comment that included section 10(j) recommendations that are consistent with the Settlement Agreement.[27] These agencies are also parties to the Settlement Agreement. In their letters, the agencies recommend adoption of the provisions of the Settlement Agreement and all the provisions thereof.

2.3.5 Staff Alternative

After evaluating the Proposed Action, including mandatory conditions filed pursuant to section 4(e) and 18 of the FPA, and other recommendations from resource agencies and interested entities under sections 10(a) and 10(j) of the FPA, we considered what, if any, additional measures would be necessary or appropriate for continued operation of the project. The measures under the Proposed Action are described in section 2.2, *DWR's Proposal (Proposed Action*).

In addition to the measures under the Proposed Action, the Staff Alternative includes the following measures:

- Supplement gravel in the Feather River to increase suitable spawning habitat for Chinook salmon and steelhead. Monitor at least 10 of the 15 riffles every 5 years on a rotating basis or after a high flow event. Develop a common definition of median size ranges of gravels to benefit Chinook salmon and steelhead (revision to Proposed Article A102).
- Identify potential actions and implement a phased program to enhance the riparian corridor and connect the Feather River to its floodplain, including how flood/pulse flows may contribute to floodplain values and benefit fish and wildlife species. DWR's evaluation of potential actions should include the potential for flood/pulse flows to increase risk of Infectious Hematopoietic Necrosis (IHN) transmission. Delineate specific on-the-ground actions, or provide a quantified benchmark by which success and compliance of measures can be assessed (revision to Proposed Article A106).
- Obtain Commission approval prior to implementing any modification to the minimum instream flow regime or water temperature objectives (revision to Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*).
- Develop a plan to install the proposed vault restroom, 5 to 10 picnic tables with shade armadas, and interpretive signs, and possibly install pole stoves at the Foreman Creek boat launch (revision to Proposed Action 127, *Recreation Management Plan*).
- Include in the Recreation Management Plan a provision to develop site plans and reconstruct the boat-in campgrounds at Bloomer, Goat Ranch, and Craig Saddle within the first 10 years after license issuance (revision to Proposed Action 127, *Recreation Management Plan*).
- Establish standards for maintaining developed recreation facilities, including trails, and incorporate these into the Recreation Management Plan (revision to Proposed Article 127, *Recreation Management Plan*).
- Include in the Recreation Management Plan a provision to conduct baseline inventory of trail conditions using established standards (see previous bullet) developed for project trails prior to proposing any changes to trail use designation (revision to Proposed Article 127, *Recreation Management Plan*).

[27] Interior letter dated March 28, 2006, and NMFS and DFG letters dated March 29, 2006.

- Include in the Recreation Management Plan a provision to monitor and report on trail conditions throughout the term of any license issued (revision to Proposed Article 127, *Recreation Management Plan*).
- Include in the Recreation Management Plan a provision to expand the recreation monitoring program to include non-trail users to detect latent demand and unmet user needs related to trails (revision to Proposed Article 127, *Recreation Management Plan*).
- Revise the non-motorized trail program of the Recreation Management Plan based on the trail condition inventory, analysis of the survey and trail use data, and results of the feasibility studies for new trails. Include recommendations, if appropriate, for changing trail use designations and a proposed implementation schedule.
- Revise and resubmit the HPMP for Commission approval.
- Close the Foreman Creek boat launch to recreational use and develop a plan for protecting cultural resources that considers a spectrum of possible actions including installing recreational facilities to redirect recreational use away from cultural resources and discontinuing recreational use at the site. Prepare the plan within 6 months of license issuance in consultation with local Native American Tribes (revision to Proposed Article 129, *Improve and Redirect Recreation Usage to Specific Areas at Foreman Creek*).
- Prepare a fuel management plan for National Forest System lands within the project boundary.
- Develop a plan to continue reseeding, as necessary, the downstream face of Oroville dam.
- Prepare a biological evaluation of the effects of any proposed project construction activities on Forest Service special status species or their habitat.
- Develop a threatened and endangered species implementation plan that would describe how DWR would comply with its proposed conservation measures and the terms and conditions contained in the FWS's biological opinion.

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

2.4.1 Federal Government Takeover of the Project

We do not consider federal takeover to be a reasonable alternative. Federal takeover and operation of the project would require Congressional approval. Although that fact alone would not preclude further consideration of this alternative, there is no evidence to indicate that federal takeover should be recommended to Congress. No party has suggested federal takeover would be appropriate, and no federal agency has expressed an interest in operating the project.

2.4.2 Issuing a Non-power License

A non-power license is a temporary license that the Commission terminates when it determines that another governmental agency will assume regulatory authority and supervision over the lands and facilities covered by the license. At this point, no agency has suggested a willingness or ability to do so. No party has sought a non-power license, and we have no basis for concluding that the project should no longer be used to produce power. Thus, we do not consider a non-power license a realistic alternative to relicensing in this circumstance.

2.4.3 Retiring the Project

Project retirement could be accomplished with or without dam removal. Either alternative would involve denial of the relicense application and surrender or termination of the existing license with appropriate conditions and cessation of power generation at the project, resulting in the following effects:

- Energy currently generated by the project would be lost. The project is estimated to produce an annual average of 2.4 million MWh of electrical power, providing about one-third of the electricity needed each year to operate the pumps that move water through the State Water Project.
- There would be significant costs involved in retiring the powerhouse and appurtenant facilities.
- The environmental enhancements currently proposed by DWR would be foregone.
- If the dam and control structures were removed and the original riverine shoreline re-established, existing recreational, residential, and commercial facilities operated by DWR, the California Department of Parks and Recreation (DPR), and commercial interests would be compromised.
- The potential for environmental effects such as release of sediments accumulated behind the dam to the river downstream and loss of lacustrine habitats and wetlands could occur.

However, removal of the dam and control structures would restore a free-flowing river and riverine habitat, eliminate any fish entrainment mortality that may be occurring, provide unobstructed fish passage past the site, provide unobstructed recreational riverine boating, and provide the potential for the Tribe to re-establish some of its traditional uses of the river prior to impoundment.

Despite these potential benefits, we do not regard this alternative as reasonable in view of the many more potential losses.

The second project retirement alternative would involve retaining the dam and control structures and disabling or removing equipment used to generate power. Project works would remain in place and could be used for historic or other purposes. This would require us to identify another government agency with authority to assume regulatory control and supervision of the remaining facilities. No agency has stepped forward, and no participant has advocated this alternative. We have no basis for recommending this action. Because the power supplied by the project is needed, a source of replacement power would have to be identified. In these circumstances, we do not consider removal of the electric generating equipment to be a reasonable alternative.

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COVER SHEET

FEDERAL ENERGY REGULATORY COMMISSION
FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE OROVILLE FACILITIES PROJECT
Docket No. P-2100-052

Section 3
Environmental Analysis
Pages 43 to 350
FEIS

3.0 ENVIRONMENTAL ANALYSIS

In this section, we first describe the general environmental setting in the project vicinity and any environmental resources that could be cumulatively affected by relicensing the Oroville Facilities. Then, we address each affected environmental resource. For each resource, we first describe the affected environment—the existing condition and the baseline against which to measure the effects of the proposed project and any alternative actions—and then the environmental effects of the proposed project, including proposed articles included in appendix A of the Settlement Agreement. Unless otherwise stated, the source of our information is the license application for the project (DWR, 2005b).

3.1 GENERAL SETTING

The Oroville Facilities are located on the Feather River and several tributaries including the North Fork, West Branch, South Fork, and Middle Forks of the Feather River. Ten creeks also flow directly into Lake Oroville. Table 7 summarizes the drainage area by major tributary and includes the local drainage to the lake in the vicinity of the major tributary (Ecosystem Sciences Foundation, 2005). The largest tributary is the North Fork, accounting for nearly 60 percent of both drainage area and inflow. Figure 7 provides a profile view of hydroelectric development along the North Fork.

Table 7. Major tributary areas and flow contribution to Lake Oroville inflow. (Source: Ecosystem Sciences Foundation, 2005)

Area	Drainage Area (square miles)	Watershed Area (%)	Mean Daily Inflow (cfs)	Inflow (%)
West Branch	167.2	4.64	346	6.47
South Fork	126.7	3.51	262	4.90
North Fork	2,156.4	59.82	3,228	60.48
Middle Fork	1,154.5	32.03	1,502	28.15
Total	3,604.8	100.00	5,338	100.00

Normal maximum pool elevations in the project range from 136 feet msl at the Thermalito afterbay to 900 feet msl at Lake Oroville. The highest point in the Feather River Watershed is Mount Lassen (elevation 10,457 feet U.S. Geological Survey [USGS] datum) and is at the northwestern end of the Lake Almanor Basin, part of the North Fork Watershed. Much of the Feather River Watershed is located on the western side of the crest of the Sierra Nevada at or above elevation 4,500 feet. Summer months are typically dry and mild, and precipitation occurs primarily during winter months, with substantial snow accumulation at the higher elevations and rain generally occurring below 3,000 feet.

3.2 CUMULATIVELY AFFECTED RESOURCES

The scope of cumulative effects is based on the Council on Environmental Quality's regulations. The following resource disciplines were determined to be cumulatively affected by the project: geology; water quantity; water quality; aquatic; terrestrial; threatened and endangered species; and cultural resources.

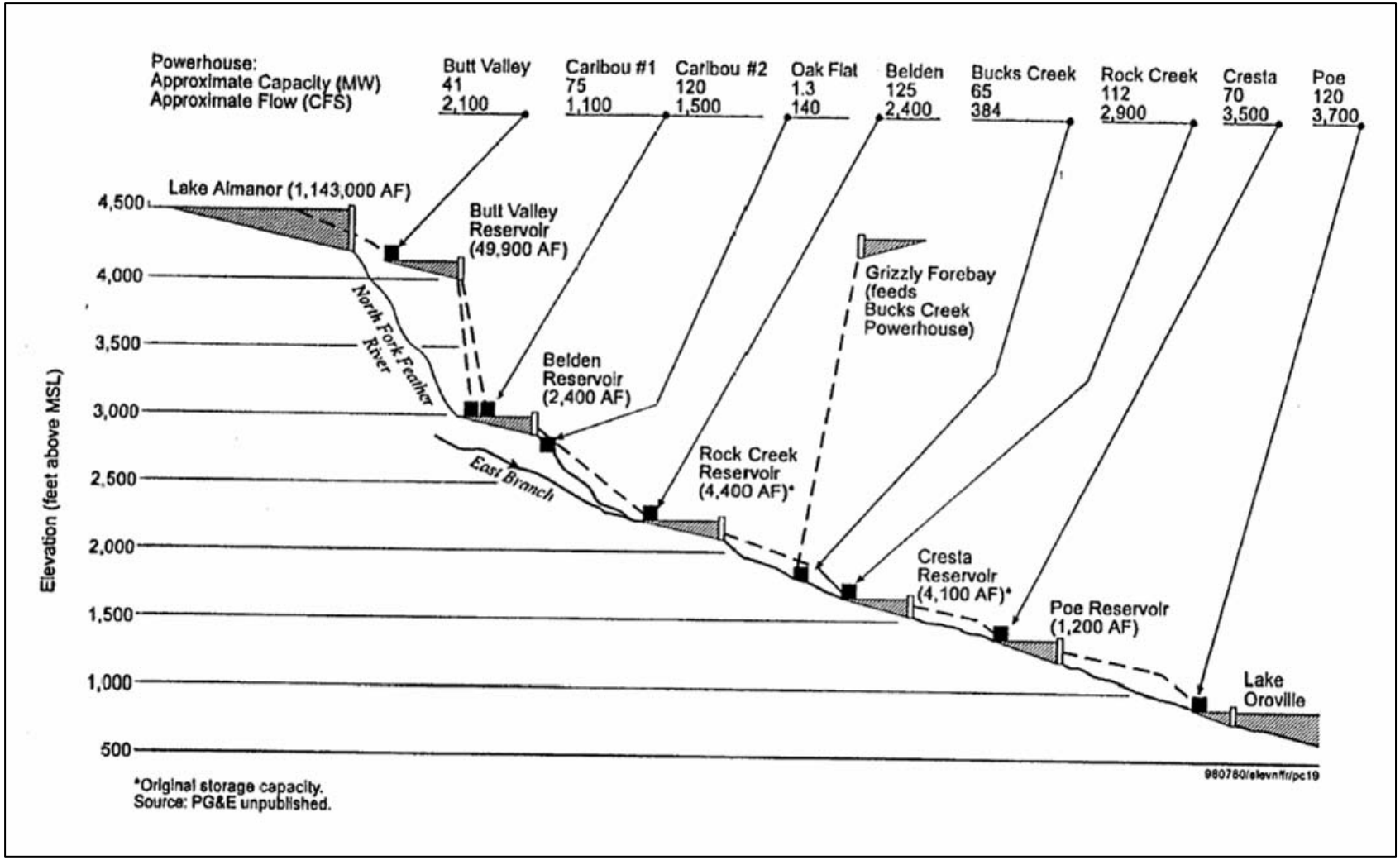

Figure 7. North Fork of the Feather River hydroelectric projects. (Source: PG&E, 2002a)

3.2.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the Proposed Action's effects on the resources. Because the Proposed Action would affect the resources differently, the geographic scope for each resource may vary.

The geographic scope for discussing cumulative effects on spring-run Chinook salmon and steelhead is broad considering the types of related actions that affect these anadromous fish species. Accordingly, the geographic scope for cumulative effects on these species ranges from the highest elevations of the Feather River basin to the Feather and Sacramento rivers and continues through the San Francisco Bay/Sacramento-San Joaquin Delta and into the Pacific Ocean. The geographic scope for geomorphologic resource topics (gravel recruitment, sediment transport, and large woody debris [LWD]) ranges from the tributaries to Lake Oroville, downstream in and along the Feather River to its confluence with the Sacramento River. The geographic scope for all other resource topics consists of the following locations and nearby lands: Lake Oroville, the Feather River, Thermalito forebay, Thermalito afterbay, and the OWA.

3.2.2 Temporal Scope

The temporal scope of our cumulative effects analysis in this EIS includes past, present, and future actions and their possible cumulative effects on each resource. Based on the license term, the temporal scope looks 30 to 50 years in the future, concentrating on the effects of the resources from reasonably foreseeable future actions. The historical discussion, by necessity, is limited to the amount of available information for each resource.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

3.3.1 Geology, Soils, and Paleontological Resources

In this section, the No-action Alternative, the Proposed Action, and Staff Alternative are evaluated for potential effects on the geologic, geomorphic, and soils-related resources within the project area. The license application includes a description of modeling efforts associated with geomorphic processes within the FERC project boundary (DWR, 2005a, appendix G).

3.3.1.1 Affected Environment

Regional Geologic Setting

About 85 percent of the project area upstream of the Thermalito diversion dam is located within the metamorphic belt of the Sierra Nevada Geomorphic Province. The remaining 15 percent of the project area (mostly to the north) is located within the Cascade Range Geomorphic Province. The area downstream of the Thermalito diversion dam is within the Sacramento Valley portion of the Great Valley Geomorphic Province.

The Sierra Nevada Geomorphic Province consists of granitic intrusions, andesitic flows and breccia, basalt, metamorphic rocks, ultramafic rocks, and unconsolidated sedimentary deposits. Intrusive rocks (medium- to coarse-grained granite and trondhjemite) dominate the landscape along the South Fork and Middle Fork within the project boundary. Highly weathered and/or decomposed granite (erodible and prone to landslides) occurs in the eastern watershed and along portions of the North Fork.

The Cascade Range Geomorphic Province comprises 495 square miles of the watershed from Lake Almanor to Lassen Peak. Rocks of this province include Pliocene- to Holocene-age tuff, breccia, volcanic ash, lava flows, and basaltic to rhyolitic lahars.

The Great Valley Geomorphic Province is a narrow, elongated, asymmetrical, north-northwest trending basin extending for about 450 miles between the Sierra Nevada and Coast Range provinces. The northern portion is known as the Sacramento Valley (Norris, 1990). The valley floor is an alluvial plain of unconsolidated Holocene deposits that overlie more consolidated alluvial and lacustrine deposits of Quaternary to Jurassic age. Below these sedimentary deposits are the shales and sandstones of the Cretaceous Great Valley Sequence and upper Jurassic bedrock of metamorphic and igneous rocks associated in the east with the Sierra Nevada and in the west with the Coast Ranges (Norris, 1990).

Geologic Conditions—Lake Oroville and Lake Oroville Tributaries

Geologic Setting

The western metamorphic belt of the Sierra Nevada Geomorphic Province underlies a significant portion of the Oroville Facilities watershed. These rocks extend from about Mariposa in the south to Lake Almanor in the north (Norris, 1990). This metamorphic belt is defined largely by a collective system of faults, the Foothills Fault System, which formed initially during the tectonic evolution of the region (Carlson, 1990).

Rocks of the western metamorphic belt include gabbroic, diabase, and granitic rocks exposed to the south and east of Lake Oroville. Much of the lower watershed consists of rocks of the western geomorphic belt. These rocks include the Foothill Melange-Ophiolite belt (Carlson, 1990), with an almost continuous 3-mile-wide band of serpentine that crosses through the watershed, as well as metamorphosed gabbroic, diabasic, and granitic rocks exposed to the south and east of Lake Oroville. These rock units are structurally weak and landslide-prone. Naturally occurring asbestos, a common constituent of serpentine, is known to occur in relatively high background concentrations.

Soil Conditions

Soils in the tributary areas upstream of Oroville dam are derived from weathering of the parent rock material in each area: Mesozoic and Paleozoic metasedimentary and volcanic rocks, Mesozoic intrusive plutonic rocks, and Cenozoic volcanic and sedimentary rocks. Soil profiles in the metamorphic and igneous rocks underlying the central and western portions of Lake Oroville tend to be thick. Thin soil profiles tend to develop on the intrusive igneous rocks underlying the eastern portion. Along the lower portions of the Middle and South Forks, exposed, intrusive rocks tend to decompose readily into their basic mineral assemblages. These rocks do not generally form deep soil profiles, but can readily be eroded by wave and wind action.

Sediment Sources in the Feather River Watershed

The upper Feather River Watershed is producing high sediment yields because of accelerated erosion. A U.S. Soil Conservation Service report, *East Branch North Fork Feather River Erosion Inventory Report* (SCS, 1989), estimated that 90 percent of the erosion in its 1,209 square mile study area was accelerated erosion.

Accelerated erosion is defined as a soil loss rate greater than natural geologic conditions. Increased sediment yield can be from “upslope” sources including human activities like road building, timber harvesting, urbanization, overgrazing livestock, and agriculture. Other sediment sources can be from within the channel itself, typically from bank erosion and/or channel incision. These in-channel sources are both associated with changes in flow regime, decreased groundwater levels, channelization and/or bank protection, bank erosion from livestock, or other actions. High sediment yields can reduce reservoir capacity, degrade water quality, and harm fish and wildlife. High sediment yields have significantly impaired storage capacity and hydroelectric operations in several reservoirs upstream of Lake Oroville on the North Fork.

Slope Stability/Landsliding

At full pool, Lake Oroville has a perimeter of about 167 miles and a surface area of about 15,810 acres. At the normal minimum water surface elevation of 640 feet, the shoreline perimeter decreases to about 107 miles and the reservoir surface area is about 5,796 acres. The areal extent between the shoreline at full pool level and the shoreline at 640 feet (the fluctuation zone) is about 10,000 acres.

Landslides are numerous along the banks of Lake Oroville and are concentrated along the North Fork arm (Bloomer Hill area) and in the South Fork arm (Stringtown Mountain area). The majority of active landslides are a result of reactivation of ancient landslides. In addition, a number of small active landslides are caused by bank/toe failure (likely due to repeated wave action along the shoreline under-cutting already unstable areas) at the edge of the reservoir, especially on the Middle Fork. Upstream of the reservoir, landslides are common along the North and Middle Forks, occurring in granitic and metamorphic rocks that form the hills and valleys of the westernmost portion of the Sierra Nevada. The amount of material derived from active landslide activity is considered minimal when compared to the amount of incoming watershed sediment and material derived from shoreline erosion.

The total area of all confirmed landslides mapped in the Lake Oroville area is about 4,154 acres. Of this total, about 328 acres (8 percent) are active, 579 acres (14 percent) are considered inactive, and the remaining 3,246 acres (78 percent) are ancient landslides. About 15 miles of shoreline are mapped as landslide material, representing less than 9 percent of the 167 miles of total shoreline length. The license application includes map coverage of landslides around Lake Oroville (DWR, 2004k, appendix c).

River Channel and Floodplain Physiography

Both the North and Middle Forks cross the crest of the Sierra, draining drier lands in the rain shadow to the east. In the lower two-thirds of the Feather River watershed both the Middle and North Forks flow in deeply incised canyons with little or no floodplain. The North Fork has several hydroelectric developments, resulting in a series of impoundments (and sediment sinks) within the Feather River Canyon (see figure 7). Some granitic domes reach the river's edge, resulting in no overbank areas in those reaches. Other river reaches allow for development of coarse, point and/or mid-channel bars. The Middle Fork has no dams in its canyon, and as a result, maintains a natural sediment regime through its canyon reach; the lower portion is dominated by large granite domes and a dearth of floodplain areas.

The South Fork enters the Middle Fork in Lake Oroville and its watershed does not cross the crest of the Sierra. Instead, the South Fork skirts the southwest portion of the Middle Fork Watershed and mostly drains into the lower foothills of the Sierra Nevada. The South Fork has been developed for hydroelectric and water supply needs by the Oroville-Wyandotte Irrigation District (now called South Feather Water and Power). Dams and reservoirs include Ponderosa dam at the high water mark of Lake Oroville and the Lost Creek, Sly Creek, and Little Grass Valley reservoirs.

Geologic Conditions—Downstream of Lake Oroville

There are two reaches downstream of Oroville dam that are defined largely by project operation, described in section 3.3.2, *Water Quantity and Water Quality*. The low flow channel extends from the fish barrier dam to the Thermalito afterbay outlet (RM 59) and the high flow channel extends from the Thermalito afterbay outlet to the confluence with Honcut Creek (RM 44) (figure 8). For the purposes of describing and discussing the Feather River, the aforementioned two areas along with the stretch of Feather River downstream to the confluence with the Sacramento River, are further subdivided into 11 geomorphic reaches which are all described in this section.

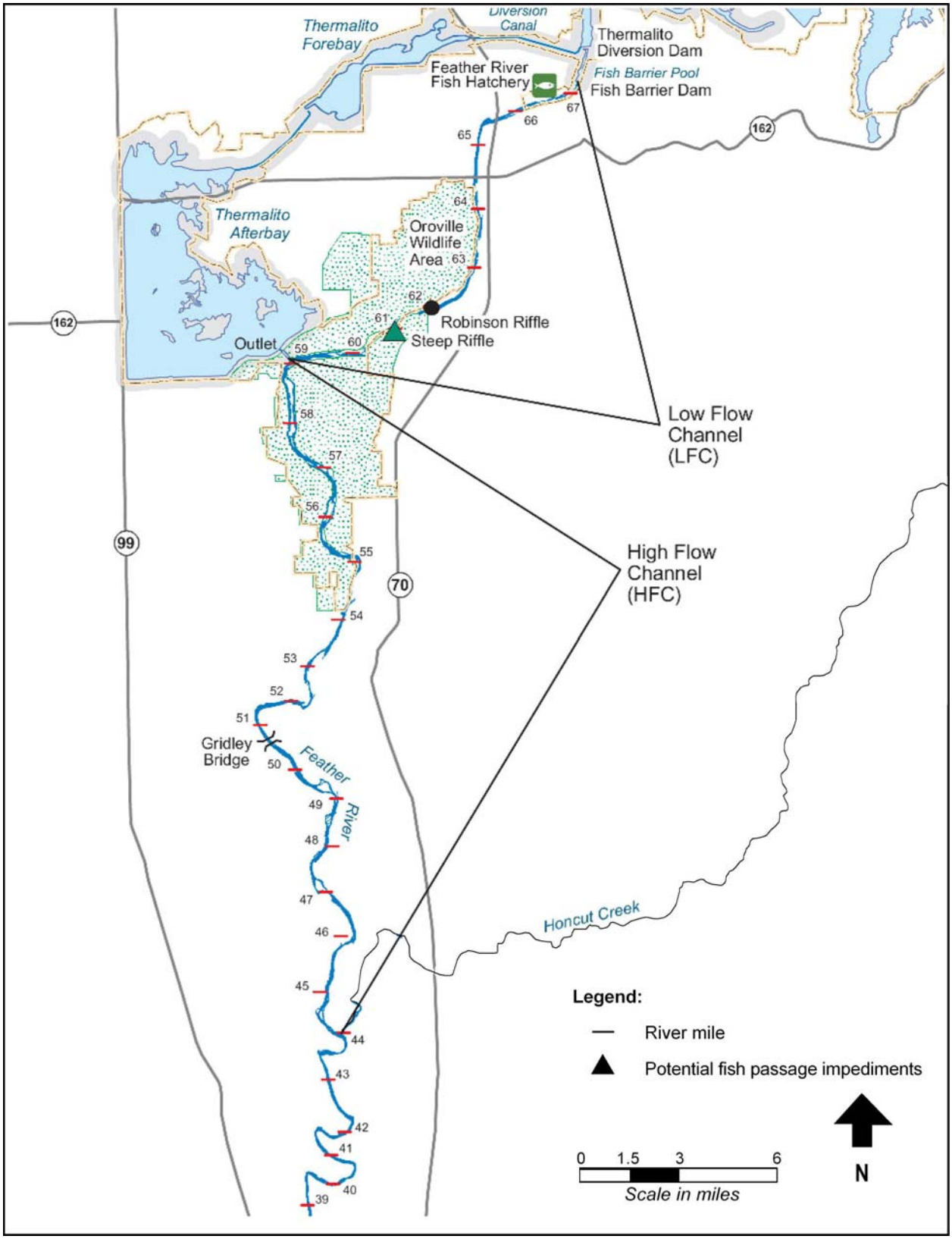

Figure 8. Distance in river miles from the confluence with the Sacramento River. (Source: DWR, 2005a) Page 1 of 2

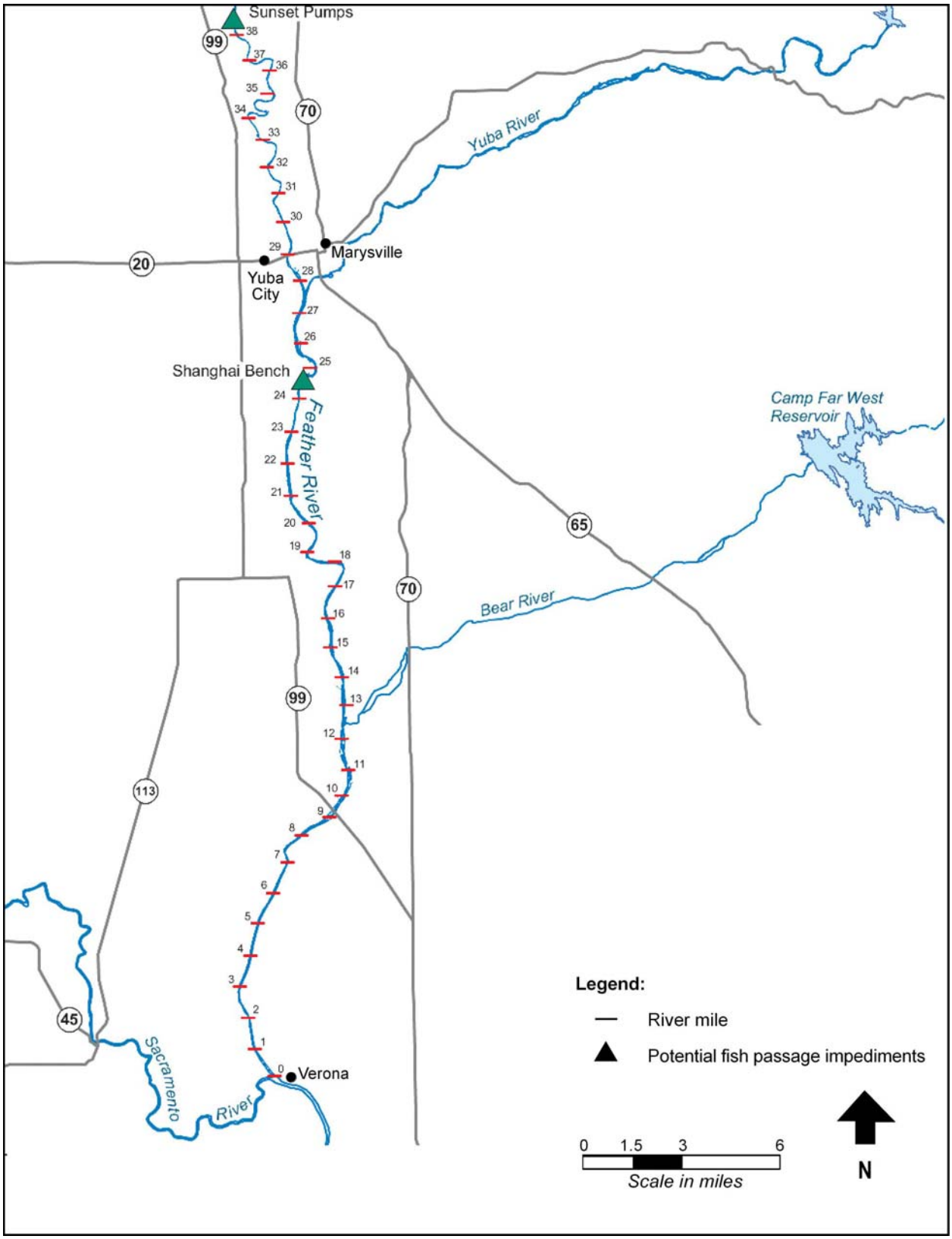

Figure 8. Distance in river miles from the confluence with the Sacramento River. (Source: DWR, 2005a) Page 2 of 2

Geologic Setting

Traveling through the Feather River watershed from upstream to downstream, it is apparent that the location of Oroville dam is roughly coincident with a marked change in the landscape. The relatively steep shorelines of the reservoir contrast with the openness of the east side of the Sacramento Valley. These changes translate to reductions in gradient and channel confinement for the river channel.

Metamorphic bedrock crops out between Oroville dam and the Feather River Fish Hatchery. Along the boundary between the Sierra Nevada/Cascade provinces and the Great Valley province west of Lake Oroville, scattered sedimentary and volcanic deposits of the Ione, Laguna, and Tuscan formations blanket older bedrock units.

River banks below Lake Oroville consist of about 1 percent bedrock, 5 percent Laguna, 3 percent Modesto, 24 percent slickens, 10 percent tailings, 14 percent floodplain deposits, 38 percent alluvial edge, and 5 percent levees. Unconsolidated river sediments including floodplain, point bar, channel, and other deposits are found in the Feather River meander belt downstream to the Sacramento River, as are outcrops of the more-resistant Laguna, Modesto, and Ione Formations that hedge in the floodplain. Stream channel deposits occur in active channels of the Feather River and tributary streams and are transported downstream as a result of current hydrologic conditions. These deposits contain clay, silt, sand, gravel, cobbles, and boulders in various layers and mixtures that reflect conditions at the time of deposition.

Soil Conditions

The soils in the area downstream of Oroville dam are found on relatively level land, with most slopes ranging from 0 to 2 percent. Steep cliff-like areas separate the surrounding landscape from the relatively incised floodplain areas in certain reaches of the river, mostly upstream of RM 64.5. The highest slope, with the exception of riverbank and road cuts, is 5 percent. The most common parent material for the soils is river alluvium, with some soils derived from mining debris deposited during the hydraulic mining period.

The predominant soil types or textures in the 100-year floodplain are characterized as fine sandy loam, loamy sand, and loam to silt loam. Minor soil types are clay, clay loam, sandy clay loam, sandy loam, silt loam, silty clay, sand and gravel, and river wash. Many of the soils are further divided by occurrence of flooding, such as occasionally flooded to frequently flooded. The soils range from shallow to very deep, with most being moderately deep to very deep. Floodplain soils are conducive to agriculture and many areas of riparian floodplain and fluvial terraces have been converted to irrigated crops and orchards.

Sediment Sources

Sedimentary debris from hydraulic mining in the late nineteenth and early twentieth centuries filled the riverbed and adjacent floodplain of the lower Feather River, resulting in thick deposits of fine-grained, clay-rich, light yellow-brown colored material known as “slickens.” These slickens have in places been buried by more-recent floodplain deposits, but are evident in eroding banks along most of the river. Dredge tailings from later gold mining are found as large piles of gravels and cobbles adjacent to the river between the cities of Oroville and Gridley. A large volume of dredge tailings was excavated and used in the construction of Oroville dam. Much of the OWA is covered with these deposits. Reductions in sediment supply to the river because of Oroville dam are discussed below in the *River Geomorphology* section under *Conditions Downstream of Oroville Dam*.

Riverbank Erosion

While erosion occurs on both river bends and straight reaches, erosion rates tend to be higher in bends than on straight reaches. Given that the Lower Feather River possesses a relatively low sinuosity, it also possesses relatively low erosion rates. The overall bank erosion rate is 1.7 feet/feet/year, which is quite low compared to the nearby Sacramento River's average rate of about 16 feet/feet/year.

River Geomorphology

Conditions Upstream of Lake Oroville

The Upper Feather River Watershed (outside the boundary of the Oroville Facilities) produces high sediment yields because of accelerated erosion. Sediment derived from accelerated erosion can degrade channels and water quality, reduce reservoir capacity, and harm fish and wildlife habitat. In the lower two-thirds of the North Fork watershed upstream of Oroville dam, sediment transported downstream of the upstream reservoirs passes through a deeply incised canyon with little floodplain. Without any reservoirs in its canyon, the Middle Fork also transports its sediment through an incised canyon with little room for floodplain deposition. Sediment in the South Fork is captured by Ponderosa reservoir.

Lake Oroville captures nearly all of the sediment passing downstream to it, and an estimated 97 percent of this sediment is trapped in the reservoir. Because Oroville Facilities operations can lower the reservoir level to between 50 and 250 feet below full pool (900 feet msl), sediment deposition does not occur above Lake Oroville. Instead, substantial sediment deposition occurs laterally within and along the reservoir's tributary channels and longitudinally within and downstream of the fluctuation zone. Deposition in the reservoir arms has created sediment wedges; the locations are shown in figure 9 and discussed further in section 3.3.3, *Aquatic Resources*.

Conditions Downstream of Oroville Dam

The Feather River emerges from the Sierra Nevada and enters the Sacramento Valley downstream of Oroville dam. In this region, the stream gradient flattens significantly and the topography becomes more subdued compared to the relatively steep topography along the tributaries and main stem upstream of the dam. Bluffs and terraces, overflow channels, multiple channel areas, and both artificial and natural levees occur along the lower river. In addition, Honcut Creek and the Yuba and Bear rivers join the Feather River before it enters the Sacramento River at Verona. The elevation of the valley floor varies from about elevation 150 feet msl at Oroville to about elevation 25 feet msl at Verona.

The Feather River meander belt between Oroville dam and its confluence with the Sacramento River consists of recent alluvium and stream channel deposits. Older alluvial deposits, not directly linked to the present Feather River, form terraces on both sides of the active stream channel. These deposits are typically higher in elevation, more resistant to erosion, and they define the boundaries of the active meander belt. Of the sediments within the meander belt, the alluvium is older. Like the stream channel deposits, these sediments consist of river deposits including floodplain and point bar deposits, channel fill, oxbow lake and tributary delta deposits, and hydraulic mining debris. The deposits range in size from clay, silt, and sand to gravel, cobbles, and boulders. Coarse deposits (including the mine tailings cobble in the OWA) predominate near Oroville and fine deposits predominate from Gridley downstream.

On the Feather River, a variety of human-induced changes have affected the balance between erosion and deposition. Normally an alluvial river is balanced in terms of erosion and deposition. A river is aggrading if deposition is greater than erosion, and degrading if erosion is greater deposition. In most

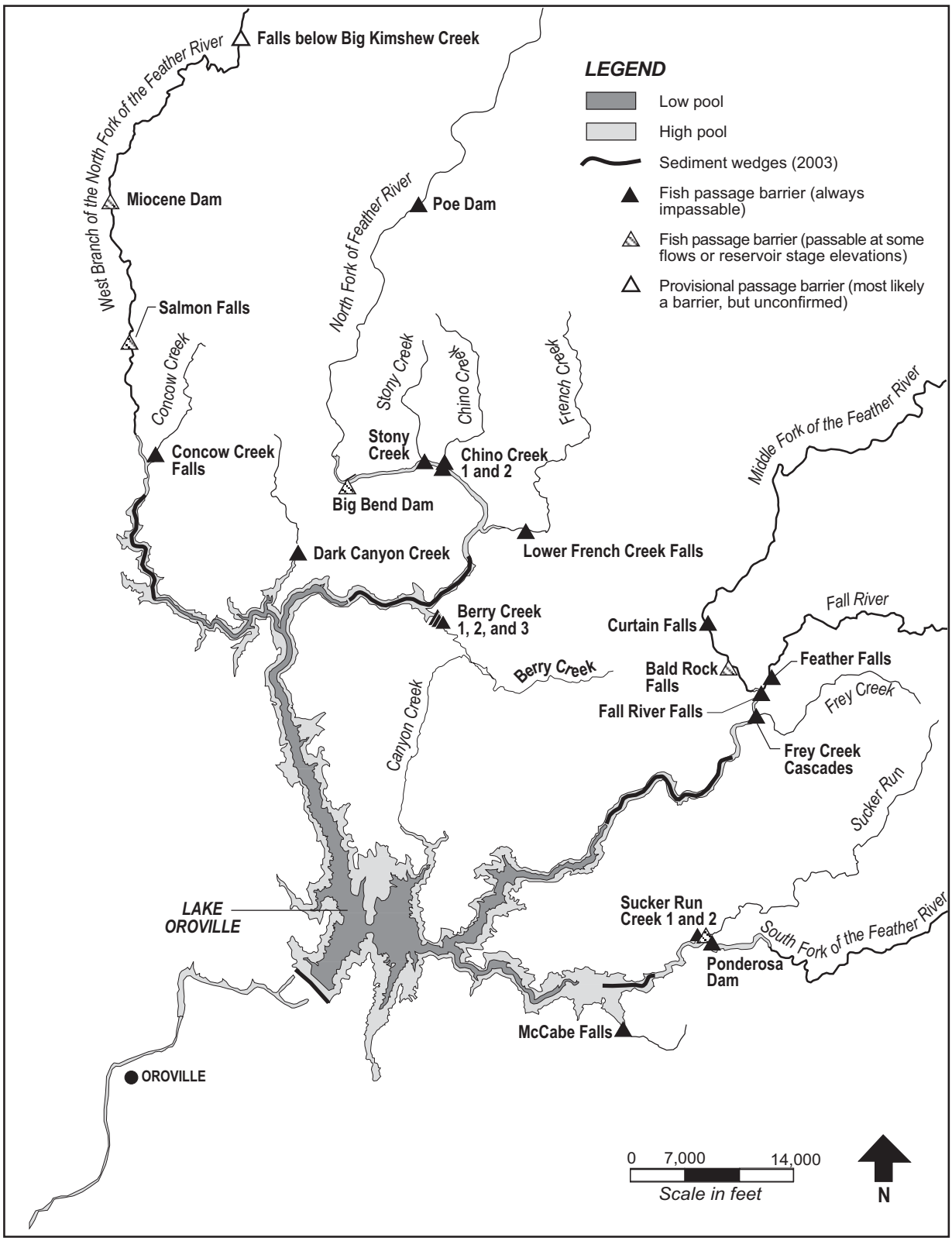

Figure 9. Lake Oroville fish passage barriers. (Source: DWR, 2005a)

cases, a river shifts from aggrading to degrading because of changes in river flow and sediment availability. Interpretation of geologic units exposed along the Feather River suggests that the river was degrading very slowly during the Holocene[28] era prior to Anglo-American occupation and alterations.

Before 1855, the Feather River was a meandering stream, believed to be similar to the present Sacramento River between Red Bluff and Colusa. Between 1855 and the early twentieth century, the large pulse of sediment from hydraulic mining changed the Feather River into an aggrading river. A thick deposit of fine, clay-rich slickens was deposited in the channel and on the floodplain. Following the period of mining debris deposition, a series of dams was built within the Feather River watershed. The cumulative effect of these reservoirs located above Lake Oroville was a dramatic reduction in sediment supply, and with the completion of Oroville dam in 1968, the nearly complete capture of sediments eroded from the watershed.

Currently, sediment from the upstream watershed is reduced by an estimated 97 percent downstream of Lake Oroville, resulting in sediment deprivation downstream. Only silt, clay, and a very small amount of sand, and no gravel or cobble-sized substrates are currently discharged to the Feather River downstream of Oroville dam. As such, the Feather River downstream of Oroville dam is sediment-starved. Honcut Creek is the only tributary providing sediment to the river between Oroville dam and Yuba City.

Sediment transport data were available from USGS (1978) for a short period directly after the construction of project facilities. The average annual pre-dam sediment yield at the Feather River at Oroville gage was estimated to be 3,264 tons per day (1902–1962). The post-dam suspended sediment yield (1968–1975) was estimated at 42.5 tons per day. Results from FLUVIAL-12 model runs for current conditions suggest the amount of bed material load in the Feather River passing the Thermalito afterbay outlet (at the end of the low flow channel) in a 50-year period is 0.5 million ton, or about 10,000 tons per year, or 27 tons per day. This is about 6 percent of the pre-dam bedload of 485 tons per day estimated by USGS. The material comprising this bedload mostly comes from channel erosion since bed material is trapped by Oroville dam and the amount of bank erosion in the low flow reach is small. The low sediment yield from the banks is a reflection of the river's stable banks which consist of erosion-resistant bedrock, terrace deposits, and cobbly dredger tailings. In addition, in-river gravel-mining operations within the historical riverbed act as localized sediment traps. This overall lack of sediment changes downriver patterns of sediment transport, deposition, scour, mobilization of sediment, and turbidity levels. These changes to the river hydrology and sedimentation patterns have, in turn, altered channel morphology, including changes to the channel shape, stability, and capacity. These effects are discussed below in section 3.3.1.2, *Environmental Effects*.

Feather River Geomorphic Reaches

The Feather River has been divided into 11 geomorphic reaches (table 8; labeled from downstream to upstream starting from the confluence of the Feather River with the Sacramento River [RM 0]) based on a variety of geologic and channel configuration characteristics, such as channel-controlling geology, planform, bed material, and depth/width ratio. A map of the Feather River with the distances from the confluence with the Sacramento River is provided in figure 8. Geomorphic reaches are discussed below, beginning at the fish barrier dam and proceeding downstream.

[28] The present Holocene era follows the Pleistocene epoch, a segment of geologic time roughly synonymous with the most-recent ice age, which included glaciation of the Sierra Nevada and Cascade ranges, and concurrently high sediment supply in most rivers emanating from glaciated terrain.

Table 8. Geomorphic reaches of the Feather River. (Source: DWR, 2004a)

Reach	River Miles	Bed Composition	Bank Composition	Stream Type	Sinuosity
FR-1	0.0–7.0	Sand	Sand and silt over slickens	Alluvial stable	Low
FR-2	7.0–12.5	Sand	Sand and silt over slickens	Alluvial meandering	Low
FR-3	12.5–17.0	Sand	Sand and silt over slickens	Alluvial geologic control	Low
FR-4	17.0–28.0	Sand	Sand and silt over slickens	Alluvial geologic control	Moderate
FR-5	28.0–33.5	Sand	Sand and silt over slickens	Alluvial stable	Low
FR-6	33.5–35.5	Sand and Gravel	Sand and silt over slickens	Alluvial erodible	High
FR-7	35.5–39.5	Sand and Gravel	Sand and silt over slickens	Alluvial stable	Low
FR-8	39.5–46.5	Gravel	Sand and silt over slickens	Alluvial erodible	Moderate
FR-9	46.5–53.5	Cobble and gravel	Cobble and gravel	Alluvial stable	Low
FR-10	53.5–64.0	Cobble and gravel	Cobble and gravel	Dredger tailings	NA
FR-11	64.0–68.0	Bedrock (and cobble)	Cobble and bedrock	Bedrock	NA

In the reach downstream of the fish barrier dam (reach FR-11), the channel is controlled by bedrock, and there is essentially no lateral channel migration. The bed material is bedrock, covered in most places by a veneer of cobbles and boulders up to 10 feet thick. Spawning gravel supplementation was conducted in this area in the 1980s. Sediment input from upstream or bank erosion is minimal to non-existent and because this is part of the low flow channel, flows are regulated by bypassing water through the Thermalito Complex.

Downstream, the reaches of the low flow channel near the OWA are characterized by coarse dredge tailings composing both the bed and banks. Riffles, point bars, mid-channel islands, and multiple channels are common, but cobbles and boulders armor most of these depositional features. Levees severely constrict the floodplain along the upper portion of this reach. There are overflow weirs into the OWA in at least four places. Much of the reach has been mined for gravel, resulting in many pits, multiple channel areas, and somewhat jumbled floodplain topography. The Thermalito afterbay outlet at RM 59 marks the point of re-introduction of bypassed flows, increasing discharge and beginning the high flow channel.

Farther downstream (reach FR-9), the river is sinuous and is characterized by multiple channels, mid-channel islands, point bars, and a gravel-cobble bed. The reach is not meandering, but localized bank erosion does occur. An important difference from upstream reaches is the transition to a floodplain comprising silt and marked by distributary overflow channels, most of which have been filled in by land

leveling and farming activity. It is unknown if the channels are a result of deposition of hydraulic mining debris or a relic feature from pre-mining days.

From RM 39.5 to 46.5 (reach FR-8), the river meanders through a narrow corridor with characteristic evidence of meandering on the floodplain. This includes old meander scars, oxbow lakes, and active bank erosion. A number of actively eroding banks occur in this reach. Bank recession of more than 500 feet in the last 35 years is common. Armored gravel point bars have developed in most of the river bends. The bed is mostly gravel.

Reach FR-7 extends from RM 35.5 to 39.5. This reach has low sinuosity, and minimal point bar development. The channel is narrower than downstream, has incised into the floodplain, and has tall, vertical banks composed of slickens overlain by floodplain silt and sand. In some places, the slickens do not appear to be present. There are minor depositional features, mostly sand bars found in the channel, and the bed is gravel.

Immediately downstream (around RM 35.5), the river transitions from a gravel-bed channel to a sand-bed channel. The bed, at this point, is mostly sand but also contains pebbles and some gravel. The banks are primarily sand and silt deposited on the presently active floodplain. This section of river is unusual compared to other reaches, with very high sinuosity and active bank erosion and point bar formation. The point bars consist of mostly sand and minor gravel and are not armored. Meander cutoffs have occurred here in the past and will likely occur here in the near future. The relatively fine composition (sand to fine gravel) of the bed and bank is probably responsible for the instability of this reach.

The next 5 miles or so down to the confluence of the Yuba River are fairly straight with minimal bank instability and meandering, and low sinuosity. This reach is influenced by backwater effects from the Yuba River. The adjacent floodplain is confined by older terrace deposits and levees to a width that is typically less than 1 mile across. The river has a sand bed, with banks consisting of floodplain deposits overlying slickens. There are minimal point bars or other depositional features, and no multiple channels in this reach.

Reach FR-4 extends from RM 28, where the Yuba River joins the Feather, downstream to RM 17. Several large meanders occur near the bottom of the reach. Erosion resistant Modesto Formation is exposed in some places. Most banks consist of floodplain deposits overlying slickens. The bed consists mostly of sand. Shanghai Bench is a noteworthy feature near RM 25. The bench is an erosion resistant unit that appears to be Laguna Formation, with Modesto Formation on top. This bench-like outcrop forms a rapid, with a near-vertical drop of several feet in places. Jet boats can navigate the bend at summer flows but generally not at lower spring and fall flows.

From reach FR-4 to the confluence with the Sacramento River, the Feather River is relatively wide and straight with a sand bed and bars that can frequently shift. Typically, one side of the river has a bank consisting of floodplain silt and sand overlying slickens. The opposite bank typically consists of active point bar deposits of sand with some silt. This alteration indicates that some bank erosion and channel migration is occurring.

In the last 7 miles above the confluence, the river is within the Sutter Bypass, and the south bank is levied. Overflow from the Sacramento River through the Bypass can enter the river in this area, and during floods a backwater is formed. The bed consists of moving bars of sand, mobile during even the moderate flows of the summer irrigation season.

Bank Protection

Between the Thermalito afterbay outlet and Verona (where the Feather River meets the Sacramento River), about 10 percent of the river is riprapped. Table 9 displays several segments of the river and notes details on riprap location and percent of the segment covered in riprap.

Table 9. Selected Feather River segments and riprap lengths. (Source: DWR, 2005a)

River Segment	Left-bank Riprap	Right-bank Riprap	Both Banks Total	Percent of River Segment
Thermalito afterbay outlet to Honcut Creek	(Data available only for both banks together)	(Data available only for both banks together)	20,000 feet	13 % of this 14.7-mile segment
Honcut Creek to Sunset Pumps	(Data available only for both banks together)	(Data available only for both banks together)	10,000 feet	18% of this 5.2-mile segment
Sunset Pumps to Yuba City	250 feet of the left bank	7,250 feet of the right bank	7,500 feet	6% of this 11-mile segment
Yuba City to Verona	(Data available only for both banks together)	(Data available only for both banks together)	More than 25,000 feet; mostly left bank in lower 7 miles of river	8% of this 28-mile segment
Total				64,000 feet, or 10% of river downstream of Thermalito afterbay outlet

Paleontological Resources

The known fossil-bearing formations within the project area are the Calaveras Limestone, the Monte del Oro, and the Laguna. These formations are known to contain noteworthy examples of invertebrate or plant fossils (Monte del Oro and Calaveras) or vertebrate fossils (Laguna). Also occurring within the project area are portions of the Ione and Tuscan Formations. These formations have the potential to contain vertebrate fossils or noteworthy examples of invertebrate or plant fossils. Other rock formations exposed within the project area are not expected to contain fossils because of their igneous or metamorphic nature.

Excavations into the Laguna Formation have, in places, revealed a Plio-Pleistocene vertebrate fauna. Based on mapped surface expressions of the Laguna Formation, one such location may occur near Thermalito afterbay, but is unconfirmed.

3.3.1.2 Environmental Effects

Under the Proposed Action, there would be some beneficial effects on the natural geomorphic processes on the Feather River below Oroville dam. These effects include increased coordination of the various ecological project work through the Ecological Committee (Proposed Article A100) and the Lower Feather River Habitat Improvement Plan (Proposed Article A101); a slight increase in the Feather River's supply of sediment with the implementation of the Gravel Supplementation and Improvement Program (Proposed Article A102) and; increased channel complexity through the addition of LWD, boulders, and other habitat structures in the Feather River as part of the Structural Habitat Supplementation and Improvement Program (Proposed Article A104). The following subsection provides qualitative analyses of potential effects on geologic, geomorphic, and soils-related resources associated with the Proposed Action.

There are no measures in the Proposed Action related to improving geology, soil, and geomorphology resources upstream of the fish barrier dam. As such, conditions related to geology, soils, and geomorphology in this area (including Lake Oroville) would continue to be the same as under the No-action Alternative. The exception to this conclusion is the potential for short-term, localized shoreline

and/or soil erosion, or increases in turbidity related to implementation of reservoir fishery habitat improvements (as part of the Lake Oroville warm water fishery habitat improvement program) and construction of trails and other recreational facility improvements (see section 3.3.6.2, *Recreational Resources*). These effects are discussed below in section 3.3.1.4, *Unavoidable Adverse Effects*.

Ecological Committee (Proposed Article A100)

Under Proposed Article A100, *Ecological Committee*, DWR would establish within 3 months of license issuance, an Ecological Committee to consult, review plans, and provide advice to DWR regarding specific license articles. Membership on the Ecological Committee would comprise Settling Parties who represent relevant federal and state regulatory agencies (such as NMFS, FWS, BLM, DFG, and DPR); local governmental entities and Native American tribes; and other interested Settling Parties (such as the State Water Contractors and American Rivers). The Water Board and the Central Valley Regional Water Quality Control Board (Regional Board) would be members of the Ecological Committee, even though they did not sign the Settlement Agreement. In addition, other persons would have the option to apply for membership on the Ecological Committee. Interior's 10(a) recommendation no. 1, NMFS's 10(j) recommendations (not numbered), and DFG's 10(j) recommendation no. 1 are consistent with this provision.

Staff Analysis

The Ecological Committee would be an appropriate entity to advise DWR on implementation of the adaptive ecological measures that may be included in the project license. The Ecological Committee would provide the important interdisciplinary resource perspective necessary to review monitoring results and foster sound management across multiple resource areas. This would include making recommendations on appropriate flow levels, as well as alterations to the project and its operations to enhance water temperature for salmonids. All such actions would increase the efficacy of applicable resource measures. As proposed, the members specified in appendix C of the Settlement Agreement appear to include appropriate representation across the spectrum of natural resources. Participation by the affected land and resource managing agencies at the local, state, and federal levels would provide important input.

Lower Feather River Habitat Improvement Plan (Proposed Article A101)

Under Proposed Article A101, *Lower Feather River Habitat Improvement Plan*, DWR would develop a comprehensive Lower Feather River Habitat Improvement Plan for the Feather River below the Oroville Facilities. The Plan would include the following programs which are defined in separate proposed articles in the Settlement Agreement: (1) a Gravel Supplementation and Improvement Program (described in section 3.3.5.2, *Threatened and Endangered Species*); (2) a Channel Improvement Program (described in section 3.3.5.2, *Threatened and Endangered Species*); (3) a Structural Habitat Supplementation and Improvement Program (described in section 3.3.3.2, *Aquatic Resources*); (4) a Fish Weir Program (described in section 3.3.5.2, *Threatened and Endangered Species*); (5) a Riparian and Floodplain Improvement Program (described in detail below); (6) a Feather River Fish Hatchery Improvement Program (described in section 3.3.3.2, *Aquatic Resources*); (7) a Comprehensive Water Quality Monitoring Program (described in section 3.3.2.2, *Water Quantity and Quality*); (8) an Oroville Wildlife Area Management Plan (described in section 3.3.4.2, *Terrestrial Resources*); and (9) Instream Flow and Temperature Improvements for Anadromous Fish (described in section 3.3.2.2, *Water Quantity and Quality*).

In addition, the Lower Feather River Habitat Improvement Plan would attempt to minimize the creation or exacerbation of predation or predatory habitat during the development, implementation, or operation of any future license program or action. DWR would annually report monitoring results and activities related to the Lower Feather River Habitat Improvement Plan, if appropriate, to the Ecological

Committee. After the fifth year of the new license, DWR would develop a single, comprehensive monitoring and adaptive management summary report, which would be prepared at 5-year intervals throughout the duration of the license. The comprehensive report would include the results of each of the various components of the Plan and would provide a summary of actions taken, management decisions, and proposed modifications to the various program components. Since many of the programs would be developed in the first 5 years of the new license, the first report on the Plan would be comprehensive to the extent the data is available at the time the report is due. Interior's (on behalf of FWS) 10(j) recommendation no. 1, NMFS's 10(j) recommendations (not numbered), and DFG's 10(j) recommendation no. 1 are consistent with this provision.

Staff Analysis

Natural resources and processes associated with the project are inextricably linked across resource disciplines such that it is not prudent to plan and implement actions to benefit one resource without considering the collateral effects on other resources. The measures in Proposed Article A101, *Lower Feather River Habitat Improvement Plan*, would ensure that implementation schedules are coordinated. The reporting component of the measure would provide an integrated means of evaluating the effectiveness of multiple programs. Providing comprehensive 5-year reports would provide a frequent and centralized opportunity for the Commission's oversight of the project.

Riparian and Floodplain Improvement Program (Proposed Article A106)

Under Proposed Article A106, *Riparian and Floodplain Improvement Program*, DWR would develop and file for Commission approval (within 6 months of license issuance) a plan for a four phase program to enhance riparian and other floodplain habitats for associated terrestrial and aquatic species. The plan would address the connection of portions of the Feather River with its floodplain within the OWA and, in anticipation of improving fish and wildlife habitats, would include a description of areas in which gravel extraction may take place. The plan would also include a definition of high flow events. The plan would be developed in consultation with the Ecological Committee, including specifically FWS, NMFS, DFG, and the Water Board (consultees). DWR would include with the filing of the plan, copies of consultation comments, including recommendations made in the course of such consultation, and explanations as to why any such comments were not adopted. Upon Commission approval, and after obtaining all necessary permits, DWR would implement the plan, including any changes required by the Commission. The Commission would reserve the right to make further changes to the Plan.

In Phase 1 (to be completed within 1 year of license issuance) DWR would, in consultation with the consultees listed above, develop and submit a screening level analysis of proposed riparian/floodplain improvement projects, including how flood/pulse flows may contribute to floodplain values and benefit fish and wildlife species, to the Commission. A recommended alternative would be identified in this phase that would include an assessment of the gravel value and potential extraction processes, in order to provide guidance on the scope, timing, and magnitude of the Program.

In Phase 2 (to be completed within 4 years of license issuance) DWR would, in consultation with the consultees listed above, begin conducting a full scope and feasibility evaluation and develop an implementation schedule of the Phase 1 recommended alternative. Within 6 years of license issuance, DWR would submit the Phase 1 recommended alternative and implementation schedule to the Commission for approval. Within 8 years of license issuance, DWR would complete the final design and commence construction and implementation of the approved alternative; within 15 years of license issuance DWR would fully implement this approved alternative.

In Phase 3 (to be completed within 15 years of license issuance) DWR would, in consultation with the consultees listed above, complete an evaluation of other potentially feasible projects and identify a Phase 3-recommended alternative. This phase would include reevaluating how flood/pulse flows may

contribute to floodplain values and benefit fish and wildlife species and would include an assessment of the gravel value and potential extraction processes similar to the one completed in Phase 1.

In Phase 4 (to be completed within 25 years of license issuance), DWR would, upon Commission approval, implement the Phase 3 recommended alternatives.

DWR would annually collect data appropriate for evaluating the effectiveness of the Riparian and Floodplain Improvement Program and would determine whether the Program's objectives are met. DWR would prepare an annual summary report describing monitoring and implementation activities completed pursuant to the program and submit the report to the consultees listed above, for their review. Throughout the term of the license, DWR would compile these annual reports every 5 years in the Lower Feather River Habitat Improvement Plan Report that is submitted to FERC.

DWR, in consultation with the consultees listed above, would reevaluate the Plan every 5 years after initial implementation and provide all Plan updates to the Commission for information. If any changes are recommended beyond the objectives, activities, or schedules identified in the plan or license article, DWR would submit final recommendations to the Commission for approval. DWR would include with the filing, copies of the comments, including recommendations, made in the course of such consultation, and an explanation as to why any such comments or recommendations were not adopted. Upon Commission approval, DWR would implement the plan, including any changes required by the Commission. The Commission would reserve the right to make further changes to the plan. DWR would include any Commission-approved revisions to the plan into any updates to the Lower Feather River Habitat Improvement Plan. Interior's (on behalf of FWS) 10(j) recommendation no. 6, NMFS's 10(j) recommendations (not numbered), and DFG's 10(j) recommendation no. 5 are consistent with this proposed article.

Staff Analysis

The Oroville Facilities attenuate peak flows in the Feather River, which affects the condition of its riparian and floodplain habitats. The proposed measure would enhance these habitats for associated terrestrial and aquatic species and connect portions of the Feather River with its floodplain within the OWA. There are two key milestone dates set for completing the physical habitat improvements—within 15 years of license issuance and within 25 years of license issuance. Riparian reforestation requires several years to become established and can require a decade or more to grow enough to provide functional large wood on a large river. Consequently, the timing of implementing the habitat improvements would likely be a determining factor in the effectiveness of this measure. Considering the proposed implementation scenario, the existing riparian, LWD source material, and other floodplain habitat conditions would remain at existing levels, or continue to decline, for up to 15 years before any changes would be made, and it would be up to 25 years before the proposed measure would be fully implemented on the ground.

The proposed program would also include a screening-level analysis of how flood/pulse flows[29] may contribute to floodplain values and benefit fish and wildlife species. This information would also be used to determine if flood/pulse flows should be implemented, which improve the condition of the channel (e.g., scour, floodplain development).

[29] Because this analysis is a part of the "Riparian and Floodplain Improvement" measure, we have assumed in our analysis that the proposed screening-level analysis is seeking to explore how strategic, geomorphically-significant pulse or flood flows could be implemented to improve riparian and floodplain conditions, as well as benefit other channel attributes such as spawning gravel and holding and rearing habitat.

Gravel Supplementation and Improvement Program (Proposed Article A102)

Under Proposed Article A102, *Gravel Supplementation and Improvement Program*, DWR would, within the first 5 years of license issuance, supplement the Feather River with at least 8,300 cubic yards of gravel that would be distributed at up to 15 locations in the low flow or high flow channels. This measure is described in detail in section 3.3.5.2, *Threatened and Endangered Species*.

Staff Analysis

DWR estimates that since 1982 over 10,000 cubic yards of gravel have been placed in the river at some sites. This volume of gravel, which is greater than the volume DWR proposes to add over the first 5 years of the license, is just 0.04 percent[30] of the estimated total sediment deficit of the river for the 22-year period of augmentation. Because spawning size gravel is only a part of the total sediment deficit, the spawning gravel added is a higher percentage of the sediment deficit of particles this size. Despite the additions since 1982, adverse effects on natural geomorphic processes and spawning substrate are documented in DWR's studies of existing conditions.

Although the rate of gravel replenishment under the Proposed Action would be greater than what has occurred, (placing a minimum of 8,300 cubic yards over 5 years versus placing more than 10,000 cubic yards over more than 20 years); it is still a small percentage of the estimated average sediment deficit for the 5-year period. Gravel would be distributed over 15 sites in the high or low flow channels, netting an average of about 550 cubic yards per site. Proposed Article A102, *Gravel Supplementation and Improvement Program*, includes specific criteria for gravel placement in section (e)(2) which states that "Gravel placement or riffle rehabilitation at the treated riffles…[would] cover the extent of naturally observed spawning areas…[and] extend at least 50 feet upstream and 50 feet downstream of the riffle, and be a depth of at least one foot."

The objective of the proposed article would be to achieve approximately 80 percent of the spawning gravels randomly sampled in riffle complexes in the median size range preferred by Chinook salmon or steelhead. DWR would randomly monitor 10 of the 15 sites on a rotating basis where augmentation or enhancement would be performed during each 5 year period., We conclude that monitoring over the license term is important to ensure objectives are met.

Channel Improvement (Proposed Article A103) and Structural Habitat Supplementation (Proposed Article A104) Programs

Under Proposed Article A103, *Channel Improvement Program*, DWR would make improvements to two existing side channels and construct five additional side channel riffle/glide complexes of not less than a cumulative total of 2,460 feet in length of new habitat. This work would be conducted to maximize quantity/quality of channel habitat with desirable salmonid attributes (appropriate depth, velocity, substrate, cover, and vegetation) while minimizing the potential for water warming, fish stranding, and predation problems.

Proposed Article A104, *Structural Habitat Supplementation and Improvement Program*, would improve salmonid rearing habitat by creating additional cover, edge, and channel complexity through the addition of structural habitat, including LWD, boulders, and other (undefined) objects. LWD for this Program would be defined as multi-branched trees at least 12 inches in diameter at chest height, and a minimum of 10 feet in length (with a preference for approximately 20 feet or longer), with approximately 50 percent of the structures containing intact rootwads. The proposal would place a minimum of 2 pieces of LWD, boulders, or other appropriate material per riffle in the low flow and high flow channels from RM 54.2 to RM 67.2, with additional habitat features placed where appropriate.

[30] We converted cubic yards to tons using the conversion factor of 1.2 tons/cubic yards.

Proposed Articles A103 and A104 are described in detail in sections 3.3.5.2, *Threatened and Endangered Species*, and 3.3.3.2, *Aquatic Resources,* respectively.

Staff Analysis

The Oroville Facilities attenuate peak flows and impede sediment and LWD delivery to the Feather River, which affects the condition of its channel habitats. Proposed Articles A103, *Channel Improvement Program*, and A104, *Structural Habitat Supplementation and Improvement Program*, would help to improve channel complexity in the low flow channel by increasing the quantity of LWD and the extent of side channels and shallow-edge habitats within existing riffles and glides. However, these measures would do little to alleviate the larger meso-scale alterations to channel processes such as decreases in channel forming flows and decreased channel migration, which in large part form and maintain the physical habitat conditions required by salmonids and other aquatic organisms.

Further, recent telemetry tracking of tagged LWD performed on the Sacramento River (Chico Landing Subreach) over the course of approximately 1 year (Henderson, 2003) indicates that while nearly all tagged pieces of LWD stayed within the river channel (rather than getting deposited on the floodplain), downed trees traveled an average of 6 miles downstream. Although the annual rate of LWD movement may be less in the small Feather River than in the Sacramento River study, this suggests that unless individual trees are cabled in place[31] or installed in larger groups (such as part of an engineered log jam designed to stay in place at higher flows), single pieces of LWD could move out of the low flow channel (and potentially the high flow channel), relatively quickly. Maintaining and monitoring channel improvements and structural habitat elements at a minimum of 5 years would provide the basis to make any necessary adjustments to the actions undertaken as part of this program.

Fish Weir Program (Proposed Article A105)

Under Proposed Article A105, *Fish Weir Program*, DWR would install one or potentially two fish weirs near the Thermalito afterbay. This measure is described in detail in section 3.3.5.2, *Threatened and Endangered Species*.

Staff Analysis

While the purpose of the proposed fish weirs is related to management of salmonid fishery stocks, the construction of these weirs could alter channel processes, although their design could likely be such that they pass sediment and LWD. Once infrastructure such as weirs and an egg-taking station are placed on or along the river, measures to ensure that the channel stays flowing through that location may need to be taken. Measures to control channel location traditionally include rock rip rap, groins, or vanes and/or active manipulation of the channel bed and/or banks. Such methods could conflict with other measures to protect and enhance natural channel processes, expand floodplain and side channel habitat, and enhance spawning riffles. Coordination with Recreation Advisory Committee and Ecological Committee would avoid potential conflicts.

Other Recommendations

The Anglers Committee et al. recommend that DWR conduct studies to determine the amount of silt deposited and the amount of silt that will be deposited for the life for the project in the North Fork arm

[31] Safety concerns relative to channel improvements and recreation have been raised by Butte County (April 26, 2006, letter) and we note that on other rivers in the western United States the cabling of logs for habitat improvement has proved controversial because once the logs and cables move, the cable is a serious danger to boaters and swimmers, while logs from un-cabled projects merely present the same hazard as naturally occurring LWD.

downstream of Big Bend dam. The study would disclose and evaluate the effects of the displacement of water; loss of power production; adverse effects to fish and aquatic life and their habitat; effects to navigation; and fish diseases related to sediment. The study would be submitted for public review and comment. A similar study would be conducted on the West Branch arm above the Lime Saddle Marina. In the event the Commission concludes that the silt must be removed, it would require DWR to remove the silt from all areas of the reservoir as determined by the Commission and other water quality enforcement agencies.

Staff Analysis

DWR investigated the textural composition of sediment deposited in the North Fork arm below Big Bend Dam, provided bathymetric mapping and estimates of total sediment deposition, and gave an estimate of when the reservoir would be full[32] by extrapolating the estimated rate of sediment deposition to date. At the time of survey, DWR estimated that the total volume of sediment in storage is about 28,300 acre-feet. Of this amount, about 11,400 acre-feet are estimated to be derived from shoreline bank erosion; the remaining 16,900 acre-feet is ostensibly sediment from the upstream watersheds. Based on a 36-year period since the initial filling of Lake Oroville, annual sediment yield is about 470 acre-feet. In the context of a reservoir with about 3.5 million acre-feet of storage, the effects of the annual average displacement of 470 acre-feet of water relative to loss of power production are considered minimal.

We evaluate the effects of this recommendation to fish and aquatic life and their habitat in section 3.3.3.2, *Aquatic Resources*.

Reservoir Sedimentation Can Influence Navigation

Based on information on the record, we conclude that sediment deposition in the reservoir arms have a minimal effect on navigation. As reservoir elevations decrease, the former riverbed re-emerges. While the character of that riverbed is oftentimes heavily altered by the sediment deposited on it during times of inundation, there is no feasible way to alleviate this phenomenon. Further, as the river migrates through the deposited sediment, it carves a new channel, sorting sediment and establishing an equilibrium channel for the sediment load and discharge available at that time. As the reservoir recedes, the reservoir surface area for power boating decreases while whitewater boating opportunities increase as the length of flowing river grows (see section 3.3.6.2, *Recreational Resources*).

3.3.1.3 Cumulative Effects

This section summarizes the potential cumulative effects on geology, soils, geomorphology, and paleontological resources under the No-action Alternative, Proposed Action, and Staff Alternative conditions. Because we have identified no potential effects for paleontological resources there are similarly no cumulative effects for this resource.

As described in section 3.2, *Cumulatively Affected Resources*, cumulative effects include past, present, and reasonably foreseeable related actions that incrementally affect resources in combination with a proposed action. For this analysis, the source of these effects is not restricted to activities directly associated with the Oroville project. For example, sediments being trapped by upstream projects above Lake Oroville that disrupt the natural geomorphic processes of sediment transportation are considered in this analysis.

[32] DWR estimates that the entire reservoir to be filled with sediment in 7,400 years.

Cumulative Effects of Past and Present Related Actions

Historically, rivers in the Sacramento Valley were bordered by extensive floodplains that supported natural geomorphic and fluvial processes, including natural hydrologic flow regimes, erosional and depositional processes, and sediment transport. The Feather River has a long history of land use that has affected natural river processes within its floodplain, including hydraulic mining, gravel mining, gold dredging, timber harvesting, construction of levees and dams, water diversion, agricultural encroachment, and urbanization. In addition, by the late 1800s, hydraulic mining had introduced massive amounts of sediment into the system, and in the early 1900s, Feather River water diversions began for agricultural and urban uses. Channelization and levee construction was mostly completed by the 1940s. Starting in the early 1900s, a number of hydroelectric and reservoir projects were constructed upstream of Oroville, which regulated streamflow and interrupted sediment transport through the watershed. Furthermore, as the risk of floodflows decreased downstream, more lands within the floodplain were converted to agricultural and urban uses (and protected with riprap and levees), which along with flow regulation, have further reduced the connection of the river with its floodplain. The construction of Oroville dam in the 1960s further altered streamflow patterns and reduced floodflows, erosion and channel migration rates, and sediment transport downstream.

Although the Feather River reaches above Lake Oroville have continued to flow through steep canyon walls, upstream hydroelectric and reservoir projects—including the Oroville Facilities—have affected the Feather River's natural geomorphic function. These facilities have been largely responsible for the reduction in sediment transport, gravel recruitment, and LWD transport though the Feather River watershed.

The principal effects on the natural geomorphic process and function of the Feather River from the many current and historical human-induced changes and land uses include:

1. A reduction in the supply of sediment and LWD in the Feather River downstream of the Oroville Facilities.
2. A reduction in gravel recruitment, sediment transport, and LWD transport/recruitment in the river downstream of the Oroville Facilities, as related to the altered flow regime.
3. A loss of channel meandering, a reduction in sinuosity, incision, and an overall loss in channel complexity, as related to the altered processes discussed in 1 and 2, above, and in conjunction with levees and bank protection.
4. Disconnection of the river channel from its ancestral floodplain through the development of non-project flood control levees, alteration in flow regime, and channel incision and expansion.
5. Dispersed and large-scale erosion and increased sediment supply from mining, timber harvest, agriculture, and other activities related to human infrastructure.

Cumulative Effects of the No-action Alternative and Future Related Actions

The interruption of natural geomorphic processes that has been occurring in the Feather River watershed beginning with timber harvesting and hydraulic mining activities in 1800s and followed by hydroelectric facility construction within the watershed since the early 1900s would continue under the No-action Alternative. The Oroville Facilities and other upstream hydroelectric dams would continue to cause a sediment deficit in the river. These facilities would also continue to reduce sediment transport, channel migration, and the recruitment of gravel and LWD on portions of the Feather River. The continued deprivation of sediment load in the Feather River from related actions would also result in a reduction in the formation of sediment benches and point bars, which in turn would affect the ability of the channel to capture and retain quantities of LWD. These geomorphic effects would result in

incremental reductions to channel complexity downstream of the Oroville Facilities. The most significant reductions in downstream channel complexity (as related to reductions in salmonid holding, spawning, and rearing habitat) are the continued coarsening of the Feather River salmonid spawning beds, homogenization of the channel (decrease in pool depth, and reduction in channel migration and alteration of pool riffle sequences), and reduction of LWD loading. The Oroville Facilities would continue to attenuate peak flows, providing a level of flood protection benefits downstream.

Cumulative Effects of the Proposed Action and Future Related Actions

Under the Proposed Action, the Gravel Supplementation and Improvement Program (Proposed Article A102), the Channel Improvement Program (Proposed Article A103), the Structural Habitat Supplementation and Improvement Program (Proposed Article A104), and the Riparian and Floodplain Improvement Program (Proposed Article A106) would provide some improvement in the level of channel complexity downstream of the fish barrier dam. Side-channel habitat improvements would provide about 2,500 feet of additional spawning and rearing habitat available to salmonids and some large wood and/or other habitat features (between 50 and 500 elements) would be placed in the river. A total of 8,300 cubic yards of gravel would be placed in the river to improve spawning habitat and offset the sediment deficit. The increase in minimum flow in the low flow channel would not affect geology, soil, and geomorphologic resources because the increase is still far below the threshold required to perform any geomorphic change, as related to channel migration, scour and sorting of spawning gravels, or recruitment of LWD. There would continue to be an estimated 97 percent reduction in sediment supply from the watershed above Lake Oroville, and a reduction in channel migration, gravel, and LWD recruitment. The Oroville Facilities would continue to attenuate peak flows, providing a level of flood protection benefits downstream.

Cumulative Effects of the Staff Alternative and Future Related Actions

Under the Staff Alternative, cumulative effects would be similar to those of the Proposed Action with the exception that the Staff Alternative would result in a smaller adverse effect on sediment supply in the river downstream of the fish barrier dam because of the five additional sites in the Gravel Supplementation and Improvement Program. The increase in minimum flow in the low flow channel would not affect geology, soil, and geomorphologic resources for the same reasons as mentioned above for the Proposed Action. There would continue to be an estimated 97 percent reduction in sediment supply from the watershed above Lake Oroville, and a reduction in channel migration, gravel, and LWD recruitment. The Oroville Facilities would continue to attenuate peak flows, providing a level of flood protection benefits downstream.

3.3.1.4 Unavoidable Adverse Effects

The continued operation of the Oroville Facilities and the functional interactions of the facilities and operations would result in unavoidable adverse effects on geologic, soil, and geomorphic resources. While some of these effects would be reduced to some degree by proposed resource enhancement measures (specifically, the supplementation of gravel, LWD, and construction of structural habitat elements), many effects such as the sediment deficit and reduced number and magnitude of geomorphically significant bankfull flows would likely continue as unavoidable adverse effects.

Some specific elements of the proposed measures could have short-term, localized unavoidable adverse effects on geology, soils, and geomorphologic resources. The Lake Oroville warm water fishery habitat improvement program would improve the habitat of the warm water fishery in Lake Oroville primarily by construction, operation, and maintenance of projects to improve warm water fishery habitat within the reservoir or fluctuation zone. While not specified, these activities would involve some sort of physical modification or addition of structure to the reservoir shoreline. As such, the construction, operation, and/or maintenance of these projects could result in localized, short-term increases in erosion.

While no detailed plans are available yet, proposed recreation enhancement measures could have similar short term effects, with the addition of hillslope erosion from recreational facility construction and improvement projects.

The proposed measure to protect vernal pools (Proposed Article A117; described in section 3.3.4.2, *Terrestrial Resources*) would include the implementation of conservation measures required by the FWS final biological opinion to protect the vernal pool invertebrate habitat within the project boundaries. While those conservation measures are not yet defined, they would likely include physical improvements to drainage infrastructure to decrease sedimentation and improve pool hydrology. These measures also could have localized, short-term increases in erosion.

The proposed measure to construct and recharge waterfowl brood ponds (Proposed Article A122; described in section 3.3.4.2, *Terrestrial Resources*) would include construction of one brood pond every 5 years over a 20-year period beginning upon issuance of this license. The ponds would be constructed by creating a small earthen berm across an inlet in the Thermalito afterbay. While the exact locations and designs of these ponds are yet to be defined, the measure would include creation of a berm by filling a portion of the Thermalito afterbay. This construction work could result in localized, short-term increases in erosion and turbidity.

The proposed Channel Improvement Program and the Structural Habitat Supplementation and Improvement Program, discussed above, would include in-channel construction consisting of the creation of habitat features and physical manipulation of the channel bed and banks. While the exact locations and designs of these actions are yet to be defined, this construction work also could result in localized, short-term increases in erosion and turbidity.

3.3.2 Water Quantity and Quality

3.3.2.1 Affected Environment

Water Quantity

The Oroville Facilities use water of the Feather River Basin to generate electricity and supply water. The river basin drains a large portion of the eastern Sierra-Cascade geomorphic area in California, and its headwaters are located on the southeastern slope of Mount Lassen and along the Sierra Nevada crest. The drainage area is 3,624 square miles at the Feather River at Oroville (USGS Gage No. 11047000)[33], located 0.4 mile downstream of the Thermalito diversion dam. The weather station most representative of the project site is the Oroville station (table 10). Comparing the data from this station with that of a higher elevation station, such as Meadow Valley (table 11) located at elevation 3,410 feet msl, it is notable that the Oroville station provides data for a relatively short 7-year period while Meadow Valley is based on a 51-year period. Accordingly, the statistics from the two stations are not directly comparable.

The Feather River Basin has mild, dry summers and heavy winter precipitation. Mean annual precipitation in the basin ranges from 11 inches in the driest areas to 90 inches in the northwestern portion of the basin near Mount Lassen. Monthly average precipitation varies considerably over the basin. For example, at Oroville, the average precipitation ranges from none in July and August to 4.1 inches in February (table 10). Much of the precipitation in the headwaters of the basin comes in the form of snow during November through March. Much of the snowpack melts by April at mid-range elevations (3,000–5,000 feet).

[33] The drainage area as measured at the USGS gage is slightly higher than the drainage area listed in table 7 because the gage is located downstream of the Lake Oroville dam.

Table 10. Meteorological summary for Oroville, California (elevation 199 feet msl). (Source: Canty and Associates LLC, 2005)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average air temperature (ºF)												
43	50	52	58	64	74	79	77	72	65	52	46	61
Average precipitation (inches)												
3.8	4.1	3.6	2.0	0.9	0.1	--	--	0.5	2.7	3.5	1.8	22.9
Average snowfall (inches)												
0.1	--	--	--	--	--	--	--	--	--	--	--	0.1

Note: -- - no value reported

Table 11. Meteorological summary for Meadow Valley, California (elevation 3,410 feet msl). (Source: Canty and Associates LLC, 2005)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Air Temperature (ºF)												
34	39	43	47	55	62	67	65	60	52	42	35	50
Average Precipitation (inches)												
7.5	6.0	5.3	2.6	1.6	0.8	0.2	0.3	0.8	2.7	5.0	7.0	39.8
Average Snowfall (inches)												
13.7	7.8	7.0	2.9	0.4	--	--	--	--	--	1.3	7.3	40.5

Note: -- - no value reported

Part of the Feather River Basin receives additional runoff generated by cloud seeding. Precipitation is increased in the basin above Lake Almanor by 5 percent annually as a result of Pacific Gas and Electric Company's (PG&E) Lake Almanor Cloud Seeding Project.[34]

Annual runoff patterns in the watershed above Lake Oroville are characteristic of snowmelt-dominated hydrology of Sierra Nevada mountain streams that experience peak runoff during the late winter and spring and low flows during the summer. Average annual flow downstream of Lake Oroville, including both flow in the river and flow diverted to the fish hatchery, is summarized in table 12.

[34] The North Fork Basin has been subject to the Lake Almanor Cloud Seeding Project since the winter of 1952–53. Pacific Gas and Electric Company (PG&E) implemented the project to increase snowfall during November through May in the North Fork Basin above Lake Almanor. PG&E's Lake Almanor Cloud Seeding Project includes a network of nine, ground-based cloud seeding burners located near the south and west boundaries of the target area. The Lake Almanor Cloud Seeding Project's goal is to increase snowfall during naturally occurring precipitation periods. Lake Almanor Cloud Seeding Project includes guidelines for temporary suspension or curtailment of operations under certain conditions to avoid runoff or reservoir storage beyond manageable limits.

Table 12. Summary of daily average flow discharge (cfs) data, by month and overall, for the Feather River at Oroville, CA (USGS Gage No. 11407000), water year 1971 to 2004. (Source: USGS, 2005, as modified by staff)

Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Overall
Mean	579	755	1,164	2,073	2,155	2,005	959	771	535	538	530	522	1,044
Maximum	1,870	27,500	62,500	126,000	132,000	70,100	38,000	44,100	2,540	1,030	1,750	708	132,000
5% exceedance	917	1,600	1,610	3,582	10,100	8,111	648	642	661	735	718	653	932
10% exceedance	770	933	923	940	991	679	641	634	639	704	655	641	655
25% exceedance	631	635	631	634	636	635	631	625	626	627	627	628	630
50% exceedance (median)	608	615	615	614	612	617	613	525	588	609	567	591	611
75% exceedance	410	409	411	410	411	412	411	411	411	412	409	409	411
90% exceedance	403	401	400	402	402	405	404	404	406	405	403	403	403
Minimum[a]	387	382	383	380	369	378	334	372	386	360	347	222	222

[a] Since 2000, flows have not dropped below 605 cfs. Between 1993 and 1999, the minimum flow was 569 cfs.

Description of Water Resources in the Project Area

Lake Oroville is created by Oroville dam and two small saddle dams. The lake has a 3.5-million acre-feet capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level at 900 feet msl. The Feather River extends from the fish barrier dam (RM 67) to the confluence with the Sacramento River (RM 0). Within this 67-mile reach of the Feather River, the low flow channel extends from the fish barrier dam to the Thermalito afterbay outlet (RM 59), and the high flow channel extends from the Thermalito afterbay outlet to the confluence with Honcut Creek (RM 44) (see figure 8). The reaches of the Feather River are identified by the confluences with Honcut Creek to Yuba River (RM 27.5), Yuba River to Bear River (RM 12.5), and Bear River to the confluence with the Sacramento River (see figure 8).

DWR (2005g) describes the process used to define five water year types for the Sacramento Valley, as part of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary regulatory activities.[35] DWR classifies water years as critical, dry, below normal, above normal, and wet. Critical water years are sometimes referred to as critically dry water years. DWR provided 4 representative years for different water conditions in its license application. Water year 1977 was characterized as the driest year on record. Water year 2001 was characterized as dry. Water year 1999 was characterized as average and water year 1995 as wet.

Lake Oroville

The inflow to Lake Oroville is reduced from unimpaired conditions from November to June, primarily due to upstream non-project diversions and storage operations. Typically, the inflow to Lake Oroville tends to be slightly greater than unimpaired conditions from August to October because of releases from storage during those months from upstream projects. The unimpaired inflow to Lake Oroville is estimated to be about 5,800 cfs.[36] By comparison, the average flow in the Feather River downstream of the Thermalito diversion pool (low flow channel) is 1,044 cfs for the water years from 1971 to 2004. This average flow includes the 30 to 130 cfs required to support the Feather River Fish Hatchery. A 30-inch water supply pipeline provides flow to the fish hatchery. Additional release from the Thermalito afterbay averaged 3,702 cfs for the same water years. The difference is about 1,200 cfs, which corresponds to water removed from the Feather River for consumptive use as described below under *Water Use*. Because of changes in diversion amounts and changes to instream flow releases, DWR developed a computer model to establish a more consistent baseline and to estimate the environmental effects of the alternatives on water quantity.

Thermalito Afterbay

In above normal and wet water years, the maximum flow in the high flow channel ranges from 9,500 cfs in a 25 percent exceedance year to a maximum of greater than 18,000 cfs (table 13). The maximum flow typically occurs during February or March because high releases from Lake Oroville are made to meet flood control criteria and maintain adequate flood reservation storage volume in the reservoir. In normal, below normal, dry, and critical water years, the maximum flow in the Feather River downstream of the Thermalito afterbay outlet typically occurs during July and ranges from 1,600 cfs in a 90 percent exceedance year (drier) to about 4,000 cfs in a normal water year. In these water years, high inflow is typically stored in the winter and spring with little or no release made for flood management.

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[35] Year types are set by first of month forecasts beginning in February. The final determination is based on the 50 percent exceedance forecast as of May 1.

[36] The period of record was not explicitly stated; however, based on Study Plan SP-G2, Task 1.2, this appears to be the annual yield from 1902 to 1967, a relatively long period of record (DWR, 2004a).

Table 13. Summary of daily average flow discharge (cfs) data, by month and overall, for the Thermalito afterbay release to Feather River, CA (USGS Gage No. 11406920), water years 1971 to 2004. (Source: USGS, 2005)

Station	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Overall**
Mean	1,942	2,268	3,977	4,020	5,066	5,499	4,251	3,299	3,329	4,370	3,636	2,814	3,702
Maximum	7,160	17,200	17,100	18,100	18,300	17,900	18,100	17,500	13,600	10,300	10,300	9,360	18,300
5% exceedance	4,620	8,661	14,500	16,100	16,800	17,100	15,405	10,335	8,540	7,950	7,030	7,030	13,500
10% exceedance	2,840	3,503	10,370	13,200	14,800	15,700	13,000	8,411	7,421	7,251	6,080	5,650	8,640
25% exceedance	2,470	1,980	5,113	5,550	8,440	9,535	5,930	4,350	4,153	6,080	4,910	3,808	4,830
50% exceedance (median)	1,780	1,670	2,220	1,405	1,900	2,570	2,135	1,890	2,530	3,990	3,590	2,380	2,220
75% exceedance	1,270	823	1,130	799	1,010	1,110	775	922	1,488	2,620	2,123	1,540	1,240
90% exceedance	642	431	614	525	509	436	436	580	862	1,610	1,259	698	586
Minimum	35	98	386	70	346	195	193	254	77	17	375	330	17

Releases from storage to meet downstream State Water Project contractor demands typically peak in July, and the minimum flow for the year typically occurs during October and can be as low as the 600 cfs release at the Thermalito diversion dam. Historically, lower flows have occurred, but not for the last several years. About 67 miles downstream of the fish barrier dam, the Feather River flows into the Sacramento River near the town of Verona. Flow in the Feather River at Verona is typically greater than the flow downstream of the Thermalito afterbay as flow increases from tributary accretions along the length of the river.

Flow Regime

The current flow regime in the Feather River downstream of Oroville dam is different than pre-dam conditions, particularly in the low flow channel reach. Figure 10 shows the flow exceedance for the Feather River at Oroville gage[37] and indicates a reduction in all flows from pre- to post-dam. The flow exceeded 99 percent of the time decreased from 950 to 300 cfs from pre- to post-dam; the 90 percent exceedance flow decreased from 1,400 to about 300 cfs; and the 50 percent exceedance flow decreased from 3,000 to 350 cfs.

Flows at the level of the bankfull discharge (typically defined as the 2-year flow event) are responsible for the majority of the sediment transport and are considered most responsible for channel form. A natural flow regime typically includes flow ranges responsible for in-channel clearing and overbank flows to support riparian vegetation, along with channel-forming flows. A bankfull discharge fills the channel but does not inundate the floodplain. Bankfull discharges meet the following two criteria for shaping channel cross sections. First, the flows are strong enough to erode banks and transport and deposit sediment. Second, the flows occur often enough to overcome the effects of larger flows; hence, it is the more-frequent bankfull flows that have the largest effect on channel form, rather than the less-frequent higher-magnitude flows.

The pre-dam bankfull discharge (2-year flow event) for the Feather River at Oroville gage was about 65,000 cfs. The post-dam 2-year recurrence interval event for the low flow reach is about 2,000 cfs, a much smaller event that is not capable of transporting significant quantities of bedload or eroding river banks. The 65,000-cfs flow now occurs at a lower frequency level of about every 10 years. The high flow reach now has a bankfull discharge of 26,000 cfs, also significantly smaller than the pre-project event of 65,000 cfs.

Flood frequency calculations show that the pre- and post-project flood frequency curves have changed. Figure 11 shows the 2-year recurrence interval flood (bankfull discharge) decreased an order of magnitude, from 65,000 to 3,000. The 10-year recurrence event decreased from 160,000 to 75,000. The 50-year event decreased from 240,000 to 180,000 cfs.

Groundwater

Oroville dam and Lake Oroville are underlain by relatively impermeable igneous and metamorphic bedrock that largely eliminates interaction between groundwater and Lake Oroville. However, Thermalito forebay and Thermalito afterbay are located on more permeable volcaniclastic and consolidated alluvial sediments, so reservoir water and local groundwater do interact. The Thermalito afterbay was constructed on an older, dissected upland, consisting of coarse gravels cemented in a sandy clay matrix. The upland area is adjacent to the edge of the groundwater basin to the west where younger alluvial materials overlap the older sediments. Existing information from well driller reports indicate that

[37] The Feather River at Oroville Gage (Gage No. 11407000) is located on the right bank of the Feather River 0.4 mile downstream of the Thermalito diversion dam, about 300 feet upstream from fish barrier dam.

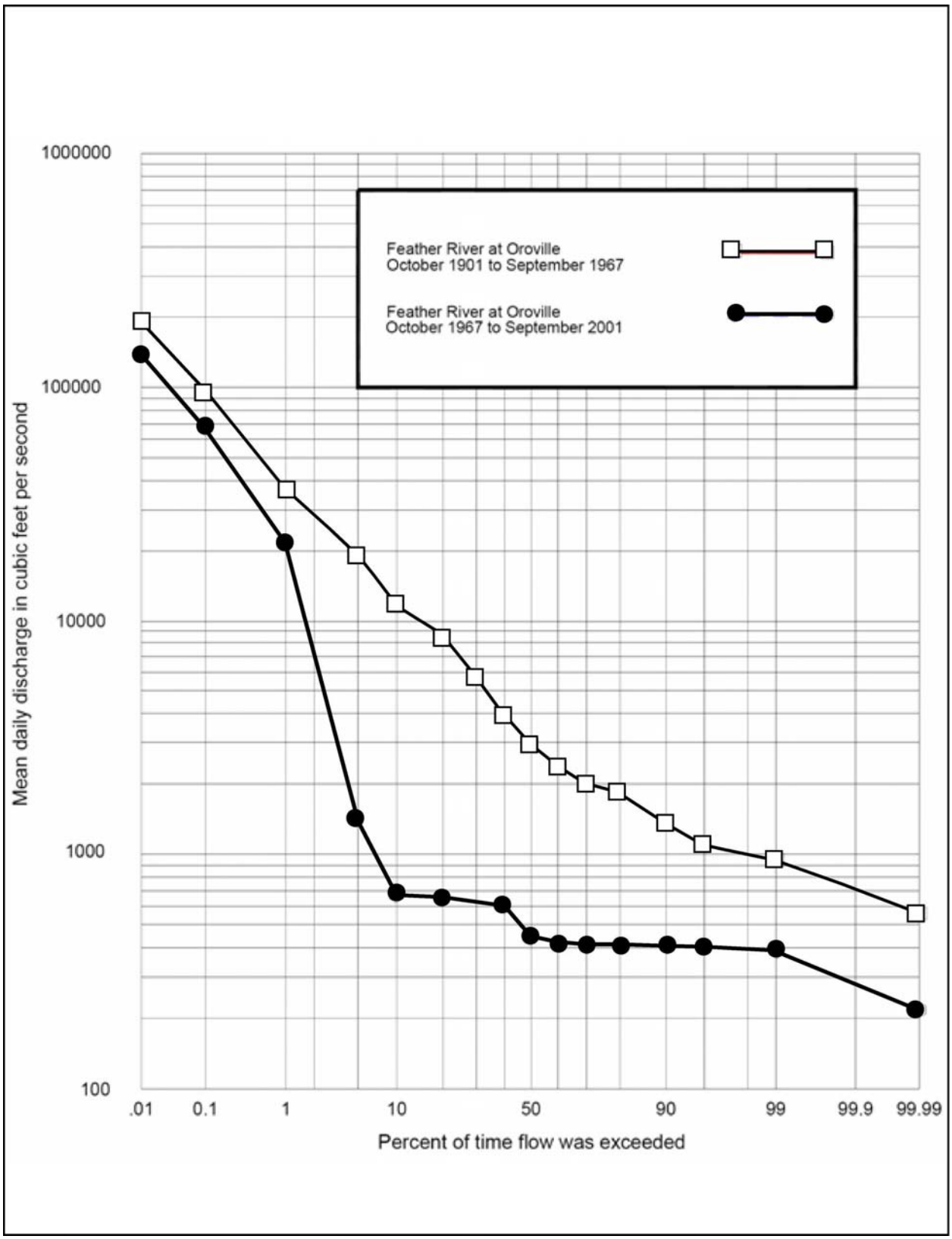

Figure 10. Flow exceedance graph for Feather River at Oroville gage. (Source: DWR, 2004l)

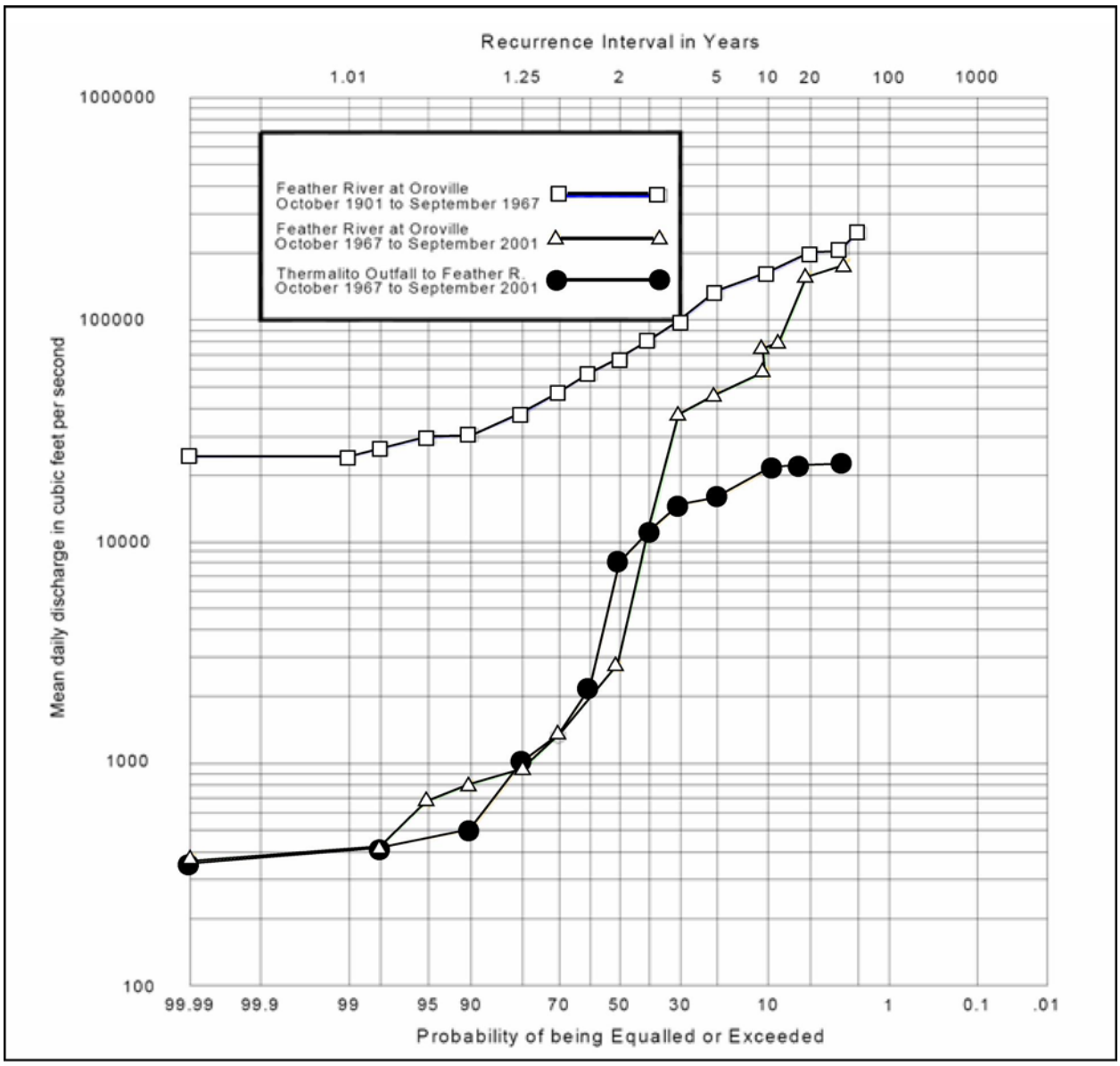

Figure 11. Flood frequency graph for Feather River at Oroville gage. (Source: DWR, 2004l).

there are at least two aquifers in the area (a confined zone and an unconfined zone), and there may be localized areas of semi-confined zones. Aquifer zones are not uniform in thickness, and there is not much uniformity in the depth at which different aquifer materials are encountered in area wells.

Groundwater flows in a south-southwest direction in the vicinity of Thermalito forebay and Thermalito afterbay. Localized seepage occurs from these reservoirs, and pumps have been installed to return the water to the reservoirs. Information developed as part of DWR (2004b) indicates that the Oroville Facilities may have increased groundwater levels through recharge in the vicinity of Thermalito forebay.

Water Use and Flood Control

The water supply component relates to the State Water Project, a complex system for water storage and delivery that includes reservoirs, aqueducts, pumping plants and power plants. The project is more than 600 miles long and covers two-thirds of the length of California (DWR, 1997a). Three reservoirs, Lake Davis (84,400 acre-feet),[38] Antelope Lake (22,600 acre-feet), and Frenchman Lake (55,500 acre-feet), are located on Feather River tributaries upstream of the Oroville Facilities. These reservoirs provide water to the city of Portola and other local agencies that have water rights agreements with DWR (DWR, 2004c).

Feather River Service Area Water Supply Entitlements

DWR has described its contractual obligations to nine local agencies in the Feather River service area that are collectively referred to as the Feather River service area water users. They receive water according to the terms of settlement in various agreements stemming from the original construction of the project. These settlements recognize the senior water rights of those agencies and determined that DWR would provide them certain quantities of water from storage in Lake Oroville in accordance with those senior water rights. The amount of water that DWR is committed to provide these agencies is about 994,000 acre-feet per year (1,372 cfs) subject to provisions for reduction in supply under certain specific low-inflow conditions.[39] The actual amount delivered varies from year to year and ranges from 611,000 to 1,057,000 acre-feet. Water needed to meet these Feather River service area entitlements is delivered at two locations in Lake Oroville, two locations in the Thermalito power canal, four locations in Thermalito afterbay, and four locations on the high-flow channel. Most diversions for the Feather River service area occur during the April through October irrigation season. Up to 150,000 acre-feet of water are diverted from the Thermalito Complex during the peak demand months of May through August. The highest total monthly agricultural diversions from both the Feather River and the Thermalito afterbay, 190,000 acre-feet, occurred in July 2002.

DWR also has executed a number of small contracts with riparian landowners along the Feather River downstream of Oroville dam. Riparian owners are entitled to divert unimpaired flow for use on riparian land, but they are not entitled to augmented flow made available as a result of project storage. Although the quantities of water are relatively small and do not ordinarily influence State Water Project operations, diversion for riparian lands can affect Oroville releases during certain years.

Water Supply Requirements of the State Water Contractors

As a component of the State Water Project, DWR describes the Oroville Facilities as being operated to provide downstream water supply for municipal, industrial, and irrigation purposes, and water is exported to meet the requests of the water contractors. To illustrate how water releases from the Oroville Facilities are distributed for multiple downstream uses, table 14 shows DWR records from 2001 and 2002, indicating actual releases for various uses. As a practical matter, water supply exports are met with whatever water is available after Delta requirements are met. In other words, some of the water released for instream and Delta requirements may be available for export by the State Water Project once the Delta standards have been met. Table 14 shows the downstream use of water from the Oroville Facilities. The United States and DWR signed the Coordinated Operations Agreement in 1986 that specifies how the U.S. Bureau of Reclamation will operate the Central Valley Project and how DWR will operate the State Water Project in such a way as to meet Delta requirements, Sacramento Valley needs,

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[38] Gross reservoir capacity.

[39] This value is higher than calculated using historical USGS records because it reflects the current level of demand. DWR estimates the range as 613,000 acre-feet per year to 1,057,000 acre-feet per year under current conditions.

and their own water supply requirements. DWR estimates that water supplied to the State Water Project ranges from 788,000 acre-feet to about 4.2 million acre-feet per year with an average of about 3.2 million acre-feet per year, including releases from Lake Oroville as well as other water available to the State Water Project to divert from the Delta.

Table 14. Downstream use of water from the Oroville Facilities (2001 and 2002). (Source: DWR, 2005b)

	2001		2002	
Downstream Use	**Amount Used (taf)**	**Percentage of Release**	**Amount Used (taf)**	**Percentage of Release**
Feather River service area	1,024	46	25	34
Support of exports	93	4	773	28
Instream and Delta requirements	1,099	50	1,043	38
Flood management	0	0	0	0
Total	2,216	100	2,741	100

Note: taf – thousand acre-feet

Flood Control

DWR has described the Oroville Facilities as an integral component of the Sacramento River Flood Control Project, the flood management system for areas along the Feather and Sacramento Rivers downstream of Oroville dam. From September to June, the Oroville Facilities are operated under flood control requirements specified by the Corps. Table 15 summarizes flood control operations throughout the year. Historically, the maximum flood flows released from Lake Oroville were about 160,000 cfs, which occurred in 1997. Volumes, inflows, and outflows associated with other large flood events are summarized in table 16.

Table 15. Flood control requirements for Lake Oroville. (Source: NMFS, 2004; DWR, 2006)

Period	**Flood Control Requirement Based on Date**	**Flood Control Requirement Based on Wetness Index[a]**	**Comment**
June 15–September 15	No	No	No flood control requirements
September 16–October 14	Yes	Yes	
October 15–April 1	Other	Other	Full flood control reservation space is required
April 2–June 15[b]	Yes	Yes	

[a] The Wetness Index is an index computed by multiplying the previous day's index by 0.97 and adding any new precipitation, thus it is based on accumulated precipitation. A value of 11.0 or greater corresponds to wet conditions and correspond to the provision of the full 750 thousand acre-feet of flood control space, while a value of 3.5 or less corresponds to dry conditions and to the minimum flood control space requirement of 375 thousand acre-feet (DWR, 2004d).

[b] The flood control season can end as early as May 8, or as late as June 15, because of a 10,000 acre-feet/day filling rate.

Table 16. Major spill events for Lake Oroville. (Source DWR, 2005b, exhibit H, page H-33)

Spill Began	Spill Ended	Peak Release (cfs)	Total Release (acre-feet)	Peak Inflow (cfs)
January 3, 1970	February 2, 1970	77,000	1,563,000	147,000
January 12, 1980	January 20, 1980	85,000	726,000	155,000
February 15, 1986	March 1, 1986	150,000	1,420,000	266,000
March 9, 1995	March 27, 1995	87,000	1,235,000	141,000
December 27, 1996	January 17, 1997	160,000	2,013,000	302,000

Several issues were raised during scoping, including improved operations (including flood control operations) through use of real-time watershed hydrologic projections, and the effect of flood releases on Lake Oroville dam and downstream facilities, including downstream levee stability and potential for ameliorating downstream flooding through coordinated releases with other water storage facilities (DWR, 2002a). Because the Corps is primarily responsible for flood control operations, these issues are outside of the FERC relicensing process.[40]

Water Rights

DWR has water rights to store, divert, and use water from the Feather River and its tributaries for the production of power, water supply, recreation, and fish and wildlife protection and mitigation (table 17). In addition, DWR entered into an agreement with the water districts that now compose the Joint Water District Board in May 1969 to preserve their prior water rights and discuss the diversion season and the allowable diversions (DWR, 1969), and entered into a similar agreement with Western Canal Water District and PG&E (DWR, 1986).

Water Quality

This section addresses water quality parameters that are important in determining compliance with applicable water quality standards to protect the designated beneficial uses in the Regional Board's Water Quality Control Plan (Basin Plan). The Feather River, downstream of Oroville dam to its confluence with the Sacramento River, is identified on the current U.S. Environmental Protection Agency (EPA)-approved (2006) Regional Board Section 303(d) list of waters as being impaired by mercury, certain pesticides, and toxicity of unknown origin (Regional Board 303(d) list). A TMDL for the pesticide Diazinon was established for this reach in 2004. The North Fork Feather River, between lakes Almanor and Oroville, is currently listed as impaired under Section 303(d) of the Clean Water Act due to temperature and mercury.

[40] The Costa-Machado Water Act of 2000 funded studies, design, construction, and mitigation for the Yuba-Feather Supplemental Flood Control Project, and progress has been made in several areas regarding flood control (Yuba County Water Agency, 2005). The Yuba County Water Agency received grant funding under this act to conduct a feasibility study of alternative means of providing supplemental flood control, including forecast-based operations and forecast-coordinated operations, on the Yuba and Feather Rivers. Studies and a model are under preparation to determine if forecast-based operations/forecast-coordinated operations can be implemented for emergency operations and what the effects might be on costs, water supply, and other project benefits. Details about the approach to forecast-based operations/forecast-coordinated operations and other flood management concerns are described in *SP-E4: Flood Management Study* (DWR, 2004d).

Table 17. DWR's water rights for the Oroville Facilities. (Source: DWR, 2005b; Water Board, 2005, as modified by staff)

No.	Issuance Date	When	Description[a]	Use(s)
Permit No. 16,477	September 26, 1972	Year-round diversion and September through July storage	Divert 7,600 cfs form Oroville Facilities and storage of 380,000 acre-feet in Oroville facilities	Power generation, recreation, fish and wildlife protection and/or enhancement
Permit No. 16,478	September 26,1972	Year-round diversion and September through July storage	Divert 1,400 cfs from Oroville Facilities and storage of 380,000 acre-feet in Oroville facilities	Water supply for consumptive use, recreation, fish and wildlife protection and/or enhancement
Permit No. 16,479	September 26, 1972	Year-round diversion and September through July storage	Divert 1,360 cfs from Oroville Facilities and storage of 3,500,000 acre-feet in Lake Oroville	Water supply for consumptive use and incidental power, recreation, fish and wildlife protection and/or enhancement
Permit No. 16,480	September 26, 1972	Year-round	Divert 11,000 cfs from Oroville Facilities	Power generation, recreation, fish and wildlife protection and/or enhancement

[a] DWR describes the distribution of storage and diversion within these water rights differently in the license application. Our descriptions are based on a query of the Water Rights Information Management System through the Water Board.

Surface Water

The Oroville Facilities are located near the confluence of the Feather and Sacramento rivers, and the water quality objectives are set by the Regional Board and published in the Basin Plan for the Sacramento and San Joaquin River basins (Regional Board, 2004). The Basin Plan designates the beneficial uses for Lake Oroville as municipal and domestic supply, irrigation, power, contact and non-contact recreation, warm and cold freshwater habitat,[41] warm and cold spawning, and wildlife habitat. Designated beneficial uses for the Feather River from the fish barrier dam to the Sacramento River include municipal and domestic supply, irrigation, contact and non-contact recreation, including canoeing and rafting, warm and cold fish migration, warm and cold freshwater habitat, warm and cold spawning, and wildlife habitat. Table 18 summarizes the state objectives for selected water quality parameters.

[41] The Basin Plan explicitly states that any stream segment with both cold and warm freshwater habitat beneficial use designations will be considered cold freshwater habitat in the application of the water quality objectives (Regional Board, 2004, table II-1, footnote 2).

Table 18. Applicable water quality objectives for Oroville Facilities. (Source: Regional Board, 2004)

Parameter	Objective
Temperature	Natural water temperatures of basin waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration does not affect beneficial uses.
Turbidity	Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following: increases of 1 NTU where natural turbidity is 0–5 NTU, increases of 20% where natural turbidity is 0–50 NTU, increases of 10 NTU where natural background turbidity is 50–100 NTU, and increases of 10% where natural turbidity is >100 NTU.
Dissolved oxygen	Dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time: waters designated WARM—5.0 mg/L; waters designated COLD & SPWN—7.0 mg/L; monthly median of mean daily saturation—not less than 85%; and early life stage intergravel—95th percentile saturation not less than 95%.
pH	The pH shall not be depressed below 6.5 or raised above 8.5 nor changed at any time more than 0.5 from the normal ambient pH levels.
Settleable solids	Waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.
Chemical constituents	Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended-sediment discharge rate of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses.
Electrical Conductivity (at 25°C)	Not to exceed 150 μmhos/cm (90 percentile) in well mixed waters.
Fecal coliform bacteria	This criterion is set for protection of water contact recreation. Based on a minimum of not less than five samples taken during a 30-day period, the fecal coliform bacterial density shall not exceed a geometric mean of 200 most probable number/100 mL, nor should more than 10% of the total samples taken during any 30-day period exceed 400 most probable number/100 mL.

Note: °C – degrees Celsius
mg/L – milligrams per liter
mL – milliliter
NTU – nephelometric turbidity unit
μmhos/cm – micro-mhos per centimeter

The Regional Board also designates beneficial uses and water quality objectives for groundwater. The Basin Plan considers all groundwater in the Central Valley region suitable or potentially suitable, unless otherwise designated, for municipal and domestic, agricultural, industrial service, and industrial process supplies (Regional Board, 2004). Although the Basin Plan states objectives for pathogens (bacteria), chemical constituents, taste and odor, and toxicity, the groundwater objectives contained in the Basin Plan are not required under the federal Clean Water Act. Groundwater is discussed at the end of the *Water Resources* section.

Water quality in the project area is generally good. The quality of water in Lake Oroville is highly influenced by the water quality of upstream tributaries. Similarly, the water quality of the Feather

River, Thermalito forebay, and Thermalito afterbay are largely determined by the quality of water released from Oroville dam.

DWR's Division of Operation and Maintenance, as part of the State Water Project, has conducted water quality monitoring for various inorganic, organic, and biological parameters regularly since 1968. This monitoring program was augmented with an additional water quality sampling program to collect additional specific data as one of DWR's relicensing studies. The study area is generally within the FERC Project boundary but also includes tributaries to Lake Oroville and the Feather River downstream to the confluence with the Sacramento River. Specific water bodies included in the study area are the North, Middle, and South forks, West Branch and Concow Creek just above their confluences with the reservoir, Lake Oroville, the Feather River downstream from Oroville dam to the confluence with the Sacramento River, Thermalito diversion pool, forebay, and afterbay, and OWA ponds. The results of these monitoring activities, as they pertain to key parameters that may be influenced by project operations, are discussed below.

Temperature

Operation of the Oroville Facilities influences Feather River temperatures, which generally meet the Basin Plan objectives. The responsibility to meet temperature requirements below the dam may be a significant factor in meeting Basin Plan objectives. In addition to the Basin Plan temperature objectives, specific numerical water temperature criteria have been established for two locations associated with the Oroville Facilities: (1) at the Feather River Fish Hatchery, and (2) in the low flow channel at Robinson Riffle (RM 61.6). The hatchery objectives (table 19) were established in a 1983 agreement between DWR and DFG concerning the operation of the Oroville Division of the State Water Project for management of fish and game (DFG, 1983). NMFS' objective for salmonids was included in the NMFS 2002 and 2004 operations criteria and plan biological opinions (NMFS, 2002, 2004). The NMFS objective is a mean daily temperature of less than or equal to 65 degrees Fahrenheit (°F) from June 1 through September 30 at Feather RM 61.6 (Robinson Riffle in the low flow channel, see figure 8).

Table 19. Feather River Fish Hatchery temperature objectives (±4°F between April 1 and November 30). (Source: DFG, 1983)

Period	**Temperature (°F)**
April 1 through May 15	51
May 16–31	55
June 1–15	56
June 16–August 15	60
August 16–31	58
September 1–30	52
October 1–November 31	51
December 1–March 31	55

Operations of the project or the hatchery and water supply deliveries from the reservoir are also governed by the water year type in an effort to maintain the coldwater pool within Lake Oroville. During drier years when reservoir levels are low, the coldwater pool is diminished. During these years, deliveries to water contractors are reduced so that carryover storage is increased and water may be conserved for critical instream needs. In critically dry years, the coldwater pool can be exhausted, resulting in water that is warmer than desired for the most critical needs (e.g., salmonid egg incubation).

The 1983 agreement between DWR and DFG also establishes a narrative water temperature objective for the Feather River downstream of the Thermalito diversion dam and Thermalito afterbay outlet. This narrative objective requires water temperatures that are suitable for fall-run Chinook salmon during the fall (after September 15) and suitable downstream of the Thermalito afterbay outlet for shad, striped bass, and other warmwater species from May through August. Additional information about temperature requirements as they relate to fisheries is provided in section 3.3.3, *Aquatic Resources*.

Water passed from Lake Oroville for power generation may be pumped back into that reservoir for re-use. While pump-back operations can draw water that has warmed in the Thermalito forebay or afterbay back into the Thermalito diversion pool and Lake Oroville, DWR monitors these activities to ensure that no adverse effects occur to other beneficial uses during pump-back operations. DWR monitors water temperatures at the hatchery, which receives water diverted from the Thermalito diversion pool during pump-back operations. Pump-back operations are curtailed if water temperatures approach the limits of hatchery requirements.

Thermal Regime of Tributaries to Lake Oroville—DWR collected water temperature data for the West Branch and North, Middle, and South Forks arms, including tributaries, such as Concow Creek, Fall River, and Sucker Run Creek (see figure 2). Seasonal patterns of flow and temperature are similar in all tributaries to the main forks of the Feather River. Water temperatures begin to warm in May and June and reach maximum temperatures of 70 to 80°F in late July and early August and then begin to cool to ranges of 40 to 50°F in November through March. Mean summer water temperatures range from 68°F in the Fall River (a tributary of the Middle Fork) upstream of Feather Falls to 75°F in the West Branch near the town of Paradise. Temperatures of the North Fork are highly influenced by upstream hydropower operations, and daily minimum temperatures downstream of the Poe powerhouse[42] are much cooler than in the other tributaries (DWR, 2004e).

Lake Oroville—Vertical profiles of water temperatures in the main body of Lake Oroville and its North, Middle, and South Fork arms exhibit seasonal patterns that show thermal stratification into three layers: (1) the warm upper layer referred to as the epilimnion, (2) the metalimnion, which has a strong thermal gradient, and (3) the cold deep hypolimnion. Near surface waters (the epilimnion) begin to warm in the early spring, reach maximum temperatures approaching the mid-80°F during late July, and then gradually cool to winter minimum temperatures typically between 45 to 55°F. Temperatures in the deep waters (hypolimnion) remain as cool as 44°F year-round near the bottom of the reservoir. The depth of the metalimnion varies by season, ranging from about 30 feet in early-June to about 80 feet in early-November. During mid-summer, the depth of the metalimnion is around 50 feet. By late winter, relatively uniform temperatures, generally between 40 to 50°F, exist throughout the water column in Lake Oroville.

Thermalito Diversion Pool, Fish Barrier Pool, and Thermalito Forebay—The Thermalito diversion pool extends between Oroville dam and the Thermalito diversion dam. Water temperatures in the Thermalito diversion pool are controlled by the temperatures of the water released from the dam as well as water released through the Kelly Ridge powerhouse (non-project).[43] Water temperatures in the upper Thermalito diversion pool are similar both upstream and downstream from the Kelly Ridge powerhouse tailrace. Little, if any, summer stratification is found in the water column at the diversion

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[42] Poe powerhouse is a non-project feature located upstream of the Oroville Facilities project boundary on the Upper North Fork arm.

[43] Kelly Ridge powerhouse is a component of the South Fork Feather River Project (FERC No. 2088). Water from the tailrace discharges into the Thermalito diversion pool immediately downstream of Oroville dam.

dam, except for the shallow surface layer, with most temperature profiles differing by no more than a degree below the surface layer to the bottom.

The fish barrier pool extends between the Thermalito diversion dam and the fish barrier dam on the Feather River. Water temperatures warm very little in this waterbody; water temperatures are generally within a degree or so between the upstream and downstream ends with maximum differences occasionally reaching 3ºF. Water temperatures immediately downstream from the Thermalito diversion dam ranged from 45.5 to 61.0 ºF, while those at the gage near the fish barrier dam were very similar, ranging from 45.9 to 60.6 ºF with negligible stratification.

Water temperature differences between the Thermalito forebay and Thermalito diversion pool and between the North and South forebays are very similar. Water temperatures in both the North and South forebays are warmer by a few degrees in the upper few feet of the water column during warmer months of the year, especially along the margins of these water bodies where velocities are reduced. Measured water temperatures throughout the entire forebay near the surface ranged from 45.7°F during the colder months to 67.5ºF during the warmer months, while temperatures at lower depths ranged from 45.5 to 59.2ºF in the North forebay and 45.5 to 59.9ºF in the South forebay.

Thermalito Afterbay—Thermalito afterbay consists of the North afterbay (north of State Route 162) and South afterbay (south of State Route 162). In general, water temperatures in the Thermalito afterbay increase from the spring to summer and subsequently decrease into the winter in response to the temperature of water delivered from the South forebay as well as atmospheric conditions. Water temperatures were also warmer at measurement points in areas protected from the main flow of water through the Thermalito afterbay (e.g., coves).

Year-round water temperatures in the North afterbay (and winter temperatures in the South afterbay) were very similar to those found in the South forebay. Water temperatures began progressively increasing from the north to south in the spring, with increasing differences between North and South afterbay temperatures through the summer. Temperature differences between the northern and southern portions of the afterbay in the deeper portion of the water column ranged from about 56 to 62ºF during May (difference of about 6ºF) to about 56ºF to 65ºF (a difference of about 9ºF) during the warmest part of the year (August/September). Thermalito afterbay exhibited seasonal thermal stratification where temperature differences between the top and bottom during the warmer months ranged from about 53 to 62ºF (9ºF difference) in the North afterbay to about 62 to 76ºF (14ºF difference) in the South afterbay.

Feather River Downstream of the Fish Barrier Dam

DWR also monitored water temperatures in the Feather River downstream of the fish barrier dam as part of a spring-run Chinook salmon habitat suitability study. Vertical profile results indicate that pools do not thermally stratify. Table 20 presents the mean profile water temperatures for pools in the Feather River that could be used as holding areas for spring-run Chinook salmon (discussed in section 3.3.3, *Aquatic Resources*). The results indicate that temperatures vary seasonally, including warming through the summer with increased temperatures at greater distances from Lake Oroville.

Because the Thermalito afterbay outlet substantially alters flow conditions in the Feather River, we discuss thermal conditions in the reaches upstream and downstream of the afterbay outlet separately.

Low Flow Channel—Water temperature results recorded with stationary data loggers in the low flow channel from March 2002 to March 2004 indicate that the water begins to warm in March with maximum temperatures reached in July and early August that ranged from 61°F upstream of the Feather River Fish Hatchery to 69°F upstream of the Thermalito afterbay outlet (see figure 12). The low flow channel begins cooling in September, with water temperatures dropping to 45°F throughout the reach by February. Temperatures of water released from the Feather River Fish Hatchery vary little from those of the river near the hatchery.

Table 20. Mean water temperatures (°F) in Feather River pools downstream of Lake Oroville, June–October 2002. (Source: DWR, 2004f, as modified by staff)

Location (RM)	6/12	6/27	7/15	7/25	8/22	8/26	9/5	9/27	10/9	10/25
Downstream from fish barrier dam (67.2)	53.4	56.5	54.3	54.3	61.3	56.7	54.1	53.1	55.2	56.1
Upstream from fish barrier pool (67.2)	54.0	56.7	54.5	57.2	61.2	56.8	54.1	52.9	55.2	56.1
Downstream from fish barrier pool (67)	54.9	57.9	55.6	57.7	62.4	57.2	54.5	52.9	56.5	55.9
Upstream from Highway 162 Bridge (64.5)	--	--	--	--	64.6	58.8	57.4	52.9	58.5	55.9
Upstream from afterbay outlet pool (59)	--	--	--	--	65.1	61.3	58.8	55.9	59.0	56.8
At afterbay outlet pool (58.75)	--	--	--	--	64.0	63.9	60.4	58.3	60.6	58.3
Downstream from afterbay outlet pool (58.5)	--	--	--	--	63.1	64.4	62.1	60.3	60.6	58.3
Near Mile Long pool (57)	--	--	--	--	63.7	65.7	63.0	61.3	61.9	58.6
Downstream from project boundary pool (53)	--	--	--	--	64.0	65.7	63.3	62.2	62.1	59.0

Note: -- Indicates no data recorded

The current water temperature objective for the low flow channel requires a daily mean temperature of less than or equal to 65°F from June 1 through September 30 at Robinson Riffle (RM 61.6). During extended warm periods in the summer of 2002 and 2003, this objective was exceeded. On June 19, 2002, the daily mean temperature was 65.5°F. During July 2003, the objective was exceeded on five occasions, with a maximum daily mean temperature of 66.0°F.

High Flow Channel (Feather River below the Thermalito Afterbay Outlet)—Temperatures in the high flow channel are a function of flows from the Thermalito afterbay outlet, Honcut Creek, Yuba River, and the Bear River. Water in the high flow channel begins warming in March and reaches its maximum during June and July, and then cools to 44 to 45°F by January or February (figure 13). DWR reported maximum temperatures for monitoring sites in the reach ranged from 71°F at the Thermalito afterbay outlet to 77°F immediately downstream of the Bear River confluence outside the project boundary.

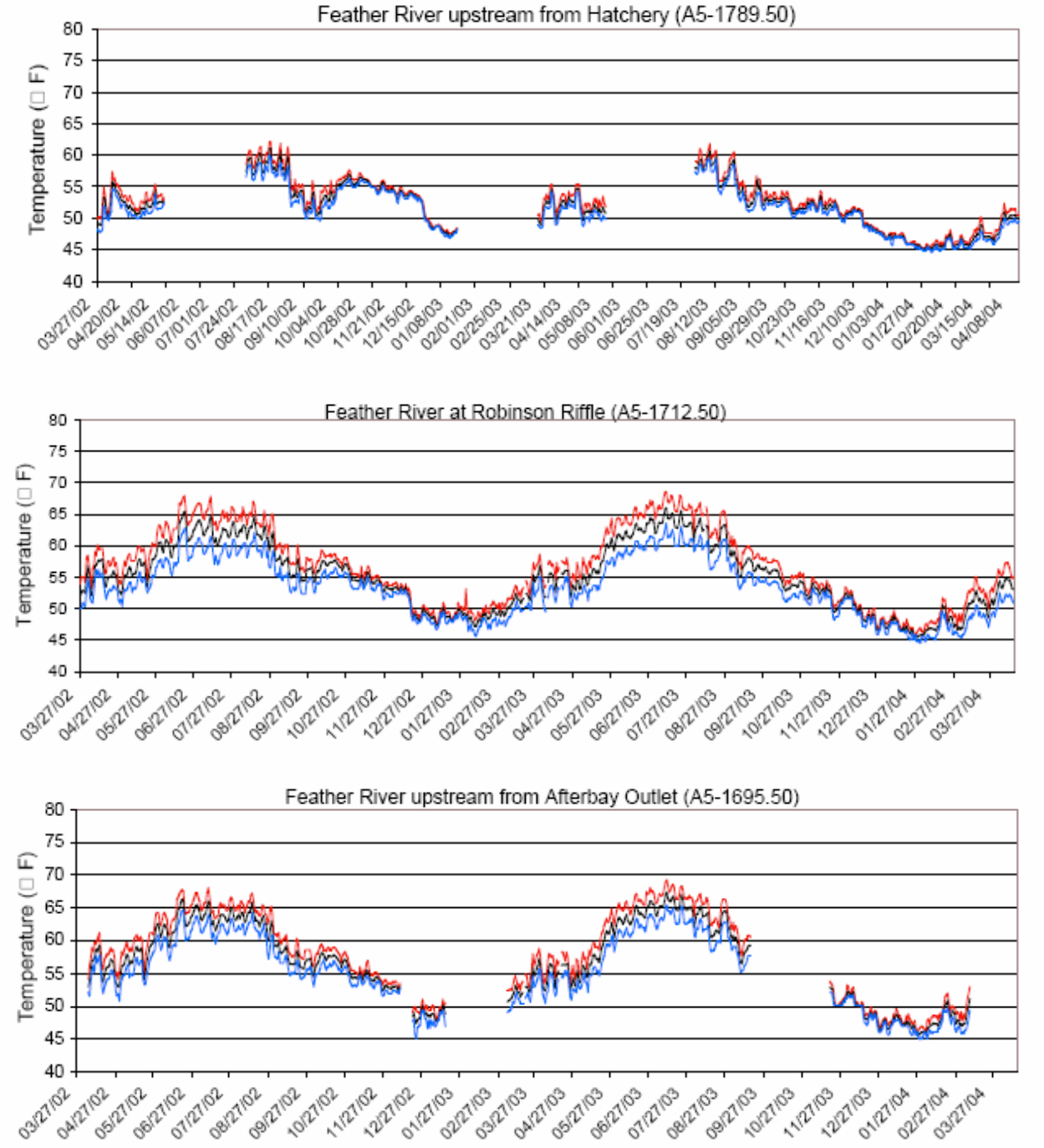

Figure 12. Maximum, mean, and minimum daily temperatures in the Feather River low flow channel. (Source: DWR, 2004e)

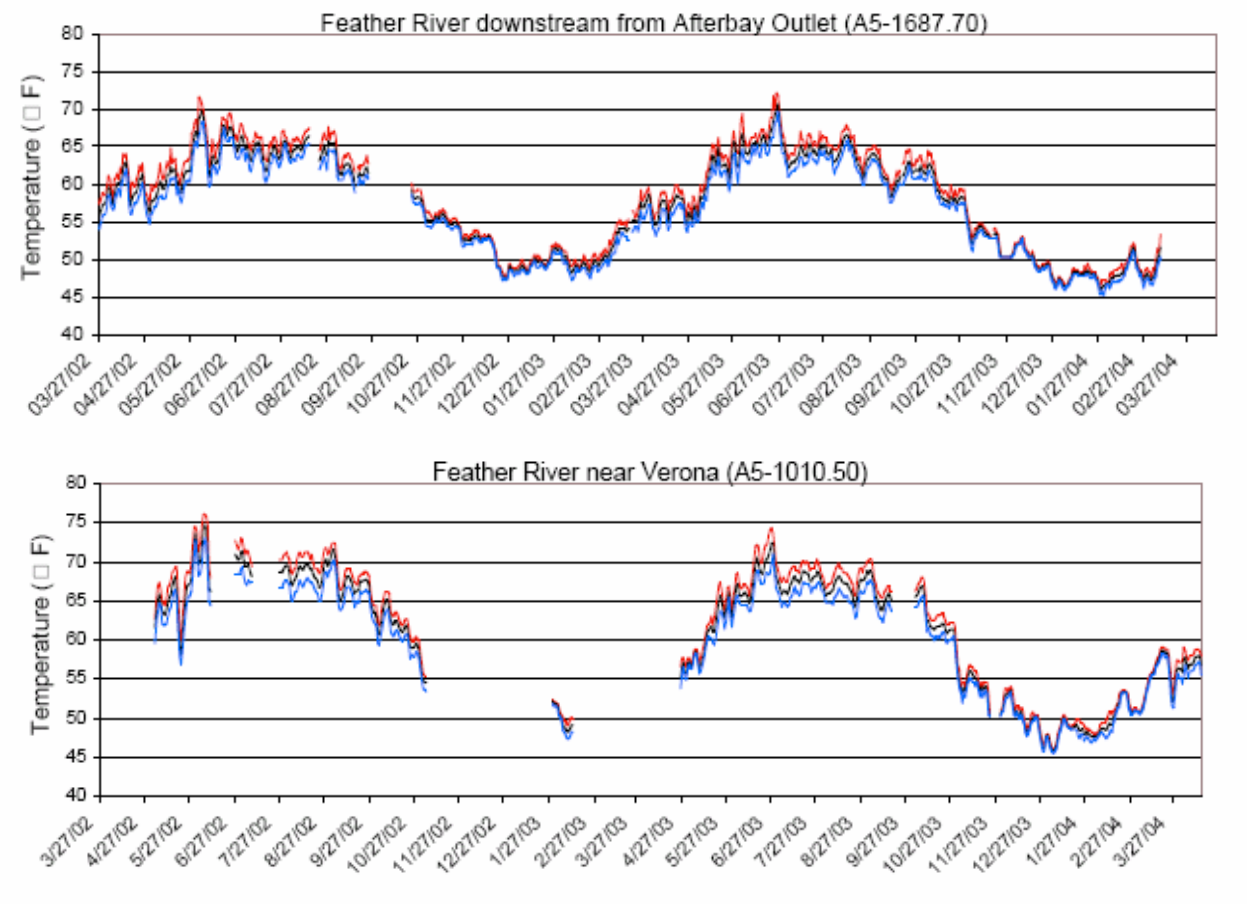

Figure 13. Maximum, mean, and minimum daily temperatures in the Feather River high flow channel. (Source: DWR, 2004e)

High flow channel water temperatures from April through October downstream of the Thermalito afterbay outlet are strongly influenced by the inflows from the Thermalito afterbay, Honcut Creek, Yuba River, and Bear River. Except during periods of high flow through Thermalito afterbay, which occur frequently in July and August, releases from Thermalito afterbay during the warm season raise the water temperature of the river. Inflows from Honcut Creek and Bear River also tend to increase Feather River temperatures downstream of their confluences during this period. Flows contributed by the Yuba River tend to cool the Feather River during the warmer spring and summer months.

DWR operates releases from Oroville dam by withdrawing water at depths that will provide sufficiently cold water to meet Feather River Fish Hatchery and the Robinson Riffle temperature requirements. Historical water temperature measurements indicate that the Robinson Riffle criterion is almost always satisfied when the Feather River Hatchery objectives are met. The reservoir depth from which water is released initially determines the river temperatures, but atmospheric conditions, which fluctuate from day to day, modify downstream river temperatures.

Temperature Conditions at the Feather River Fish Hatchery—Generally, monitored water temperatures satisfy the criteria set for the Feather River Fish Hatchery in the 1983 agreement between DFG and DWR. Monitoring data indicate frequent compliance with the Feather River Fish Hatchery temperature requirements, with the exception of an extended warm period in the fall of 2002 when temperatures were above the criteria about 38 percent of the time (table 21).

Table 21. Frequency at which fish hatchery water temperatures met temperature objectives from April 2002 to March 2004. (Source: DWR, 2004f)

Dates	Days Below Minimum Objective	Days Above Maximum Objective	% of Days Below Min.	% of Days Above Max.
Year 2002–2003				
April through May 15	0	1	0	2
May 16–31	0	0	0	0
June 1–15	0	0	0	0
June 16–August 15	7	0	11.5	0
August 16–31	2	0	12.5	0
September	0	0	0	0
October–November	0	23	0	37.7
December–March	0	0	0	0
Year 2003–2004				
April through May 15	0	0	0	0
May 16–31	1	0	6.3	0
June 1–15	0	0	0	0
June 16–August 15	2	0	3.2	0
August 16–31	1	0	5.9	0
September	0	0	0	0
October–November	0	0	0	0
December–March	0	0	0	0

Dissolved Oxygen and pH

Generally, dissolved oxygen (DO) concentrations and pH levels monitored within the study area complied with the water quality objectives of the Basin Plan (table 18). The majority of the exceedances were observed at the bottom of either Lake Oroville or Thermalito afterbay.

DO concentrations of less than the applicable state objectives were recorded in the West Branch arm, Thermalito afterbay, and in the low flow channel. Table 22 summarizes the monthly profile results that failed to meet the Basin Plan objective for DO (7.0 milligrams per liter [mg/L] for cold/spawning habitat). DO concentrations that failed to meet the objectives at the surface and bottom of Lake Oroville occurred when the reservoir was thermally stratified in the summer (DWR, 2005b). In the Feather River between the fish barrier dam and Honcut Creek, the Basin Plan has a specific DO objective of 8.0 mg/L for September through May. Measured DO concentrations in the Feather River decreased to 5.4 mg/L, which is less than the objective, at the station downstream of the Feather River Fish Hatchery on October 27, 2003. This low value occurred during the salmon spawning period when decomposing salmon carcasses were present (DWR, 2005b). DO concentrations of less than the objective were also recorded at three other stations during mid-December 2002 (6.5–7.6 mg/L).

Table 22. Summary of Basin Plan DO exceedances during 2002 to 2003. (Source: DWR, 2005b, as modified by staff)

Location	Exceedances/Samples	Minimum (mg/L)
Lake Oroville		
North Fork arm, surface	3 of 29	6.5
North Fork arm, bottom	1 of 28	0
Middle Fork arm, surface	1 of 29	5.9
Middle Fork arm, bottom	6 of 29	4.9
South Fork arm, surface	1 of 28	6.5
South Fork arm, bottom	12 of 28	1.0
Main Body, bottom	1 of 21	6.9
In front of dam, surface	1 of 30	6.4
In front of dam, bottom	4 of 29	0.7
Feather River		
Downstream of fish hatchery	1 of 30	5.4
Robinson Riffle	1 of 30	7.6
Thermalito afterbay, bottom	2 of 26	6.4
Downstream of project boundary	1 of 30	6.5

Only one measurement of pH was less than the minimum applicable pH objective (6.5 units); this was a pH value of 6.3 units reported at the Thermalito afterbay outlet.

Conductivity and Minerals

Measured concentrations of dissolved inorganic minerals and associated electrical conductivity routinely comply with Basin Plan water quality objectives in the project study area. However, use of salt at the Feather River Fish Hatchery coincided with detectable changes in electrical conductivity in the low flow channel on one occasion. A single observation in the low flow channel downstream of the hatchery recorded the conductivity slightly over the Basin Plan objective, 151 μmhos/cm, which barely exceeds the objective of 150 μmhos/cm.

Turbidity

Dams and reservoirs can cause suspended sediments to be deposited in their impoundments and also reduce the size of the materials that are released or spilled downstream of the dam. DWR monthly sampling results indicate that settleable solids concentrations were at trace or undetectable levels for the majority of samples. Monitoring results from the tributaries and main branches of the North Fork indicate that typically very low levels of turbidity and total suspended solids occur, except during high flow

events.[44] Generally, many of the total suspended solids readings in the North, Middle and South Forks upstream of the project boundary were well below 10 mg/L. Lake Oroville acts as a sediment trap which results in low concentrations of total suspended solids within Lake Oroville, the Feather River immediately downstream of Oroville dam, and the Thermalito Complex. Turbidity readings within the main body of Lake Oroville were typically below 10 nephelometric turbidity units. The maximum turbidity values in front of the dam were 11.6, 2.9, and 3.8 nephelometric turbidity units at the surface, middle, and low depths, respectively. Turbidity in the diversion pool, Thermalito forebay, and Thermalito afterbay was recorded consistently below 8 nephelometric turbidity units in more than 200 samples. Downstream of the Thermalito afterbay outlet, turbidity and total suspended solids concentrations generally increase, which may potentially be related to inputs from downstream tributaries in the Feather River and high flows resulting from storm events (DWR, 2005b).

The Soil Conservation Service (now the Natural Resource Conservation Service) considers the Feather River watershed upstream of Lake Oroville to be subject to accelerated erosion as a result of human-caused disturbances (DWR, 2005b). Based on the current monitoring results, the numerous dams and reservoirs upstream of Lake Oroville are likely effective traps of (suspended) sediment, thereby reducing the quantity of sediment transported into Lake Oroville. Although the quantity is reduced, what does come into the lake is trapped and settles in the upper arms of the lake as discussed in section 3.3.1.1, *Affected Environment* in *Geology, Soils, and Paleontological Resources*.

Metals

DWR monitored metal concentrations in the main tributaries to Lake Oroville, in Lake Oroville, Thermalito forebay, afterbay, and the low flow and high flow channels of the Feather River. Basin Plan objectives include dissolved metal concentrations due to their possible influence on aquatic organisms (table 23). The Basin Plan states that at a minimum, waters designated for use as domestic or municipal supply (Lake Oroville and the Feather River between the fish barrier dam and the Sacramento River) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels as specified in Title 22 of the California Code of Regulations—Drinking Water Standards. DWR's monitoring program measured total and dissolved metals concentrations throughout the project area (mercury was sampled for total recoverable mercury and total methyl mercury).

Table 23. Water quality objectives and criteria for trace metals in waters of the Feather River watershed. (Source: Regional Board, 1998, as modified by staff)

Chemical Constituent	Basin Plan Objectives (mg/L)[a,b]	California Drinking Water Standards (mg/L)[c]
Aluminum	--	Primary MCL 1.0
Arsenic	--	Primary MCL 0.05
Cadmium[d]	--	Primary MCL 0.005
Chromium	--	Primary MCL 0.05
Copper[d]	0.0056	Primary MCL 1.3
Iron	0.3	Secondary MCL 0.3

[44] Total suspended solids readings taken on February 18, 2004, at the sampling sites along the main branches and tributaries to the Feather River upstream of Lake Oroville were well above 10 mg/L with maximum readings of 393 and 262 mg/L upstream and downstream of the Poe powerhouse, respectively. Flow at USGS Gage No. 11404500 on the North Fork near Pulga for this date was above 15,000 cfs (USGS, 2005).

Chemical Constituent	Basin Plan Objectives (mg/L)[a,b]	California Drinking Water Standards (mg/L)[c]
Lead[d]	≤0.015 in waters designated as domestic or municipal supply	Primary MCL 0.015
Manganese	0.05	Secondary MCL 0.05
Nickel[d]	--	Primary MCL 0.1
Selenium	--	Primary MCL 0.05
Zinc[c]	0.016	Secondary MCL 5.0

[a] As dissolved.

[b] Chemical constituent objectives listed in this table have are for water bodies other than the Feather River, and are shown here for comparison purposes only.

[c] Title 22 of the California Code of Regulations.

[d] Hardness-dependent criteria. The listed criteria are for a hardness of 50 mg/L.

Metal concentrations in several water samples exceeded the Basin Plan objectives in Lake Oroville and in the Feather River downstream of the dam. DWR study results also indicate that exceedance of the objectives typically increased in frequency in the Feather River downstream of the project boundary. Table 24 summarizes metal concentrations of samples that exceeded Basin Plan objectives. Generally, sampling sites below Oroville dam had a greater percentage of samples that exceeded Basin Plan objectives than those within project waters. Arsenic levels exceeded the EPA National Toxics Rule, toxicity to humans objective in every sample, but met drinking water and aquatic life protection objectives. DWR noted that the majority of metal concentration exceedances in the upper tributaries were recorded during storm events.

Table 24. Summary of metal concentrations that exceeded Basin Plan objectives. (Source: DWR, 2004g, as modified by staff)

Metal	Number of samples[a]	Number of samples that exceeded Basin Plan[b]	Percent	Maximum concentration (mg/L)	Comments on locations of exceedances
Aluminum	1,613	39	.0241	5.523	Tributary samples and with increasing frequency downstream
Iron[c]	1,245	286	22.97	8.088	Inputs to power canal and with higher frequency downstream of Robinson Riffle pond
Mercury	1,534	2	.0013	0.183	Sucker Run and upstream of fish hatchery
Manganese	1,612	132	.0818	2.260	All locations save for 1 near the dam in Lake Oroville and all locations in Oroville Wildlife Ponds save for 1. Other locations include Oroville fishing pond, Robinson Riffle, and Long Pond.

Metal	Number of samples[a]	Number of samples that exceeded Basin Plan[b]	Percent	Maximum concentration (mg/L)	Comments on locations of exceedances
Lead	1,620	20	.0123	3.93	Tributary samples, Thermalito afterbay, and Feather River below Oroville dam.

[a] Sum of all samples taken from all locations which include locations above and below the project boundary.

[b] Basin Plan objectives listed in table 23.

[c] Dissolved concentrations.

DWR also examined fish tissues for metals. Results from the DWR fish tissue sampling study indicate that metals concentrations in tissue samples are occasionally elevated based on comparison to recommended guidelines from various regulatory agencies, while results for mercury concentrations were noticeably higher than the 0.3 mg/kg criteria set by the EPA for methylmercury concentrations in fish tissue to protect human health (EPA, 2001). Concentrations of mercury in 214 individual fish sampled from the project area, tributaries, and the OWA ranged from 0.01 to 1.26 mg/kg (wet weight) with a mean of 0.3 mg/kg. Ninety-four of the 214 fish sampled had mercury concentrations greater than 0.3 mg/kg (DWR, 2006e). Figure 14 shows the mercury levels in individual fish and their sampling location. Incidences of fish with mercury concentrations greater than the EPA criteria diminish below the Thermalito afterbay outlet, as shown in figure 14.

Fish consumption advisories by California/EPA Office of Environmental Health Hazard Assessment (OEHHA) are fairly common in the Sierra Nevada foothills, Sacramento River Delta, and coastal ranges of California where historical mercury ore mining and processing or gold mining activities occurred. OEHHA released a Draft Health Advisory containing "Safe Eating Guidelines for Fish from the Lower Feather River" (as defined from the fish hatchery dam to the confluence with the Sacramento River) in August 2006. The advisory suggests that women and men beyond childbearing age, as well as women of childbearing age, pregnant or breastfeeding women, and children under 17 avoid eating striped bass or Sacramento pike minnow. The advisory also suggests women of childbearing age, pregnant or breastfeeding women, and children under 17 avoid eating large mouth bass, small mouth bass, and catfish.

DWR states that historical gold mining practices upstream of the project area, as well as the development of municipal and industrial land uses in the upper watershed and along the Feather River, continue to be the primary source for most of the metals found in the project area. Since metals are usually associated with sediments and Lake Oroville inhibits sediment transport (see section 3.3.1, *Geology, Soils, and Paleontological Resources*), the Oroville Facilities probably act as a sink for metals from upstream sources. A principal beneficial effect of this is the inhibition of contaminated sediments transport to the Feather River and other water bodies. Conversely, there is evidence that mercury concentrations in hatchery raised coho salmon are significantly lower than Lake Oroville coho salmon, indicating the presence of mercury in the food web such that uptake of mercury in Lake Oroville coho salmon is occurring. Because the Oroville Facilities provide sport fishing opportunities, the potential for human consumption of fish from the project area exists. We discuss the effects of the proposed water quality monitoring and public education program below.

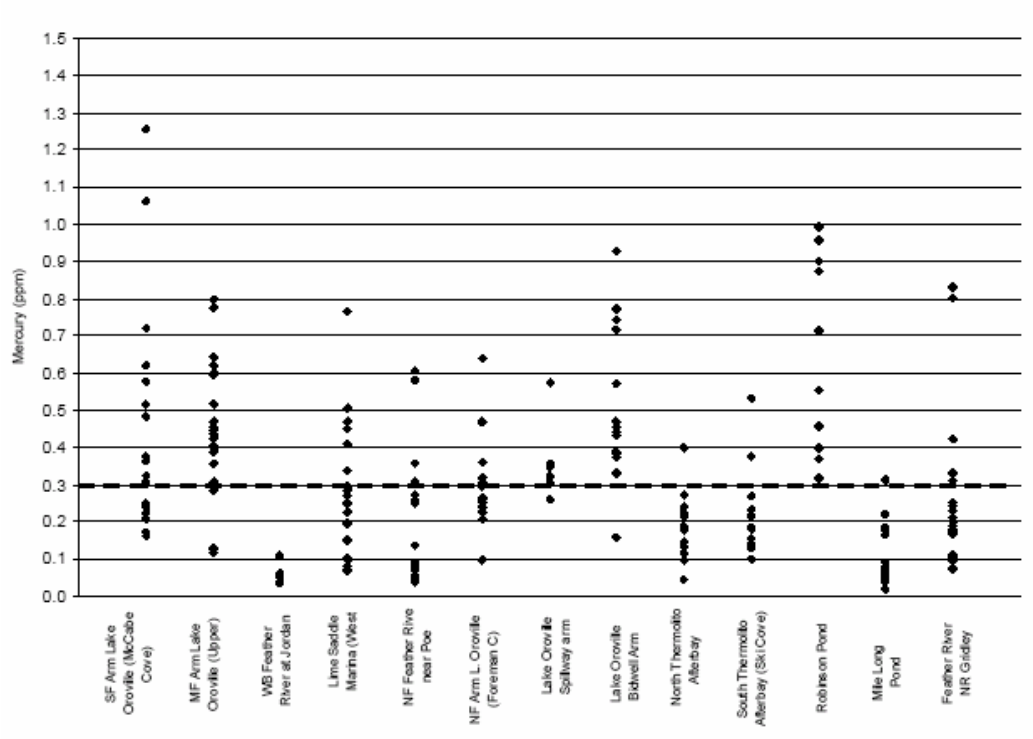

Figure 14. Concentrations of mercury in individual fish from the Oroville Facilities area (the dashed line represents the EPA recommended criteria for the protection of human health). (Source: DWR, 2006e)

Pesticides

DWR characterizes the use of pesticides at the Oroville Facilities as minor. The local Mosquito Abatement District is responsible for mosquito control within the OWA and herbicides are applied for maintenance of recreational and other facilities within the project boundary.

DWR collected samples upstream of Lake Oroville from the surface water of Lake Oroville and the Thermalito forebay and afterbay complexes, and downstream of the Thermalito afterbay outlet during the fall (after first seasonal rains) and winter (February/March; the dormant spray period) to determine if pesticides were present in project waters. DWR monitoring results indicate that the pesticide diuron was detected in one sample (recorded concentration of 1.91 micrograms per liter (μg/L), although its concentration was considerable less than the EPA drinking water criterion of 10 μg/L. This sample was collected upstream of the FERC project boundary. Methoprene and malathion, pesticides typically applied for mosquito control in the OWA, and their breakdown byproducts were not detected in DWR's sampling.

Petroleum Byproducts and Fuel Additives

Methyl tertiary butyl ether (MTBE, a fuel additive[45]), oils, greases, and waxes were investigated because of the potential to be released into Lake Oroville through boating use, fuel pumping, and fuel storage activities at or near marinas, or along the Lake Oroville shoreline. DWR study results reported in the license application indicate that MTBE (concentration of 3.1 μg/L) was detected in a single sample from the Thermalito diversion pool downstream from the Kelly Ridge powerhouse in a water sample

[45] The state of California banned MTBE as a fuel additive in gasoline beginning on January 1, 2004.

collected on November 17, 2003. This is well below the California Department of Health Services (DHS) secondary maximum contaminant level for drinking water of 5 μg/L. No other organic contaminants were detected at concentrations greater than the minimum detection limit. No oil, grease, waxes, or other similar materials causing nuisance, visible film, or coating on the surface of the water or on objects in the water were evident during monitoring.

Nutrients

DWR investigated nutrient concentrations (nitrogen and phosphorus) in the study area, near recreational facilities (near floating campsites and toilets) and in stormwater runoff to investigate whether project-related recreation use and operation of the Feather River Fish Hatchery is contributing to increased nutrient loading in the project area. Results of these efforts show that nutrient concentrations throughout the study area were consistently below most Basin Plan objectives.

Phosphorus and nitrate plus nitrite concentrations did not exceed Basin Plan criteria or objectives. Levels of total phosphorus in water samples from the tributaries upstream of Lake Oroville were frequently below 3 μg/L, and levels of total nitrogen (ammonia plus nitrate plus nitrite) were sometimes below 15 μg/L. Water samples collected from the tributaries to Lake Oroville frequently exceeded the EPA-recommended criteria for phosphorus and nitrate plus nitrite that were set to avoid eutrophication, which suggests that these tributaries often have an overabundant supply of nutrients.

DWR collected samples for periphyton (attached algae) analyses from four sites on the tributaries upstream from Lake Oroville and 13 sites on the Feather River downstream of the fish barrier dam from May 2003 to March 2004. Periphyton dominated most samples in the tributaries upstream of Lake Oroville and in the Feather River. Green algae, which are considered indicative of higher nutrient levels than diatoms, were dominant in a single sample downstream of the Sewerage Commission—Oroville Region outlet collected in June 2003. This level of green algae density was not found in the upstream sampling site or at the other stations in the immediate area of the outlet (upstream and downstream of afterbay outlet and near One Mile Pond). This bloom could indicate nutrient enrichment, possibly from the Sewerage Commission—Oroville Region Outlet.

Low concentrations of nutrients were detected in most of the water samples collected during the salmon spawning season, indicating that salmon carcasses do not excessively increase nutrient concentrations in the Feather River. Water samples collected from the water column and from within gravel substrates at stations immediately upstream and downstream of the Sewerage Commission—Oroville Region outlet showed no consistent differences in nutrient concentrations. However, the periphyton community at the station downstream of the Sewerage Commission—Oroville Region outlet had characteristics indicative of a nutrient status that was greater than the communities at other stations.

Pathogens

DWR investigated coliform bacteria presence throughout the study area, near recreational facilities (including near floating campsites, restrooms, pump-out facilities and marinas with high densities of house boats) and in stormwater runoff using a monthly sampling regime and a more intensive sampling regime to collect data that is directly comparable to the Basin Plan objectives (no less than 5 samples in 30-day period criteria). The monthly monitoring study results generally indicate very low bacteria concentrations in the tributaries to Lake Oroville and most open water sites in Lake Oroville. Results of the more intensive, summer recreation site monitoring effort revealed that several recreation sites in Lake Oroville and the Thermalito Complex had elevated bacteria densities (Bedrock Park

recreation area,[46] Foreman Creek boat access, Loafer Creek swim area, and Monument Hill swim area) and that the two sites sampled in the North forebay (swim area and cove) consistently exceeded Basin Plan and DHS objectives for total coliform, fecal coliform, and enterococcus bacteria. Seven of 10 samples at both the beach and cove recorded individual fecal coliform samples greater than 200 organisms per 100 milliliter (mL) and together these two sites produced nine results that exceeded the 5-day geometric mean threshold used by the Basin Plan. DHS recommends that beaches be posted or closed to protect public health when total coliform bacteria exceed 10,000 organisms, fecal coliform bacteria exceed 400 organisms, or enterococcus bacteria exceed 61 organisms per 100 mL of water sample. DHS recommended levels of bacteria contamination to trigger beach posting or closure were exceeded at least once at each recreation area monitored in 2003. Table 25 shows the number of samples that exceeded either the Basin Plan or DHS fecal coliform criteria. Bacteria contaminations were elevated during both seasonal peak recreational activity and non-recreation periods when numerous waterfowl were present indicating that both humans and waterfowl may be sources of contamination. Testing to determine the source of pathogens (human or animal) was not conducted.

Table 25. Number of exceedances of either the Basin Plan and/or DHS fecal coliform thresholds based on 10 samples collected at recreation sites in June through August 2003. (Source: DWR, 2004g, as modified by staff)

Location	Number of Samples Exceeded		Maximum Number/ 100 mL	Month of Maximum
	Basin Plan Objectives[a]	DHS Criteria		
Foreman Creek beach access	0	1	>1,600	June
Loafer Creek swim area	0	2	>1,600 (twice)	June
Monument Hill swim area	0	1	500	July
North forebay swim area (beach)	6	7	>1,600 (twice)	June and July
North forebay swim area (cove)	3	3	22,000	August
North forebay swim area (mouth)	0	2	>1,600	August
South forebay boat ramp	1	4	>1,600 (twice)	July and August
South forebay swim area	0	2	>1,600 (twice)	July and August
Stringtown boat ramp	0	1	>1,600 (twice)	July

Note: DHS – California Department of Health Services

[a] No more than 200 per 100 mL based on geometric mean of 5 samples per 30 days.

[b] Single sample maximum of 400 per 100 mL.

Aquatic Toxicity Tests

DWR's license application summarizes aquatic toxicity study results that were compiled using EPA's standardized freshwater acute and chronic toxicity tests using fathead minnow and zooplankton

[46] Redrock Park is part of the Feather River Recreation and Parks District and is located on the south side of the Feather River in the city of Oroville between 4th and 5th Streets, outside of the project boundary.

(*Ceriodaphnia dubia*). Water samples from nine Lake Oroville tributary sites were collected bimonthly in the summer, following the first flush in the fall, following winter dormant spraying in February, and during the high runoff period in April or May. Water samples from eight Feather River monitoring sites (fish barrier dam to Honcut Creek) were analyzed monthly. Water samples from three OWA ponds were also analyzed. Toxicity identification evaluation procedures were used for samples from sites with confirmed toxicity to evaluate whether particulate matter, metals, and/or polar organic compounds were associated with the toxicity (DWR, 2004g).

The tributaries to Lake Oroville had positive reproductive toxicity to zooplankton at all 9 regularly sampled sites, with frequency of toxicity per site ranging from 20 to 83 percent of the sampling dates. Survival toxicity to zooplankton was generally absent. Survival toxicity to fathead minnows in filtered samples occurred for all but one of the Lake Oroville tributary sites, with frequency of toxicity per site ranging from 0 to 20 percent of sampling dates.

The Feather River sites had reproductive toxicity to zooplankton on 21 to 58 percent of the sampling dates, which is similar to the range of frequencies for the Lake Oroville tributary sites. However, survival toxicity to zooplankton was detected more frequently at the Feather River sites than at the Lake Oroville tributary sites, ranging from 4 to 33 percent of sampling dates. The hatchery settling pond and the Feather River downstream of the hatchery had the two highest reproductive toxicity and survival toxicity rates. Zooplankton reproductive toxicity was also present in the majority of storm event samples, and survival was reduced at several sites during one storm event.

Survival toxicity to fathead minnows was present at all 8 regularly tested Feather River sites, with the frequency in filtered samples ranging from about 4 to 18 percent of sampling dates. The sites with the highest fathead minnow toxicities were the city of Oroville, the hatchery settling pond, the Feather River downstream of the hatchery, and the Thermalito afterbay outlet. Fathead minnow toxicity was generally absent in the storm event samples. Detections of toxicities in the OWA ponds were relatively infrequent or absent both for zooplankton and fathead minnows. The toxicity identification evaluation for several August 2003 sample sites confirmed that toxicity could be reduced when particulate matter, metals, and/or polar organic compounds were removed from the samples, but the cause-and-effect relationships for specific contaminants or sample locations could not be determined. The results from the toxicity analysis suggest that waters within the project area contain toxins that affect the survival and reproduction of the fathead minnow (test organism), which may also be affecting other larger organisms. Targeted Toxicity Identification Evaluations were preformed on several samples in 2003 and 2004 in an attempt to identify the contaminants. Results from this analysis did not identify a pattern other than identifying the toxic as metal or non-polar organic.

Groundwater Quality

DWR monitored the quality of groundwater around the Thermalito forebay and Thermalito afterbay by sampling groundwater from 18 wells in the vicinity of these reservoirs (two sampled wells were upgradient from the Thermalito Complex). Each well was sampled once in the late spring or early summer and once in the fall of 2003. Temperature, pH, and specific conductance were measured at the time of sampling. Groundwater samples were collected and analyzed for general mineral composition, aluminum, and mercury.

Groundwater quality results were compared to the surface water quality results collected from two sites in Thermalito afterbay and two sites in Thermalito forebay (DWR, 2004g). Results from the two upgradient wells showed no obvious differences from those of the 16 downgradient wells. The mineral content of the groundwater samples was consistently higher than that of the surface water samples. Specific conductance and total dissolved solids were consistently higher in the groundwater samples than in the surface water samples. The metal content in groundwater was consistently lower than that of surface water samples.

Hazardous Materials

Hazardous materials are defined in Section 66260.10, Title 22 of the California Code of Regulations as:

A substance or combination of substances which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may either (1) cause, or significantly contribute to, an increase in mortality or an increase in serious, irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, or disposed of or otherwise managed.

Hazardous materials within the FERC project boundary are managed through the coordination of federal, state, and county laws, regulations, and programs. A search of available environmental databases has indicated that there are 36 sites within the FERC project boundary for which there is some type of hazardous materials information, whether it relates to existing underground storage tanks, aboveground storage tanks, hazardous materials handling, hazardous waste generation, or hazardous materials spill incidents.

DWR reports that there appear to be no significant hazardous materials or waste issues within the FERC project boundary. DWR conducts its hazardous materials and wastes management activities within the requirements of local, state, and federal laws and regulations.

3.3.2.2 Environmental Effects

Water Quantity

This section discusses the effects of the Proposed Action on flow regimes in river reaches affected by project facilities, operations, flood control, instream flows, ramping rates, and water rights.

Flow/Temperature to Support Anadromous Fish (Proposed Article 108)

Proposed Article A108.1, *Flow/temperature to Support Anadromous Fish*, would establish a new minimum flow of 700 cfs in the low flow channel during part of the year, but the minimum flow would be increased to 800 cfs during the Chinook salmon spawning season from September 9 through March 31. Additionally, a river valve[47] would be replaced or refurbished under Measure B108, *Flow/Temperature to Support Anadromous Fish*. The modification would likely occur prior to issuance of a new license. Ramping rates would continue as set by a 1983 agreement between DWR and DFG.

DWR proposes to maintain a minimum flow in the high flow channel, based on the April through July unimpaired runoff of the Feather River near Oroville of the preceding water year (October 1 through September 30). The minimum flow required in the high flow channel would be the same as that currently required (see table 2), provided that such releases would not cause Lake Oroville to be drawn down below elevation 733 feet (approximately 1,500,000 acre-feet).

The Settlement Agreement also contains low flow and high flow provisions for the high flow channel. If the April 1 runoff forecast in a given water year indicates that, under normal operation of the project, Lake Oroville would be drawn to elevation 733 feet msl (approximately 1,500,000 acre-feet), minimum flows in the high flow channel could be diminished on a monthly average basis, in the same

[47] The two river valve systems are located just downstream of the plug in Diversion tunnel no. 2. Each valve can discharge water up to 2,700 cfs into the tunnel through a 72-inch spherical guard valve and 54-inch fixed-cone dispersion valve via two 72-inch-diameter steel conduits located inside the plug. The combined capacity is 5,400 cfs under rated conditions of 428 feet of head. Diversion tunnel no. 2 is located in the left side of Oroville dam and to the right of the Hyatt pumping-generating plant.

proportion as the respective monthly deficiencies imposed on deliveries for agricultural use from the project; however, in no case would the minimum flow releases be reduced by more than 25 percent. If, between October 15 and November 30, the highest total 1-hour flow were to exceed 2,500 cfs, DWR would maintain a minimum flow within 500 cfs of that peak flow, unless such flood flows or an inadvertent equipment failure or malfunction caused the flow exceedance.

Ramping requirements are summarized in tables 3 and 4, and no changes from the current conditions are proposed.

Staff Analysis

The current minimum flow in the low flow channel is 600 cfs. We note that the Chinook spawning season, the period when the 800-cfs flow requirement would be in effect, covers a period of 204 days per year and the 700-cfs requirement would exist for the remaining 161 days of the year. Establishing a minimum flow of 700 cfs from April 1 through September 8 would increase the targeted flow by 16.7 percent from current conditions. Similarly, the targeted flow during the Chinook spawning season would represent a 33.3 percent increase over existing conditions. Higher flows would correlate with higher stages and the channel would experience a wider wetted top width under this proposal. Higher flows in the low flow channel would negatively affect generation, and we assess those effects in section 4.0, *Developmental Analysis.*

Higher flows in the high flow channel are not proposed under the Settlement Agreement; however, the Settlement Agreement contains a provision to implement facility modifications to achieve water quality objectives under the existing high flow channel flow requirements after a 5-year testing period, if water quality objectives are not achieved. Because this measure would primarily affect aquatic resources (section 3.3.3) and water quality (discussed later this section), we provide additional analysis of these measures in those sections.

Flood Control and Early Warning System (Proposed Articles A130 and A131)

DWR operates Lake Oroville to maintain up to 750,000 acre-feet of storage space to capture significant inflows for flood control under the direction of the Corps. This operation provides storage space for springtime flood waters and provides for subsequent flows releases to meet minimum targets of 150,000 cfs downstream of Lake Oroville, 180,000 cfs upstream of Yuba River, 300,000 cfs downstream of Yuba River, and 320,000 cfs downstream of Bear River. The Corps has not recommended any changes to project flood control measures under this proceeding. Lake Oroville would continue to be operated in accordance with the Corps' 1970 Reservoir Regulation Manual.[48]

Under Proposed Article A130, *Flood Control*, DWR would operate the project in accordance with the rules and regulations prescribed by the Corps pursuant to section 204 of the Flood Control Act of 1958. This is consistent with the existing license requirements.

Under Proposed Article A131, *Early Warning System*, DWR would improve communication and coordination with affected agencies by developing and filing for Commission approval an early warning plan for flood events. The plan would describe how DWR would communicate and coordinate project operations with the Corps, the California Office of Emergency Services, and the Butte County Office of Emergency Services before and during flood emergency events. DWR already communicates and coordinates with these entities regarding flood events, but would formalize communication and

[48] The 1970 Reservoir Regulation Manual implements the rules and regulations that are prescribed pursuant to section 204 of the Flood Control Act of 1958. Specifically, Article 32 of the original license states that "the Licensee shall collaborate with the Department of the Army in formulating a program of operation for the project in the interest of flood control.

coordination through the early warning plan. The plan would be developed and filed with the Commission within 1 year following license issuance. DWR would consult with the Corps, the U.S. Bureau of Reclamation, the California Office of Emergency Services, and the Butte County Office of Emergency Services in developing this plan. Upon Commission approval, DWR would implement the plan, including any changes required by the Commission and the Commission would have the right to make further changes to the plan.

Section 4.10 of the Settlement Agreement acknowledges that DWR would comply with the rules and regulations prescribed by the Corps and that the Settlement Agreement Parties reserve the right to present evidence or argument relative to the effects posed by any flood control proposal raised by any intervenor or otherwise before the Commission or the Corps.

Butte County, Sutter County et al.,[49] Friends of the River, and Anglers Committee, in their letters dated April 26, 2006, April 26, 2006, October 17, 2005, and December 15, 2005, respectively, recommend that additional measures be undertaken with respect to flood control.

Butte County recommends that DWR should be directed to work with the County to address potential flood risks by providing additional security at the Oroville dam and relocate the Butte County Emergency Operations Center outside of the project flood plain in order to ensure that DWR would have an appropriate emergency action and dam safety plan in place.

Sutter County et al. recommend that DWR address the following critical flood protection and control issues as outlined in their Amended Motion to Intervene:

- Make a formal request to the Corps for the agency to immediately develop a revised operational plan for Oroville to establish flood-control management on the Feather River System that accounts for the absence of Marysville dam and full regulation of the Yuba River without the necessity for surcharge operations of or at the project above the ungated spillway.
- Investigate the adequacy and structural integrity of Oroville dam's ungated auxiliary spillway that may currently pose a risk to the project facilities and downstream levees in Sutter County in the event extreme flood releases are required, as recently experienced in flood release events of 1986 and 1997, and take all necessary actions to correct any identified deficiencies, in this regard.
- Investigate the adequacy and structural integrity of levees on the Feather River, in the context of its hydroelectric, water supply, and flood control operations and repair, replace, and maintain those levees to provide appropriate levels of flood protection, in light of project operations.

Friends of the River recommend that DWR work with the Corps and other interested parties, such as the Work Group,[50] to develop revisions to the Oroville dam reservoir regulation manual concerning surcharge, forecast, and coordinated operations.

The Anglers Committee et al. recommend that the Oroville dam emergency spillway deficiency be corrected by DWR to protect public safety in the downstream areas downstream of Oroville dam.

Plumas County, in its March 15, 2006, Motion to Intervene, recommends that a new license for the Oroville Facilities address flood planning to protect downstream communities and give consideration to the open questions and uncertainty about levee improvements and future land use decisions. As one

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[49] The Sutter County Intervenors include Sutter County, the City of Yuba City, and Levee District Number 1 of Sutter County.

[50] This refers to the Yuba Feather Work Group that is not connected to the Oroville relicensing. We note that DWR has participated in this work group and provided grant funding.

component of the flood control solution, it recommends that the licensee should continue the pilot program it initiated as part of the Plumas Watershed Forum, with the new license incorporating a program of upstream reinvestment in projects that restore natural infrastructure to attenuate flood flows.

Plumas County also recommends that DWR address the possibility of climate change impacts on water supply and flood control. Because of its relatively low elevation, the Feather River Watershed would be one of the first areas to experience a reduced snowpack and altered hydrograph as a result of rising temperatures. For that reason, according to Plumas County, the new license should provide the opportunity to review changing conditions and make operational adjustments to respond to changes in the quantity and timing of flows into Lake Oroville.

In its May 26, 2006, filing with the Commission (DWR, 2006a), DWR states its opposition to Butte county's recommendation to relocate the Butte County Emergency Operations Center. It also states that the project provides significant flood control benefits to Butte County and that many of Butte County's requests are redundant with what is already contained in the Settlement Agreement.

The State Water Contractors and the Metropolitan Water Districts of Southern California (Metropolitan) in their joint May 26, 2006, filing (SWC and Metropolitan, 2006) state that global warming could be addressed under the Commission's ongoing regulatory role, including a possible license reopener. They also recommend issues related to the emergency spillway be addressed under the Commission's Part 12 process and/or by the Corps. Similarly, they recommend that any changes in flood control operations be addressed by the Corps. They also recommend rejecting the transfer of levee maintenance costs to DWR.

Staff Analysis

DWR would continue to operate the project for the purpose of flood control as directed by the Corps. Any modification of the project's flood control operation would be the responsibility of the Corps. To the degree that modifications would potentially affect dam safety, the Commission's Division of Dam Safety and Inspections and DWR's California Division of Safety of Dams would also be involved in the review process. Reservoir regulation manuals are strictly maintained and revised by the Corps, although DWR could be consulted by the Corps. If major operational revisions to the project are required as a result of future changes in hydrology, those could be addressed through the standard license reopener article.

Article 50 of the existing license states "The operation of the project in the interest of flood control as provided in Article 32 of the license shall be in accordance with the rules and regulations to be prescribed by the Secretary of the Army pursuant to Section 204 of the Flood Control Act of 1958 (Order amending license-major, Issued January 22, 1964)." Article 32 of the existing license states "The licensee shall collaborate with the Department of the Army in formulating a program of operation for the project in the interest of flood control (Order issuing license-major, December 14, 1956)." Continuation of the flood control stipulation of articles 32 and 50 into a new license would ensure that DWR operates the project consistent with Corps mandates.

Any dam safety issues associated with the emergency spillway are properly addressed through the Commission's ongoing dam safety program, not the relicensing process.

We encourage voluntary efforts by DWR to continue the pilot program it initiated as part of the Plumas Watershed Forum. The Oroville Facilities currently contribute up to 750,000 acre-feet of storage without compensation for the purpose of attenuating flood flows. We consider that providing additional attenuation upstream of Lake Oroville and outside the project boundary represents a discretionary, rather than an obligatory, measure on the part of DWR. We reviewed the bylaws for the Plumas Watershed Forum (Plumas County, 2006) and note that DWR is included as a participant. According to the bylaws, the Plumas Watershed Forum is a locally driven program. As such, we consider that imposing a federal obligation would seem contrary to its mission.

Formalizing communication and coordination with the affected flood control agencies through an early warning plan would improve flood safety and communication during emergencies. Staff considers that Sutter and Yuba counties could also be included in this process. Because any changes to flood control operations could affect Sutter and Yuba counties, and would use USGS data, these entities should be included in the development of communication protocols.

We analyze the recommendation for relocating the Butte County Emergency Operations Center in section 3.3.10, *Socioeconomic Resources.*

Additional Gaging (Measure B103)

Under Measure B103, *Additional Gaging*, DWR would evaluate and potentially implement additional stage and/or precipitation gaging locations to improve flood forecasting and monitoring.

Butte County recommends that, within 1 year following license issuance, DWR prepare a compliance and monitoring plan for existing project and non-project gages and submit to the Commission for its approval. Butte County recommends that DWR evaluate the existing project and non-project gages located within and upstream of the project boundaries, but within the Feather River Watershed, that measure precipitation, snow, reservoir stage, and stream flow. DWR's evaluation would determine the location and type of additional telemetered gages that would be needed to improve project flood flow forecasting, monitoring, and emergency management. Additionally, Butte County recommends that DWR install all such gages within 2 years of Commission approval of the plan and that all such gages be telemetered to the California Data Exchange Center real-time network. It recommends that the plan be developed in coordination and consultation with the Corps; USGS; and Butte, Yuba, and Sutter counties.

Staff Analysis

Stream gaging and forecasting (including other weather stations such as precipitation gages and snow pack measurement sites) aid the ability to forecast flood behavior and coordinate flood response. We have reviewed the existing stream gaging at the project[51] and find that it is adequate to ensure operational compliance with existing and proposed license articles. However, we recognize the concerns about flood control and would encourage DWR's efforts to coordinate with other agencies in developing plans, including additional stream gaging, to improve forecasting in the case of severe flood events as intended in Measure B103, *Additional Gaging*. We see an advantage in linking the compliance monitoring to the flood communications and coordination plan[52] for purposes of consultation. We do not see Butte County's recommendation and Measure B103 as mutually exclusive because preparing a compliance plan for gages both within the project boundary and outside the boundary would appear to support this measure.

Water Rights

The Anglers Committee et al. in their December 15, 2005, letter recommend that DWR obtain a water right permit to divert the underflow of the Feather River in the area of the Thermalito afterbay.

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[51] The existing USGS gaging stations that provide compliance information about instream flows and ramping rates within the project boundary are Lake Oroville near Oroville, CA (11406800), Feather River at Oroville, CA (11407000), Thermalito Afterbay Release to Feather River near Oroville, CA (11406920), and Thermalito Afterbay near Oroville, CA (11406870).

[52] According to appendix D of the preliminary draft environmental assessment (see page D-8), DWR installed a siren at Oroville dam as an Interim Project to alert recreationists and others in the diversion pool area downstream of Oroville dam that spillway releases are imminent. We are not aware of any information on this system that has been filed with the Commission.

Additionally, the Anglers Committee recommends that DWR provide proof that it is only storing and diverting the amount of water authorized for Lake Oroville and other project facilities in accordance with the State of California water right permitting process. Finally, the Anglers Committee recommends that DWR submit to the Commission a report that shows the amount of water stored and diverted by the licensee at the Oroville Facilities, including the water right permits that authorized said storage and diversion.

Staff Analysis

Water rights in California are regulated under the Water Board's Division of Water Rights. The Commission does not have jurisdictional authority to resolve California's water rights issues. We summarize DWR's water rights related to the Oroville Project in section 3.3.2.1, *Affected Environment,* in *Water Quantity and Quality*

Water Quality

In general, waters in the project area meet applicable water quality standards for temperature, DO, nutrients, pH, and other pollutants in the majority of samples DWR collected. In the few instances in which Basin Plan objectives were not met, exceedances can be attributed to non-project sources (e.g., natural conditions and runoff from roads and parking areas) and are not related to project operations. However, operational changes agreed upon in the Settlement Agreement, as well as facility upgrades, such as the proposed minimum instream flows, facility modifications, Feather River Fish Hatchery temperature requirements, and monitoring plans are designed to manage the quality of project waters. Therefore, we further consider water quality issues pertaining to instream flows and temperatures, Feather River Fish Hatchery temperatures, and monitoring.

Flow/Temperature to Support Anadromous Fish (Proposed Article A108)

Low Flow Channel—Water releases from the Hyatt powerhouse flow into the Thermalito diversion pool. From here, most water is diverted to the Thermalito Complex for additional hydropower generation and a smaller quantity of water is released into the low flow channel. This comparatively lower volume of water released into the low flow channel is susceptible to warming, potentially compromising the water quality and other resources. Currently, DWR is required to release 600 cfs to the low flow channel under the existing license. Under Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*, the minimum instream flows in the low flow channel would be increased to 700 and 800 cfs, depending on the time of year (see bulleted items titled Low Flow Channel—Instream Flow in section 2.2.2, *Proposed Project Operations*), to improve the aquatic habitat and resources in these areas. Although these flow releases would primarily be provided to enhance aquatic habitat, the releases are also designed to meet certain proposed temperatures objectives in the receiving reaches. To ensure the project would consistently meet the proposed flow and temperature objectives presented in the Settlement Agreement for the low flow and high flow (if possible, as this is a second priority) channels, DWR proposes to study the feasibility of making structural modifications to the project, which, at a minimum, would include one of the following: (1) Palermo Canal improvements, (2) Hyatt intake extensions, (3) replacement of the river valves with valves specifically designed to incrementally control water releases, (4) construction of a diversion canal around or through the Thermalito afterbay, and (5) construction of an alternative Thermalito afterbay outlet and channel in the OWA to the Feather River. DWR has committed to implementing one or more facility modifications or other actions that the feasibility study suggests are most effective in terms of meeting low and high flow temperatures (shown in section 2.2.2, *Proposed Project Operations*) and cost.

Before physically modifying the facility, DWR would perform, in consultation with resource agencies, a comprehensive reconnaissance study, and prepare both a feasibility report and an implementation plan for modifying the facility to improve temperature conditions in the low flow and

high flow channels and allow DWR to meet other water resource obligations (e.g., anadromous fish needs, flood control, recreational needs, water deliveries). The study plan, feasibility report, and implementation plan as well as documentation of consultation would be filed with the Commission within 3 years of license issuance.

Plumas County, in its March 15, 2006, letter to the Commission, recommends that DWR maintain sufficient coldwater reserves within Lake Oroville to support the habitat needs of the endangered species in the Feather River. The Anglers Committee et al., in their December 12, 2005, letter filed with the Commission recommend that whenever the elevation of Lake Oroville drops below the bottom outlet shutter at Oroville dam, DWR release water from the river outlet to maintain coldwater temperatures in the Feather River downstream of the dam for the protection of anadromous fish resources. The Feather River Diverters, in their February 13, 2006, letter filed with the Commission, recommend the temperatures in the Thermalito afterbay be sufficiently warm enough (equal to or greater than 65°F during the 4-week planting season, and warmer than 59°F during the rest of the season until harvest or October 31) to ensure continued use of diverted water to irrigate rice crops in the service area.

Staff Analysis

DWR suggests several alternative facility modifications that could be implemented to supply temperature appropriate water to both the low flow and high flow channels; however, without knowing which of the facility modifications would be implemented at this time, staff can only analyze the effects that would exist under the interim and post-facility modification temperature requirements. Under the Proposed Action, the minimum flows in the low flow channel would be 100–200 cfs higher than current conditions, and the temperature objective in the low flow channel would be cooler than the existing maximum of 65°F stated in the NMFS 2002 and 2004 Biological Opinions. The periods for specific proposed temperature objectives are more refined (e.g., down to 2-week intervals) and include a not-to-exceed maximum water temperature, which is not included in the existing requirements. Although the interim temperature objectives would be considered targets and exceedances would not be violations of the license, DWR would operate the project so that temperatures would be lower than what currently exists in the low flow channel at Robinson Riffle.

During drier years, the coldwater pool in Lake Oroville could become exhausted, making it difficult to meet the temperature objectives. Allowing the temperature objectives to be considered targets that DWR would seek to attain during the interim period would provide DWR sufficient time to transition to post-facility modification operations. Although this operational flexibility would allow warmer temperatures to exist within the low flow channel, the duration of such effects would likely be temporary. Because the temperature objectives would become license requirements after facility modifications were completed or after 10 years, whichever occurs first, this potential condition would not exist beyond year 10 of any new license issued.

Until the facility modifications are completed, increased flows to the low flow channel would likely originate from the Thermalito diversion pool, which could also improve other water quality conditions in the Feather River. Increased flows to the low flow channel could flush out the decomposing salmon carcasses present at the end of the spawning season which could have been responsible for the reported low DO concentration (see 3.3.2.1, *Affected Environment* in *Water Quantity and Quality*). Increased flows would also provide more water to mix with the fish hatchery effluent. As such, implementation of the proposed temperature objectives and slightly higher flow regime would result in cooler temperatures in the low flow channel as measured at Robinson Riffle than those that exist under current conditions. The biological effects of the proposed temperature regime are discussed in greater detail in section 3.3.3.2, *Effects on Aquatic Resources*.

Although the proposed minimum instream flows for the high flow channel are the same as under current operations, DWR proposes to meet certain temperature objectives (see low flow and high flow

channels table in section 2.2.2, *Proposed Project Operations*). Establishing and achieving these temperature targets downstream of the project would increase the amount and extent of cool water in the Feather River to support anadromous fish resources beyond existing conditions.

Temperatures of project waters are also of interest to the irrigators and rice farmers who receive their water from the Thermalito afterbay. Water in the Thermalito afterbay can be used for pump-back operations, releases to the Feather River, and/or releases to the Feather River service area. Under the Proposed Action, DWR would increase flow in the low flow channel to accommodate aquatic resource requirements. It is difficult to project the effects of the Proposed Action in terms of the temperature of the water delivered to irrigators and rice farmers due to the absence of operational and temperature modeling, the dynamic nature of pump-back operations and the impending facility modifications. Even if less water would need to be released from the Thermalito afterbay to meet temperature objectives in the high flow channel and other operational aspects of the projects were not drastically changed, water temperature in the Thermalito afterbay would likely be very similar to what currently exists. Overall, we expect temperatures of water delivered to the agricultural diversion under the Proposed Action to be similar to current conditions. It is likely that any positive effects would be most pronounced during drought years when DWR's ability to make releases above the minimum flows would be compromised, allowing for additional warming.

Under the Proposed Action, increased minimum flows in the low flow channel would result in about 17 percent more water in the low flow channel from April 1 to September 9 (the growing season), resulting in a corresponding reduction in water needed to meet the minimum instream flows in the high flow channel (assuming temperature requirements are being met) since that water would already be in the river. Because the volume of the power canal is so large relative to the amount of additional water proposed to be released to the low flow channel, this would result in less than 1 percent change in the volume reaching the Thermalito afterbay. As such, if DWR does not select a facility modification involving the Thermalito Complex, the irrigators could expect water temperatures at least similar to existing conditions. Changes in temperatures of the water delivered would depend on climatic factors (e.g., air temperatures, water year types, etc.) that would affect how DWR operates to meet minimum flow requirements; however, staff expects that overall, any changes in temperature would be modest. The effects of the Proposed Action on the irrigators and subsequently county tax revenues are discussed in section 3.3.9.2, *Effects on Socioeconomic Resources*.

Feather River Fish Hatchery—DFG currently operates the Feather River Fish Hatchery in conjunction with DWR to meet anadromous salmonid production goals under the existing license. Sufficiently cool water temperatures throughout the hatchery complex are required for successful fish rearing at the hatchery. Under Proposed Article A108, *Flow/Temperature to Support Anadromous Fish,* DWR would continue working with and operating the fish hatchery with DFG and develop a comprehensive management plan to set forth certain temperature goals and other items. DWR proposes interim and post-facility modification temperature objectives for the Feather River Fish Hatchery as measured hourly at the intake/aeration tower at the fish barrier dam. The proposed temperature objectives for both the interim and post-facility modifications are presented in section 2.1.2.4, *Minimum Instream Flows*, and 2.2.2, *Proposed Project Operations*.

During the interim period, DWR would attempt to meet the temperature objectives at the fish hatchery through either (or in combination) releases from the river outlet at the base of Oroville dam, eliminating pump-back operations, or removing stoplogs at the Hyatt intake structure. Upon completion of the facility modifications, DWR reserves the right to develop new hatchery temperature requirements that would be at least as protective as the pre-facility modification temperature objectives described in section 2.2.2. New temperature objectives would be developed in consultation with FWS, NMFS, DFG, the Water Board, and the Regional Board and filed with the Commission.

Staff Analysis

The proposed (interim) temperature objectives for the fish hatchery during the pre-facility modification period would be similar to existing conditions. Because they would be set at or below the maximum temperature objectives in the current agreement with DFG, staff expects DWR to use the river outlet to meet the temperature objectives at the fish hatchery until at least the facility modifications are completed. However, coldwater reserves within Lake Oroville could be diminished at low lake elevations and the river outlet may not be able to supply enough cold water to the fish hatchery to meet the temperature targets under all circumstances. DWR's proposal to allow exceedances of the temperature objectives prior to completing facility modifications would allow DWR to pass warmer water to the fish hatchery without violating a condition of the license. Even if DWR makes every attempt to meet the temperature objectives using releases from the river outlet or by curtailing pump-back operations, the potential to exceed the objectives exists, which could also affect water temperatures in the Feather River downstream of the fish hatchery. Exceedances of the interim targets have the highest probability to occur during drought years, when the coldwater pool within Lake Oroville is diminished.

Once facility modifications are completed, the maximum temperature objectives would be the same as those listed in the existing 1983 agreement between DWR and DFG.

Releases from the river outlet originate in Lake Oroville between the depths of about 350 feet and 90 feet, at normal full and normal minimum pools, respectively. Water passed from the river outlet would exhibit similar characteristics as deep water in the reservoir which, during the summer when the reservoir is stratified, is low in DO. If the river outlet were used as a source to provide coldwater increases under extreme conditions, water with low concentrations of DO from the bottom of the reservoir could pass to the Thermalito diversion pool. An aeration device at the fish hatchery intakes would prevent DO-deficient water from entering the facility, and water passing over the fish barrier dam would become aerated through natural mixing. DWR reports that, since project development, there have been no DO-related issues recorded at the Fish Hatchery.

The quality of water within the Thermalito diversion pool could also influence water quality in the low flow channel. However, it is unlikely that water with low DO concentrations would enter the low flow channel because the proportion of water entering the Thermalito diversion pool from the river outlet is quite small compared to the overall volume of the impoundment. Depending on the generation mode, water in the Thermalito diversion pool consists of a combination of waters from Lake Oroville from the depth of the intake shutters; the river outlet; the Kelly Ridge powerhouse; and during pump-back operations, from the Thermalito Complex. As such, the Thermalito diversion pool is usually well mixed, diminishing the risk of passing low DO water from the river outlet to the low flow channel.

Fish Weir Program (Proposed Article A105)

Under Proposed Article A105, *Fish Weir Program*, DWR would install one or potentially two fish weirs near the Thermalito afterbay. This measure is described in detail in section 3.3.5.2, *Threatened and Endangered Species*.

Staff Analysis

While the purpose of the proposed fish weirs is related to management of salmonid fishery stocks, construction of these weirs could affect water quality. We conclude that implementation of best management practices during construction would minimize potential effects on water quality.

Comprehensive Water Quality Monitoring Program (Proposed Article A112)

Although the overall water quality of the project is meeting the Basin Plan objectives, the numerous facility developments outlined in the Proposed Action and extensive recreational use at the

project have the potential to negatively affect the water quality throughout the term of a new license. Pathogen monitoring studies performed by DWR in 2003 and 2004 indicated that bacteria levels in project waters exceeded Basin Plan objectives at public recreational sites, requiring occasional public postings or beach closures.

Under Proposed Article A112, *Comprehensive Water Quality Monitoring Plan*, DWR would design and implement a comprehensive water quality monitoring plan. The objective of the plan would be to track potential changes in water quality associated with the project and collect data necessary to develop a water quality trend assessment through the life of the new license. The sampling plan would include components to sample water chemistry, fish tissue, petroleum product concentrations, water temperatures, bioassays, and aquatic macroinvertebrate monitoring. Interior's and DFG's 10(j) recommendation no. 9 are consistent with this proposed article. Fish tissue sampling and consumption advisories are discussed in greater detail in subsequent sections.

To address the high pathogen monitoring results, DWR proposes to monitor fecal coliform, enterococcus bacteria, and/or other bacterial indicators between June 1 and September 30 at developed and popular undeveloped swim areas within the project boundary at the North forebay recreation area, South forebay recreation area, Loafer Creek recreation area, Monument Hill recreation area, Lime Saddle recreation area, Foreman Creek boat launch, Stringtown boat launch, and One Mile Pond as shown in figure 17. Monitoring would be performed in a manner consistent with the Basin Plan criteria. If indicator bacteria levels exceed the Basin Plan standards, DWR would notify the appropriate public agencies and take measures to educate the public about bacteria levels in project waters and post beach closures as appropriate.

The comprehensive water quality monitoring plan would be developed in consultation with the Ecological Committee, including specifically FWS, NMFS, DFG, the Water Board, Regional Board, and Butte County Health Department. DWR would file summary reports of its findings in each of the first 5 years of the initial program with the Ecological Committee and a summary report to the Commission. DWR would develop a final comprehensive water quality monitoring plan based on the results of the first 5 years of sampling and consultation with interested parties. Pathogen monitoring would be performed in consultation with the Butte County Health Department, DHS, DPR, the Water Board, the Regional Board, and any other appropriate public agency.

Butte County, in its letter to the Commission dated April 24, 2006, states that DWR's proposal to post human-health warnings and close recreational areas would be an inadequate way to protect human health. Instead, it recommends that DWR work with Butte County Health Department, the Water Board, and the Regional Board to develop mitigation options that would improve the water quality specifically at the North forebay swim area and cove. Butte County recommends exploring improvements to water circulation within the forebay, channel improvement to deliver more water into certain areas increasing circulation near the public swim areas, or another method. The Anglers Committee et al., in its December 12, 2005, letter to the Commission suggest that children swimming at Bedrock Park are at risk of high bacterial counts due to project operations.

In its comments on the draft EIS, the Water Board states that alternatives that avoid or reduce the effect of poor water quality at the project swim areas, due to high levels of pathogens, should be developed and included in the final EIS. Butte County makes a similar suggestion in its comments on the draft EIS, stating that the Commission should require DWR to substantively address every water quality problem that poses a threat to public health and safety.

Staff Analysis

Currently, DWR regularly monitors water quality for a few constituents throughout the project. Developing a comprehensive water quality monitoring program that includes additional types and numbers of water quality parameters and increases the sampling frequency would develop a thorough

record, which would be more valuable than the existing sampling program. The proposed comprehensive monitoring program would allow the DWR to assess water quality from upstream areas, within project waters, and outflow downstream of the project boundary. Collecting enough data to develop a water quality trend assessment throughout the term of any new license issued would establish a large, detailed water quality record providing DWR and the Ecological Committee with data sufficient for adaptive management of the various resources.

DWR's proposal to monitor the water quality is prudent and appropriate because the Proposed Action would include developing new facilities and modifying existing facilities, structures, flow, temperature regimes, and river channels. Installing permanent temperature monitoring devices at the fish hatchery, Robinson Riffle, Thermalito afterbay outlet, and southern project boundary as well as providing real-time flow information would improve DWR's ability to protect the resources within the project. Regular reporting to the Ecological Committee and Commission would allow for adaptive measures to be developed if proposed operations threaten to fail the proposed temperature requirements and the Basin Plan objectives.

A permanent pathogen monitoring program would address the high bacterial counts recorded in DWR's relicensing studies and protect public health. The North forebay swim area is one of the most popular swim areas within the Thermalito Complex because of its easy access and proximity to Oroville. Monitoring results for the swim area had the greatest number of exceedances and the highest levels of bacteria out of the popular recreational areas. Because the swim beach is in a small bay with a very narrow opening to the main North forebay, the exchange of water between the two waterbodies is severely limited. The configuration makes for a swim area protected from the river current, which appeals to families with children, but it also provides suitable conditions for bacteria to thrive. Developing and implementing a pathogen monitoring plan would be an appropriate first step in understanding risks to public health because such a plan would require that exceedances currently occurring at specific recreational sites be monitored. A regular monitoring plan with monthly reporting would provide the public with important information to assist in making recreation-based decisions. If unsafe bacteria levels are recorded, public notices posted by DWR would alert the public to the potential hazard and trigger consultation with relevant public health agencies to determine if a companion public education program to inform the public about potential bacteria sources in the water would be necessary.

Multiple closures of the beach throughout the recreational season could severely limit swimming opportunities within the North forebay. If monitoring results in multiple closures of the swim area and consultation with the appropriate agencies then investigating and implementing improvements would reduce or possibly eliminate beach closures.

Public education and deterring waterfowl presence at the swim area could reduce bacteria loading. Public education efforts should start immediately as the proposed monitoring program could evaluate whether educational efforts improve water quality conditions.

The swim area at Bedrock Park,[53] specifically constructed for that purpose, is protected from the main channel by an extension of the shoreline that extends from the south shore upstream from Bedrock Park into the river, turns and runs parallel with the river blocking off the main channel from the shoreline. DWR monitoring results from 2002 show fecal coliform counts were high on Labor Day weekend in the swim area (332 colonies per 100 mL), which is just below the DHS single sample criteria. However, samples collected directly upstream of the swim area exhibited bacterial levels below 10 colonies per 100 mL during the same period. The configuration of the swim area and its isolation from the main channel create an environment supportive of high bacterial counts (i.e., stagnant, warmer water used for swimming), rather than operation of the project as suggested by the Anglers Committee et al.

[53] Bedrock Park is part of the Feather River Recreation & Parks District and is located on the south side of the Feather River in Oroville between 4th and 5th streets outside the project boundary.

Public Education Regarding Fish Contamination (Proposed Article 114)

Land disturbances within the watershed upstream of the project (e.g., natural resource extraction practices, residential development) have released metals and other contaminants into the waters, and these contaminants make their way into the project area and subsequently into the food chain. One waterbody upstream of Oroville dam is listed as impaired under Section 303(d) of the Clean Water Act. The North Fork Feather River below Lake Almanor is listed for temperature and mercury. The Feather River downstream of Oroville dam to its confluence with the Sacramento River is listed on the 303(d) list of waters as impaired by sources of mercury, certain pesticides, and unknown toxicity. A TMDL has been established for the pesticide Diazinon for the Feather River below Oroville dam to the confluence with the Sacramento River. Sport anglers who harvest their catch from project waters are susceptible to exposure to potentially harmful toxins by eating fish with elevated concentrations of contaminants. Under Proposed Article A114, *Public Education Regarding Fish Contamination*, DWR proposes a public education campaign to post notices at all boat ramps and any other locations specified by OEHHA about health issues associated with consuming fish taken from project waters. The reporting would be developed in consultation with OEHHA, the Water Board, Regional Board, and Butte County Health Department. Compliance reports would be filed annually with the Commission.

Staff Analysis

Results from the DWR fish tissue sampling study performed during the relicensing studies indicate that metal concentrations in tissue samples are occasionally elevated as compared to recommended guidelines from various regulatory agencies. Proposed fish tissue sampling performed under the comprehensive water quality monitoring program would supply the data necessary to initiate posting advisory notices related to fish consumption. Further monitoring, agency consultation and the postings would alert the public to the hazards associated with the consumption of fish caught from project waters. Educating the public would serve to minimize the consumption of fish with high levels of contaminants. DWR's proposed long-term monitoring program would help determine if contaminant concentrations in fish tissue change over time and would determine the need for future public fish consumption advisories.

3.3.2.3 Cumulative Effects

Water Quantity

Since construction of the Oroville Facilities and other FERC-licensed projects upstream of the Oroville Facilities, project operations have affected water quantity throughout much of the Feather River Basin. No dedicated flood control exists in the upper basin. However, typically hydroelectric projects will refill during the spring runoff period and may provide incidental flood control. The Integrated Regional Water Management Plan (Ecosystem Sciences Foundation, 2005) does include flood control as one of seven strategy elements and this may eventually result in improved flood flow management in the Upper Feather River Watershed.

The Proposed Action would slightly increase flows in the low flow channel; however, such changes would not be expected to produce a major shift in flows downstream of the Oroville Facilities. Under all the alternatives, we would expect average annual Feather River service area deliveries under existing conditions and year 2020 conditions[54] to remain 994,000 acre-feet, and average annual South Delta deliveries to increase from the existing 3,051,000 acre-feet to 3,247,000 acre-feet in year 2020. Although the annual flows in the Feather River downstream of Thermalito afterbay would remain similar over time, there is a seasonal change in flow distribution with higher flows occurring from May through

[54] DWR bases its water use projections presented in its application using the year 2020.

August and lower flows occurring from September through April under year 2020 conditions as compared to existing conditions.

We view Feather River flood control activities as cumulative effects because flood control at the Oroville Facilities is the responsibility of the Corps. The Corps is currently involved in several studies and reports that were summarized in *SP-E4: Flood Management Study* and appended to the final license application. We summarize briefly the conclusions and status of several of these flood related items.

The Feather River Floodplain and Water Surface Profiles report presents, for the Feather River from Oroville Dam to the mouth of the Yuba River, maps of floodplains for the floods with 1 percent and 0.2 percent probability of exceedance, floodway boundaries for the flood with 1 percent probability of exceedance, and water surface profiles for the floods with 10 percent, 2 percent, 1 percent, and 0.2 percent probability of exceedance. It also includes various input parameters and was performed to FEMA specifications to support federal flood insurance purposes.

The Yuba Feather Supplementary Flood Control Project began in 1997. Its goal is to define and implement as soon as possible a cost-effective, practicable program of measures to achieve a reliable level of protection against floods from the Feather and Yuba Rivers. Five measures for probable implementation include a storage increase at New Bullards Bar Reservoir, enlargement of outlets at New Bullards Bar Reservoir, tailwater depression at New Colgate Power Plant, forecast-based operations at New Bullards Bar Reservoir and Lake Oroville, and levee setback on the Feather River. In the opinion of Yuba County Water Authority, these measures collectively fall short of meeting the stated goal, therefore, YCWA is considering additional projects in the future.

The Yuba River Basin Project Feasibility Report and Final EIS and EIR were completed in April 1998. Congress authorized the project in the Water Resources Development Act of 1999, and the Record of Decision was signed in June 2000. The authorized project included specific levee modifications on 6.1 miles of the left bank of the Yuba River upstream of the confluence with the Feather River; 10 miles of levee on the left bank of the Feather River downstream of the confluence of the Yuba River; and 5 miles of the Marysville ring levee. The levee modification work as authorized was intended to bring the level of protection for these levees up to about a 200-year level of protection. On March 17, 2004, a notice of Intent to Prepare a Draft Supplemental EIS and EIR for the Yuba River Basin Project was posted in the Federal Register, with the Corps as the lead federal agency. A Supplemental Draft EIS, an EIR, was noticed on January 19, 2006, in the Federal Register. The proposed action would be a general reevaluation of the authorized project and other alternative plans to provide the level of flood protection previously planned and to restore riparian and aquatic habitats in the project area.

Another Corps regional study with an interim report was issued in December 2002 and was focused on the Sacramento and San Joaquin river basins. The goal of the *Sacramento and San Joaquin River Basins Comprehensive Study* is to develop an approach for projects on those rivers and their major tributaries that will solve flooding and ecosystem problems more effectively than present methods do.

A third major regional Corps study involves Sutter County. The notice of Intent to Prepare a Joint EIS and EIR for the Sutter County Feasibility Study, Sutter County, CA was published in the Federal Register on September 12, 2001. The objective of the Sutter County Feasibility Study is to present the purpose and status of alternatives to reduce future flood damages on the Sacramento River, the Feather River, the Sutter Bypass, and other watercourses in Sutter County. The study focuses on the integrity of the facilities of the Sacramento River Flood Control Project, particularly at those locations where flooding problems have been most likely to occur. The Sutter County Feasibility Study will also investigate opportunities to integrate ecosystem restoration measures and will produce an environmental document." The Corps, Reclamation Board, and Sutter County are all participants in the study. Some of the alternatives under consideration in this study include (1) enlarging existing levees along the Feather and Sacramento Rivers, and the Natomas Cross Canal; (2) realigning levees along the Feather, Bear, and Sacramento Rivers; (3) constructing a ring levee to the east of Yuba City; (4) constructing a channel or

levee intercepting flows above Yuba City; (5) reoperating Feather and Yuba River upstream reservoirs; (6) adopting a local flood plain management plan; (7) removing sediment from the Sutter Bypass, Feather and Sacramento River, and canal systems; (8) reoperating state pumps and drain lines; (9) improving levees along the Sutter Bypass; and (10) modifying the Tisdale Bypass to convey higher flows sooner.

Water Quality

None.

3.3.2.4 Unavoidable Adverse Effects

Water Quantity

None.

Water Quality

Extractive land use practices in the watershed upstream of Lake Oroville are expected to continue throughout the term of a license, and could continue to release metals into the Feather River and Lake Oroville. Many of the metals are associated with sediments, and staff expects sediment metals to increase over the term of a license because the dam traps much of the settleable material within Lake Oroville. DWR would sample fish tissue, as proposed under the comprehensive water quality monitoring plan, to detect any threats to sport anglers who ingest contaminated fish. This practice would trigger fish consumption advisories. Long-term monitoring would also allow DWR to assess how metal concentrations change over the term of a license.

3.3.3 Aquatic Resources

3.3.3.1 Affected Environment

Aquatic environments associated with the Oroville Facilities include the upper Feather River tributaries, Lake Oroville, the Thermalito diversion pool, Thermalito forebay, Thermalito afterbay, the fish barrier pool, the Feather River Fish Hatchery, OWA ponds, and the Feather River. Lake Oroville and its tributaries, together with the Thermalito Complex, support warmwater and coldwater recreational fisheries.

Fish species of primary management concern found in the project area include the following:

- Species listed as threatened under the California Endangered Species Act or federal Endangered Species Act (ESA): Spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss*), and green sturgeon (*Acipenser medirostris*);
- State species of special concern: Fall-run Chinook salmon, Sacramento splittail (*Pogonichthys macrolepidotus*), river lamprey (*Lampetra ayresi*), and hardhead (*Mylopharodon conocephalus*); and
- Species that are recreationally or commercially important: Fall-run Chinook salmon, Central Valley steelhead, American shad (*Alosa sapidissima*), coho salmon (*O. kisutch*), striped bass (*Morone saxatilis*), and four species of black bass.

Table 26 summarizes the overall fish species composition within the project study area, identifies species of primary management concern related to the Oroville Facilities, indicates whether each species is native or introduced, identifies the general geographic distribution of the species by water body, and summarizes both the regulatory and abundance/management status of each species within the project study area.

Table 26. List of fish species within the study area. (Source: DWR, 2005a, 2001b)

Common Name ***Scientific Name***	**Regulatory Status**[a]	**Primary Management Concern Species**[b]	**California Native or Introduced**	**Location Within Study Area**[c]	**Abundance/Mgmt Status**[d]
Pacific lamprey *Lampetra tridentata*	FSC	No	Native	LFR	DFG watch list
River lamprey *Lampetra ayresi*	CSC FSC	Yes	Native	LFR	DFG watch list
Green sturgeon *Acipenser medirostris*	CSC FT	Yes	Native	LFR	Special concern
White sturgeon *Acipenser transmontanus*	--	No	Native	LO, LFR	Stable or increasing
American shad *Alosa sapidissima*	--	Yes	Introduced	LFR	Widespread and stable
Threadfin shad *Dorosoma petenense*	--	No	Introduced	LO, TA, LFR	Infrequently observed
Common carp *Cyprinus carpio*	--	No	Introduced	UT, LO, TF, DP, TA, LFR, OWA	Widespread and expanding
Golden shiner *Notemigonus crysoleucas*	--	No	Introduced	LO, DP, TF, TA, OWA	Widespread and expanding
Hardhead *Mylopharodon conocephalus*	CSC	Yes	Native	LO, TF, DP, TA, LFR	DFG watch list
Hitch *Lavinia exilicauda*	--	No	Native	TA, LFR	DFG watch list
Sacramento pikeminnow *Ptychocheilus grandis*	--	No	Native	UT, LO, TF, DP, TA, LFR	Stable or increasing
Sacramento splittail *Pogonichthys macrolepidotus*	CSC[f] FSC	Yes	Native	LFR	Special Concern
Sacramento blackfish *Orthodon microlepidotus*	--	No	Native	OWA	Stable or increasing
Goldfish *Carassius auratus*	--	No	Introduced	LO	Widespread and stable

Common Name *Scientific Name*	**Regulatory Status**[a]	**Primary Management Concern Species**[b]	**California Native or Introduced**	**Location Within Study Area**[c]	**Abundance/Mgmt Status**[d]
Sacramento sucker *Catastomus occidentalis*	--	No	Native	UT, LO, TF, DP, TA, LFR, OWA	Stable or increasing
Black bullhead *Ameiurus melas*	--	No	Introduced	LFR	Widespread and stable
Brown bullhead *Ameiurus nebulosus*	--	No	Introduced	LFR, OWA	Widespread and stable
White catfish *Ameiurus catus*	--	No	Introduced	LO, LFR, OWA	Widespread and stable
Channel catfish *Ictalurus punctatus*	--	No	Introduced	LO, LFR, OWA	Widespread and stable
Wakasagi *Hypomesus nipponensis*	--	No	Introduced	LO, TF, DP, TA, LFR	Widespread and expanding
Fall-run Chinook salmon *Oncorhynchus tshawytscha*	CSC, FSC[g]	Yes	Native	FRFH, LFR	DFG watch list
Spring-run Chinook salmon *Oncorhynchus tshawytscha*	ST FT	Yes	Native	FRFH, LFR	Threatened or endangered
Coho salmon *Oncorhynchus kisutch*	CSC FT[h]	No	Native	LO	Threatened or endangered
Central Valley steelhead *Oncorhynchus mykiss*	FT	Yes	Native	FRFH, LFR	Threatened or endangered
Rainbow trout *Oncorhynchus mykiss*	--	Yes	Native	UT, LO, TF, DP, TA, LFR	Widespread and stable
Brown trout *Salmo trutta*	--	Yes	Introduced	UT, LO, LFR	Widespread and stable
Brook trout *Salvelinus fontinalis*	--	Yes	Introduced	TF, DP, TA, LFR	Widespread and stable
Lake trout *Salvelinus namaycush*	--	No	Introduced	LO	Localized
Western mosquitofish *Gambusia affinis*	--	No	Introduced	OWA	Widespread and expanding

Common Name ***Scientific Name***	**Regulatory Status**[a]	**Primary Management Concern Species**[b]	**California Native or Introduced**	**Location Within Study Area**[c]	**Abundance/Mgmt Status**[d]
Threespine stickleback *Gasterosteus aculeatus*	--	No	Native	LO	Stable or increasing
Prickly sculpin *Cottus asper*	--	No	Native	UT, LO, TF, DP, TA, LFR, OWA	Stable or increasing
Riffle sculpin *Cottus gulosus*	--	No	Native	UT, LO, TA, LFR, OWA	DFG watch list
Striped bass *Morone saxatilis*	--	Yes	Introduced	LFR	Widespread and stable
Bluegill *Lepomis macrochirus*	--	No	Introduced	LO, TF, DP, TA, LFR, OWA	Widespread and stable
Green sunfish *Lepomis cyanellus*	--	No	Introduced	LO, LFR, OWA	Widespread and stable or expanding
Redear sunfish *Lepomis microlophus*	--	No	Introduced	LO, LFR, OWA	Widespread and stable
Warmouth *Lepomis gulosus*	--	No	Introduced	LO, OWA	Localized
Black crappie *Pomoxis nigromaculatus*	--	No	Introduced	LO, DP, TA, OWA, LFR	Widespread and stable
White crappie *Pomoxis annularis*	--	No	Introduced	LO, TA, OWA, LFR	Widespread and stable
Largemouth bass *Micropterus salmoides*	--	Yes	Introduced	LO, TF, DP, TA, LFR, OWA	Widespread and stable
Smallmouth bass *Micropterus dolomieu*	--	Yes	Introduced	LO, DP, TA, LFR	Widespread and stable
Redeye bass *Micropterus coosae*	--	Yes	Introduced	LO, LFR	Localized
Spotted bass *Micropterus punctulatus*	--	Yes	Introduced	LO, TA, LFR	Widespread and expanding
Tule perch *Hysterocarpus traski*	--	No	Native	DP, TF, TA, LFR	Stable or increasing

[a] FT – listed as threatened under ESA; ST – listed as threatened under the California Endangered Species Act; FE – federally listed as endangered; FC – candidate for listing under ESA; FSC – federal species of concern; CSC – California species of special concern.

[b] Species of primary management concern evaluated in this analysis include those that are recreationally or commercially important, state- and/or federally listed species within the project study area under the ESA or California Endangered Species Act, candidate species for listing under ESA or the California Endangered Species Act, and California species of special concern.

[c] Frequently or infrequently observed in the following: UT – upstream tributaries; LO – Lake Oroville; DP – Thermalito diversion pool; TF – Thermalito forebay; TA – Thermalito afterbay; FRFH – Feather River Fish Hatchery; OWA – Oroville Wildlife Area ponds; LFR – Lower Feather River.

[d] As defined in Moyle (2002).

[e] However, on April 6, 2005, after reviewing new and updated information about the status of green sturgeon and considering whether green sturgeon is in danger of extinction now or in the foreseeable future throughout all or a significant portion of its range, NMFS published a proposed Federal Register Rule (70 FR 17386 to list the Southern Distinct Population Segment of green sturgeon as threatened under the ESA), but reaffirmed its earlier finding that the Northern Distinct Population Segment does not warrant listing under the ESA at this time. They did, however, recommended that it remain on NMFS Species of Concern List (69 FR 19975) due to remaining uncertainties about its status and threats.

[f] FWS removed the Sacramento splittail from the list of threatened species on September 22, 2003, and did not identify it as a candidate for listing under ESA. Sacramento splittail is identified as a California species of special concern and, informally, as a federal species of concern.

[g] Although late-fall-run Chinook salmon does not occur within the project study area, the Central Valley fall-run/late-fall-run Chinook salmon is identified as one evolutionarily significant unit (ESU). In 1999, the Central Valley ESU underwent a status review after NMFS received a petition for listing. Pursuant to that review, NMFS found that the species did not warrant listing as threatened or endangered under ESA, but sufficient concerns remained to justify addition to the candidate species list. On April 15, 2004, NMFS published a notice in the Federal Register acknowledging establishment of a species of concern list, addition of species to the species of concern list, and revision of the candidate species list. In this notice, NMFS announced the Central Valley Fall-run and Late Fall-run Chinook Salmon ESU change in status from a candidate species to a species of concern. Therefore, according to NMFS' April 15, 2004, interpretation of ESA provisions, the Central Valley ESU now qualifies as a species of concern, rather than a candidate species (69 FR 19977).

[h] These special-status species designations pertain only to coho salmon within their native habitats. Coho salmon occur within the project study area because of stocking programs and are managed for their recreational importance only.

Description of Project Area Waters

Tributaries to Lake Oroville

Lake Oroville has four main tributaries: the North Fork, West Branch, Middle Fork, and South Fork (see figure 2). The Middle Fork is designated as a National Wild and Scenic River and a Heritage Trout Water, and it is designated by DFG as a Wild Trout River through the Trout and Steelhead Conservation and Management Planning Act of 1979. Trout management in the Middle Fork includes rainbow trout and brown trout.

Habitat in the tributary reaches upstream of Lake Oroville is mountain trout stream habitat and has the potential to support salmonid spawning and rearing. Generally, DFG manages the tributaries upstream of Lake Oroville for coldwater fish species. The Oroville Facilities and operations do not affect flow and water temperature in the tributaries upstream of Lake Oroville.

The Oroville Facilities and operations prevent fish passage upstream of the fish barrier dam. Fish species in the tributaries upstream of Lake Oroville and downstream of the first impassable fish barrier on those tributaries include rainbow trout and brown trout, bluegill, brown bullhead, carp, largemouth bass, redeye bass, roach, smallmouth bass, spotted bass, Sacramento pikeminnow, Sacramento sucker, roach, and sculpin. Of the game fish observed, only rainbow trout are considered native to the drainage. PG&E confirmed the presence of hardhead, largemouth bass, and brown bullhead in the North Fork during surveys conducted prior to 2002. Of these three species, only hardhead are native to California.

Fish species of primary management concern observed in upstream tributaries were not unique to the tributaries; all have been previously observed in Lake Oroville or downstream reaches of the Feather River (DWR, 2005a, appendix G). Historical records indicate that Chinook salmon were present in all four major branches of the Feather River upstream of the present location of Oroville dam, but their specific distribution and abundance among the smaller tributaries are largely unknown. Spring-run Chinook salmon usually spawned in higher streams and headwaters than fall-run Chinook salmon, which prefer lower regions of tributaries and mainstem river areas for spawning. Early documentation of historical salmon abundance rarely mentions steelhead distribution or abundance in the Feather River Basin. Because steelhead have similar spawning habitat preferences as spring-run Chinook salmon, they are believed to have occupied the same areas as the spring-run Chinook (DWR, 2003a).

Lake Oroville reservoir operations influence the accessibility of the upstream tributaries to fish species within Lake Oroville through the stage elevation of the reservoir. Although currently unavailable to anadromous species due to downstream barriers to migration, the four major tributaries generally provide suitable habitat for all life stages of Chinook salmon and steelhead. The fish barrier dam was constructed during the early 1960s as part of the Oroville Facilities. Located upstream of the Feather River Hatchery and 5 miles below Oroville dam, the fish barrier dam is identified as the first impassible salmonid migration barrier on the Feather River (DWR and USBR, 2000; Yoshiyama et al., 1998).

Historically, the upper Feather River watershed provided habitats for anadromous and resident salmonids. Spring-run Chinook salmon and steelhead were reported to ascend the very highest, accessible streams and headwaters of the Feather River Watershed, while fall-run Chinook salmon occupied the lower foothill reaches (DWR and USBR, 2000; Yoshiyama et al., 1998). Prior to the construction of Oroville dam, the upstream extent of fish passage was limited by natural fish barriers and previously constructed hydroelectric projects. PG&E maintained a seasonal flashboard dam downstream of the current Highway 162 bridge until the Oroville Facilities were constructed. Hydropower development was preceded by aggressive mining techniques in the 1800s that included complete diversion of the North Fork Feather River through a pipeline that blocked river access for migratory fishes, so that the miners could access the riverbed.

Currently, the first impassable fish barriers in the upstream tributaries are identified as the falls downstream of Big Kimshew Creek for the West Branch, Curtain Falls for the Middle Fork, and Ponderosa dam for the South Fork. Big Bend dam on the North Fork may be passable during some high reservoir elevations; if so, the next upstream barrier would be Poe dam (figure 9 shows these fish barriers). Figure 15 (from DWR, 2004) shows the historical extent of anadromous salmonid spawning habitat in the upper Feather River watershed above the Oroville Facilities as defined by Yoshiyama et al. (1998) and the current habitat potential upstream of the fish barrier dam. Figure 15 also shows the current geographic scope for cumulative effects analysis.

Thalweg bathymetric surveys indicate substantial deposits of sediment in the middle-upper portions of all four major tributary arms (DWR, 2004k, appendix c). These deposits are located straddling the boundary between the fluctuation zone (those reservoir elevations from 640 feet to 900 feet msl) and the reservoir storage zone (below 640 feet[55]). Hence, channel reaches above the 900-foot elevation are never inundated by the lake and are always subject to fluvial conditions; those channel reaches below the full pool level (i.e., within the fluctuation zone) experience repeated inundations and alternate from fluvial to lentic (i.e., still water) conditions.

Updates from the *Interim Report to the Final Report for SP F3.1: Task 1A* include an evaluation of the Lake Oroville sediment wedges as potential fish passage barriers. Results indicate that during some years, anadromous salmonid passage could be impeded by the sediment wedges in each of the four major tributaries to Lake Oroville (DWR, 2004q). The sediment wedges are shown in figure 9.

Elevations of the upstream ends of the sediment wedges ranged from 700 to 720 feet at the time of the bathymetric survey (June 2003). Elevations of the downstream ends ranged from 530 feet (North Fork arm) to 630 feet (South Fork arm). All four sediment wedges had a long, nearly level upper portion that ranged from about 4,300 feet (South Fork arm) to 11,200 feet (North Fork arm) in length (see figure 9). All sediment wedge profiles displayed a series of slope breaks downstream of the upper nearly level portion.

Although the greater bulk of sediment currently resides below the 720-foot elevation, some minor sediment features (lag deposits) still reside above 720 feet along the tributary channels within the fluctuation zone. Lateral gravel and sand deposits along the edges of the exposed river channel were observed in the West Branch, Middle Fork, and South Fork arms. These deposits are remnant portions of the sediment wedge material and are generally located in the wider portions of the former river channel where stream energy tended to erode only the center portion of the channel. The sediment characteristics are similar to materials in the sediment wedge but have a greater amount of cobble-sized material.

Channel morphology and movement of sediment wedge material within the exposed fluctuation zone vary according to several key criteria, including reservoir water level elevation, the rate of decline or increase of that water level elevation; sediment wedge elevation; tributary discharge quantity; and the incoming sediment volume. Because of this, channel morphology in one location can range markedly over time. For example, a channel at a specific site can go from a braided, sand-bedded channel to a relatively steep, cobble-dominated plane-bed channel several weeks later when reservoir levels are declining.

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[55] The reservoir storage zone has been inundated ever since the initial filling of Lake Oroville in 1967. The lowest lake levels that have been attained to date were 645.11 feet on September 7, 1977, and 651.48 feet on January 30, 1991.

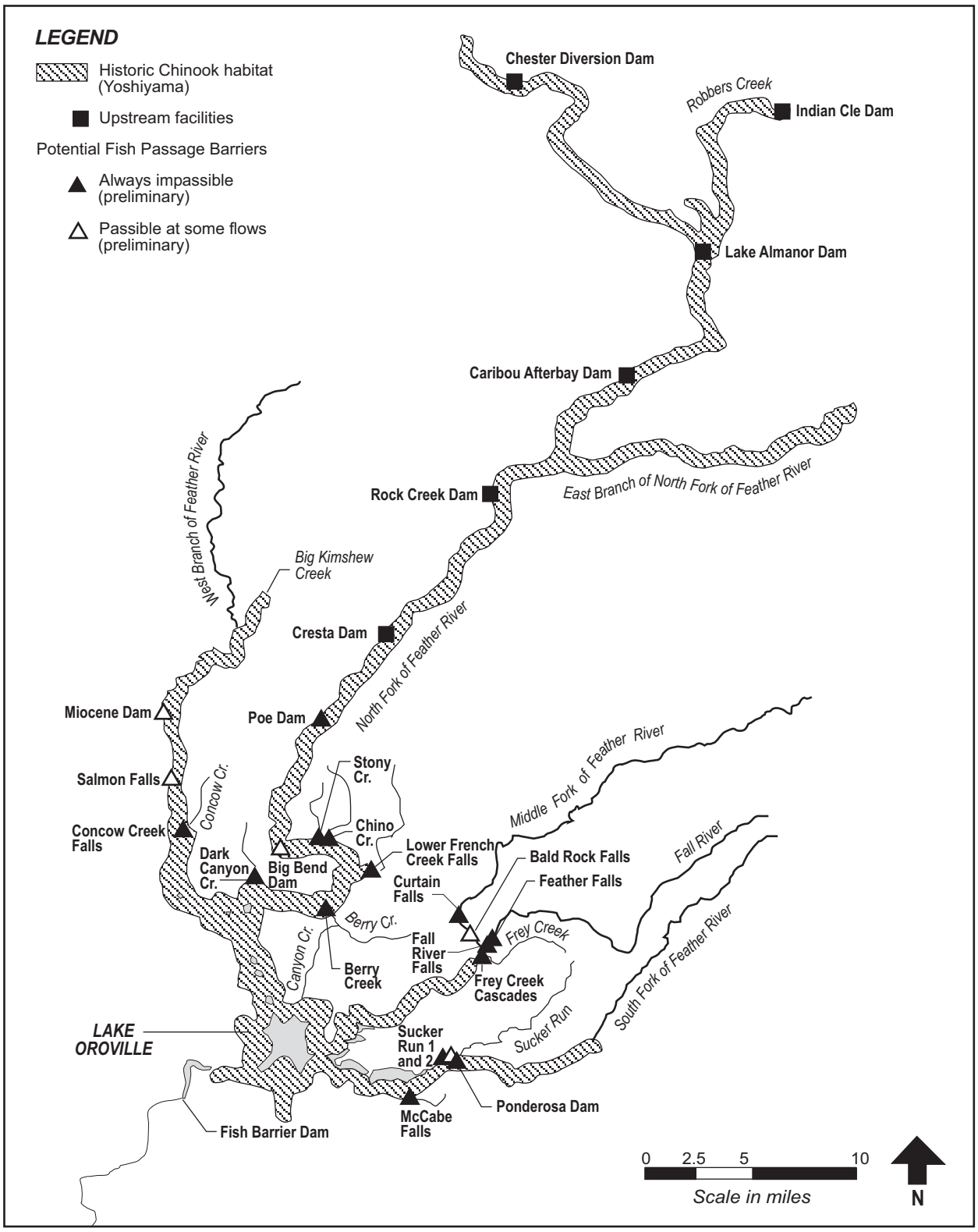

Figure 15. Historical Chinook salmon spawning distribution (Yoshiyama et al., 1988) and current expected geographic scope of the cumulative effects analysis for fish passage. (Source: DWR, 2004, as modified by staff)

When Lake Oroville is at high water surface elevation (typically in the spring), fish can pass over the sediment wedges that exist within the fluctuation zone of Lake Oroville and access the reaches of the tributaries upstream of Lake Oroville's high water mark (figure 9). When Lake Oroville is at low water surface elevation (typically in the fall), low water levels in the tributaries within the fluctuation zone may be low enough to prevent access to tributaries above Lake Oroville's high water mark. In this case, fish cannot access the spawning areas in the regions of the tributaries above Lake Oroville's high water mark.

Lake Oroville

Lake Oroville has a maximum surface area of 15,810 acres at elevation 900 feet msl, 167 miles of shoreline, and a normal maximum seasonal drawdown of 260 feet. The reservoir typically thermally stratifies into three layers beginning in the spring, begins to de-stratify in the fall, and remains relatively uniform throughout the winter (see section 3.3.2.1). Because of this stratification regime, Lake Oroville supports both coldwater and warmwater fisheries that are thermally segregated for most of the year. The coldwater fish use the deeper, cooler, well-oxygenated hypolimnion, whereas the warmwater fish are found in the warmer, shallower, epilimnetic and littoral zones. Once Lake Oroville de-stratifies in the fall, the two fishery components mix in their habitat use. Project operations influence fish habitat in Lake Oroville through manipulation of the amount of cold water for downstream releases into the Feather River and changes in Lake Oroville's water surface elevation necessary for flood control, power generation, and water releases downstream. Cold water is taken from Lake Oroville's hypolimnion for releases to the downstream fishery in the main channel of the Feather River, thereby potentially limiting the amount of cold water available for salmonids in Lake Oroville.

The Lake Oroville coldwater fishery is managed as a put-and-grow fishery, meaning that hatchery raised fish are stocked in Lake Oroville as juveniles, with the intent that they will grow in the lake before being caught by anglers. The coldwater fishery is sustained by hatchery stocking because natural recruitment to the Lake Oroville coldwater fishery is very low due to a lack of spawning and rearing habitat in the reservoir and accessible tributaries, and natural and artificial barriers to migration into those upstream tributaries with sufficient spawning and rearing habitat (DWR, 2001b). From 1993 through 2000, Chinook salmon and brown trout were the only salmonid species stocked in the lake (table 27).

IHN (see more detailed discussion under *Fish Diseases*) is a viral disease that affects salmon, first recognized in the 1950s. IHN outbreaks at the Feather River resulted in significant mortality at the Feather River Fish Hatchery; in 1998, 2000, 2001, and 2002, several million juvenile Chinook salmon died or had to be destroyed because of IHN. DFG attributed the source of the IHN to Oroville salmonids and water from Lake Oroville entering the hatchery (letter from R.A. Torres, Acting Deputy Director, DWR, Sacramento, CA, to the Commission, dated October 25, 2005). The outbreaks prompted DFG to halt stocking Chinook salmon and brown trout in Lake Oroville because of their susceptibility to IHN. However, stocking may resume in the future if IHN is eradicated.

Because coho salmon are less susceptible to IHN, coho salmon were stocked as a replacement for Chinook salmon and brown trout from 2002 to 2003. However, a bacterial kidney disease outbreak in the source aquaculture facility in Washington State prohibited procurement of additional coho salmon eggs in 2004 and 2005. Also, NMFS requested that coho salmon stocking be halted pending a risk assessment of the potential effects associated with stocking out-of-basin anadromous salmon upstream of Oroville dam. In August 2005, DFG issued revised coho disease testing procedures, and if source coho pass these tests, coho may be stocked in Lake Oroville (letter from R.A. Torres, Acting Deputy Director, DWR, Sacramento, CA, to the Commission, dated October 25, 2005.). In late November 2005, DWR began stocking 13,000 coho smolts a week, with a goal of stocking 65,000 coho by the end of 2005. The stocking goal for Lake Oroville for 2006 and 2007 is 170,000 yearling or yearling-equivalent coho raised in the Feather River (letter from R.A. Torres, Acting Deputy Director, DWR, Sacramento, CA, to the Commission, dated November 21, 2005).

Table 27. Salmonid stocking activities in Lake Oroville (1993–2005). (Source: DWR, 2003b; letter from R.A. Torres, Acting Deputy Director, DWR, Sacramento, Ca, to the Commission, dated October 25, 2005)

Year	BN-FING	BN-SUB	BN-CAT	ChS-FING	ChS-YEAR	CoS-FING	CoS-YEAR
1993	0	123,655	7,800	102,585	60,650	0	0
1994	0	50,004	0	104,410	55,200	0	0
1995	0	65,400	0	101,922	90,001	0	0
1996	8,402	80,200	0	105,841	150,435	0	0
1997	0	67,403	0	105,000	250,000	0	0
1998	0	55,000	0	106,163	352,970	0	0
1999	0	50,008	0	128,750	158,290	0	0
2000	0	155,700	0	0	28,600	0	0
2001	0	0	0	0	0	0	0
2002	0	0	0	0	0	50,249	128,280
2003	0	0	0	0	0	39,222	133,570
2004	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	65,000[a]

Notes: BN – Brown trout
CAT – Catchable
ChS – Chinook salmon
CoS – Coho salmon
FING – Fingerling
SUB – Subcatchable
YEAR – Yearling

[a] Goal.

The Lake Oroville warmwater fishery is a self-sustained fishery. The black bass fishery is significant, in terms of both angler effort and economic effect on the area. Spotted bass are the most abundant bass species in Lake Oroville, followed by largemouth, redeye, and smallmouth bass. Catfish are the next most popular warmwater sport fish at Lake Oroville, and both channel and white catfish are present. White and black crappie are also found in Lake Oroville, although populations fluctuate widely from year to year. Bluegill and green sunfish are the two primary sunfish species in Lake Oroville, and redear sunfish and warmouth are present in low numbers. Although common carp are considered by many to be a nuisance species, they are abundant in Lake Oroville (DWR, 2001b). The primary forage fish present are wakasagi and threadfin shad. Threadfin shad were intentionally introduced in 1967 to provide forage for game fish, whereas the wakasagi migrated down from an upstream reservoir in the mid-1970s (DWR, 2001b). The population of threadfin shad has dwindled since the early 1990s, which may be a result of poor overwinter survival, or perhaps interspecific competition with wakasagi, Lake Oroville's primary forage fish.

Terrestrial vegetation along the reservoir shoreline provides spawning and nursery habitat for warmwater fishes, offers protection from predation, and results in increased food availability (DWR, 2001b; DWR and BOR, 2000). This terrestrial vegetation is inundated at higher lake levels but gradually becomes unavailable to fish as the reservoir is drawn down during the summer months.

Some species (e.g., rainbow trout, Chinook salmon, Sacramento pikeminnow, smallmouth bass) were established in the reservoir because of the impoundment of Feather River when Oroville dam was constructed in the early 1960s. Although rainbow trout and Chinook salmon were present previously, these species were stocked along with brown trout, largemouth bass, and spotted bass; wakasagi were unintentionally introduced. Illegal introductions have no doubt occurred as well. Movement of fish, such as rainbow trout, into Lake Oroville from the tributaries occurs on a regular basis, and the potential exists for fish to be moved from the Thermalito diversion pool into Lake Oroville via pumpback operations.

Anadromous salmonids play an important in role in the transport of marine-derived nutrients and organic matter into the freshwater aquatic ecosystems where they spawn. The majority of their body mass is accumulated during their time in the ocean as they mature. After the salmon migrate upstream to their natal streams, spawn and die, their carcasses enter the stream ecosystem. Essential nutrients, such as nitrogen, phosphorous, and dissolved organic matter, leach from the carcasses leading to their colonization by microbes and formation of biofilms on the surrounding stream substrates (Bilby et al., 1996; Wipfli et al., 1998). Salmon also supply inorganic nitrogen to the ecosystem during their upstream migrations via excretion of ammonia and other nitrogenous compounds (Mathisen et al., 1988). The Oroville dam, the Thermalito diversion dam, and fish barrier dam prevent the migration of Chinook salmon and steelhead to the historical spawning grounds in the tributaries of the Feather River located upstream of Lake Oroville, therefore eliminating the contribution of marine-derived nutrients to these streams.

To estimate the potential losses of anadromous salmonid biomass and associated nutrients and organic matter due to construction of the Oroville Facilities, DWR conducted a study that used estimates of spawning habitat availability in the historical Feather River tributaries upstream of Oroville reservoir. The estimated potential losses of nutrients and organic matter were found to be substantial, but the significance of the losses was difficult to evaluate because of limitations in the available information, including imprecision of the estimates for potential spawning densities and insufficiently low detection levels of measured nutrient concentrations in the upstream tributaries. Additional studies found periphyton and macroinvertebrate communities in the tributaries to Lake Oroville that were indicative of healthy ecosystems (DWR, 2004g). Comparisons of the periphyton and macroinvertebrate communities in the upper tributaries with communities in the low flow channel and other streams do not indicate that the upstream tributaries suffer from nutrient deprivation due to the blockage of salmonid spawning in the upper tributaries caused by Oroville dam.

Feather River Downstream of Oroville Dam

Oroville Facilities releases primarily are managed to benefit coldwater fisheries. Fish species of primary management concern present in the Feather River include spring-run Chinook salmon, fall-run Chinook salmon, Central Valley steelhead, rainbow trout, brown trout, brook trout, green sturgeon, striped bass, river lamprey, American shad, hardhead, Sacramento splittail, largemouth bass, smallmouth bass, redeye bass, and spotted bass. Chinook salmon are very abundant in the Feather River as an estimated 30,000 to 170,000 Chinook salmon spawn in the Feather River annually.

Minimum flows and ramping criteria in the Feather River were established in the August 1983 agreement between DWR and DFG (DWR, 1983). The agreement specifies that DWR release a minimum of 600 cfs into the Feather River from the Thermalito diversion dam for fisheries purposes. Therefore, the low flow channel is operated at 600 cfs all year with variations in flow occurring rarely, only during flood control releases, or in the summer to meet downstream temperature requirements for salmonids.

Flows in the high flow channel are maintained between the minimum flow and a flow no greater than 2,500 cfs from October 15 through November 30 to prevent Chinook salmon redd dewatering in the event that flows were to decrease during the egg incubation period. The flow regime in the reach of the

Feather River extending from the Thermalito afterbay outlet (RM 59) to the confluence of the Feather and Sacramento rivers (RM 0) varies depending on runoff and month. Flows in this reach of the Feather River typically vary from the minimum flow requirement up to a flow of 7,500 cfs (DWR, 2003e). Small flow contributions from Honcut Creek and the Bear River and larger flow contributions from the Yuba River also influence flow in this segment (figure 2). Shanghai Bench, a clay riffle located between RM 26 and RM 25, has been identified as the most likely physical, flow-related impediment to upstream migration in the Feather River (DWR, 2002d).

Ramping criteria established in the 1983 agreement are discussed in section 3.3.2.1. These ramping rates were implemented to minimize stranding of juvenile spring-run Chinook salmon in the high flow channel.

Water temperatures tend to be coldest in the upper-most portions of the Feather River near the fish barrier dam, and they warm progressively moving downstream during the spring, summer, and fall. The low flow channel water temperatures have been managed to comply with terms of the October 2004 NMFS' biological opinion (see section 3.3.2.1, *Water Quality*) about the effects of the long-term operations, criteria, and plan of the Central Valley Project in coordination with operations of the State Water Project, which superseded all previous biological opinions regarding the Central Valley Project and State Water Project long-term operations, criteria, and plan (NMFS, 2004).

Thermalito Diversion Pool

The water temperature requirements (see section 3.3.2.1, *Water Quality*) create primarily coldwater fishery habitat in the Thermalito diversion pool, which is dominated by coldwater salmonids, including rainbow trout, brook trout, brown trout, and Chinook salmon (DWR, 2001b, 2002b). Although the Thermalito diversion pool is not currently stocked with fish, the lack of barriers between the Thermalito diversion pool and Thermalito forebay allows fish stocked in Thermalito forebay to migrate freely into the Thermalito diversion pool (DWR, 2001b, 2002b).

Thermalito Forebay

The Thermalito forebay is an open, cold, shallow reservoir with a high surface area-to-volume ratio with small water surface elevation fluctuations. Thermalito forebay remains cold throughout the year because it is supplied with water from the Thermalito diversion pool, although pumpback operations from Thermalito afterbay can increase water temperatures in the forebay. Additional information about water temperature in the Thermalito Forebay is provided in section 3.3.2.1, *Water Quantity and Quality.*

The Thermalito forebay provides habitat primarily for coldwater fish, although the same warmwater fish species found in Lake Oroville are believed to exist in the forebay in low numbers. DFG manages Thermalito forebay as a put-and-take trout fishery, and about 30,000 catchable rainbow trout are stocked annually (DWR, 2001b, 2002b). Surplus inland Chinook salmon from Lake Oroville stocking efforts have been stocked twice in Thermalito forebay (table 28).

Thermalito Afterbay

The Thermalito afterbay provides habitat for both coldwater and warmwater fish. This 4,300 surface-acre reservoir has gently sloping banks with vast areas of rooted aquatic vegetation along its upper margins. Depths rarely exceed 20 feet. Changes in flow rates, pumpback operations, and water surface elevations resulting from project operations affect water temperatures and the quality, quantity, and distribution of fish habitat in the Thermalito afterbay. The operational range of surface elevation fluctuations is 12 feet, although the normal fluctuation range is between 4 and 8 feet. As discussed in section 2.2.1, *Project Description and Operation*, the water surface elevation can fluctuate rapidly and frequently, resulting in a high degree of variability in water levels from day-to-day and from week-to-week, depending on project operation.

Table 28. Thermalito forebay fish stocking history. (Source: DWR, 2004h)

Year	Rainbow Trout	Brook Trout	Brown Trout	Chinook Salmon
1980	0	0	0	0
1981	38,347	38,347	0	0
1982	24,765	3,025	27,790	0
1983	34,922	22,750	57,672	0
1984	31,346	31,346	0	0
1985	58,405	58,405	0	0
1986	41,380	41,380	0	0
1987	127,435	127,435	0	0
1988	76,310	76,310	0	0
1989	54,548	54,548	0	0
1990	55,150	55,150	0	0
1991	54,440	54,440	0	0
1992	45,180	45,180	0	0
1993	32,190	14,640	7,400	54,230
1994	77,400	5,760	83,160	0
1995	40,240	40,240	0	0
1996	0	0	0	0
1997	29,300	10,660	39,960	0
1998	18,380	10,150	28,530	0
1999	28,450	9,740	25,000	63,190
2000	24,700	8,840	33,540	0
2001	22,400	8,600	31,000	0
2002	32,350	9,340	41,690	0
2003	29,830	29,830	0	0
2004	14,540	14,540	0	0
Total	992,008	770,656	375,742	117,420

Fish species observed in the Thermalito afterbay include largemouth bass, smallmouth bass, rainbow trout, brown trout, bluegill, redear sunfish, black crappie, channel catfish, carp, and large schools of wakasagi. Salmonids have not been stocked in Thermalito afterbay and it is unlikely that they spawn in tributaries of Thermalito afterbay. Therefore, rainbow trout and brown trout that occur in the afterbay likely passed through the Thermalito pumping-generating plant from the Thermalito forebay. A review of the literature by DWR concluded the Thermalito afterbay likely provides good habitat for black bass species, and large schools of wakasagi provide a good source of forage fish. Bass nest dewatering from reservoir fluctuations likely limits juvenile recruitment in the afterbay. Based on DWR analysis (DWR, 2004i), it is likely that black bass populations in the Thermalito afterbay will persist unless changes in operations create additional water surface level or water temperature fluctuations during spawning periods.

Fish Barrier Pool

Species occurring in the fish barrier pool are likely similar to those in the upstream Thermalito diversion pool, although no stocking or sampling has been conducted. The fish barrier dam diverts upstream-migrating salmon and steelhead into the fish ladder that leads to the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low flow channel between the dam and the Thermalito afterbay outlet and provides attraction flow for the fish hatchery.

Feather River Fish Hatchery

The Feather River Fish Hatchery facilities include the fish barrier dam, a fish ladder, holding tanks, hatchery buildings, and raceways. DWR constructed the Feather River Fish Hatchery in 1967 to compensate for salmonid spawning habitat lost with construction of Oroville dam, and DFG operates the hatchery. The fish hatchery uses water diverted from the Thermalito diversion pool, which receives cold, hypolimnetic water (which rarely exceeds the mid to high 50s [°F]) from Lake Oroville. The hatchery water intake temperatures are monitored for operational compliance with the 1983 Oroville Operating Agreement between DWR and DFG (see section 3.3.2.1, *Water Quality*).

The fish ladder gates are opened on or about September 1 to allow adult spring-run Chinook salmon to enter the hatchery and early entrants are typically ready for spawning in October. DFG has recently initiated a program to mark the progeny of all early returning Chinook and is incorporating only the early run fish into the Feather River Fish Hatchery spring-run Chinook stock. A small percentage of these marked early run hatchery fish (i.e., those that do not return to the hatchery or are not harvested) spawns naturally in the Feather River (70 FR 37,160). Fish entering the hatchery after September 15 are considered fall-run. When the gates are open, upstream migrating fish can move into the 0.5-mile-long ladder leading to the hatchery. All salmon adults entering the hatchery are retained for egg taking or fertilization. About 9,000 to 18,000 salmon and 2,000 steelhead are artificially spawned annually, producing 8 million fall-run Chinook salmon, 5 million spring-run Chinook salmon, and 400,000 steelhead (NMFS, 2004).

Salmon and steelhead are raised at the hatchery; transported in oxygenated, temperature-controlled tanks; and released in the Feather and Sacramento rivers, Lake Oroville, other California reservoirs, and San Pablo Bay near San Francisco Bay. Chinook salmon are released from the hatchery as young-of-the-year smolts, while steelhead are released to the Feather River as yearlings.

As discussed previously, the DWR has implemented disease control procedures that minimize both the outbreak of disease in the hatchery and the possibility of disease transmission to wild fish populations (DWR, 2004j). Hatchery operating procedures, such as periodic examinations by fish pathologists and disinfecting procedures are designed to control disease in hatchery stocks.

Historical Chinook and steelhead returns to the Feather River Fish Hatchery are presented in figure 16.

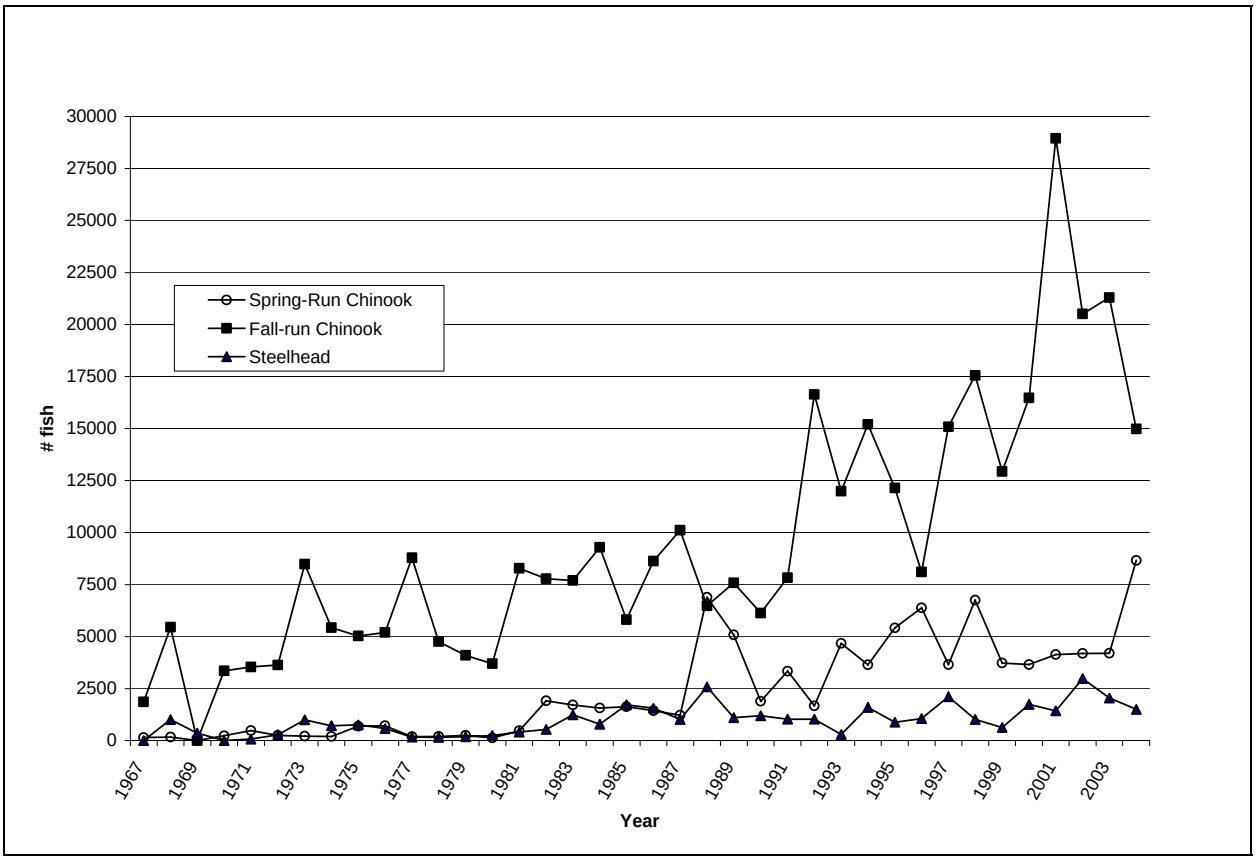

Figure 16. Feather River Fish Hatchery returns from 1967 to 2005. (Source: DFG, 2005)

Feather River

Oroville dam, Thermalito diversion dam, and the fish barrier dam (see figure 8) block gravel contribution to the Feather River. High flow releases from the Oroville Facilities mobilize smaller substrate particle sizes. The smaller substrate sizes are not replaced by upstream gravel, resulting in a gradual coarsening of the particle size distribution of the substrate in the upper portions of the Feather River. Coarsening and armoring of the substrate size can affect the quality of spawning habitat and the distribution of spawning salmonids and other fishes. In general, the reach of river with the highest proportion of coarse substrate components is the upstream-most portion of the Feather River downstream of the fish barrier dam and above the Thermalito afterbay outlet.

DWR's study results show that an estimated 97 percent of the sediment from the upstream watershed is trapped in Lake Oroville, resulting in sediment starvation downstream (see section 3.3.1, *Geology, Soils, and Paleontological Resources*, for additional information about sediment recruitment). Only very fine sediment is discharged from Lake Oroville to the river below. Depletion of the sediment load in the Feather River results in reduced formation of sediment benches, which affects riparian vegetation colonization and succession. The riparian vegetation provides overhanging cover for rearing fish, riparian shade, invertebrate contributions to the fish food base, and future LWD site contributions. Soft sediment substrates also contribute to the capture and retention of LWD.

LWD is an important functional component in the development and maintenance of habitat diversity and contributes to instream cover complexity (DWR, 2002b). Logs, rootwads, and undercut banks provide juvenile salmonid rearing cover from predators, velocity refuges, and increased concentrations of drifting food organisms. Debris-formed pools also provide adult salmonid holding habitat. The project dams block the downstream movement of LWD. LWD can have a substantial effect

on river channel morphology by sediment trapping, creating turbulence, diverting flows, and creating scour holes in the channel and enhance aquatic habitat by creating gravel bars for use as spawning habitat by anadromous salmonids (Lassettre and Harris, 2001). The size of LWD relative to the size of the channel is important in the degree to which LWD can affect channel morphology. For the purposes of inventories conducted for this proceeding, LWD was defined as woody material measuring at least 4 inches (10 centimeters) diameter and 6.5 feet (2.0 meters) in length. In order to be functional (i.e., substantively function to change channel morphology) in the Feather River, wood of this relatively small size would need to accumulate or entangle with a much larger piece of LWD, known as a "key piece." Analysis of survey data indicates that LWD is unevenly distributed in the Feather River. The low flow channel contains the lowest amount (28.5 pieces per mile on average). This area is also downstream of Oroville dam, which captures the vast amount of LWD. From the Thermalito afterbay outlet to Honcut Creek, the river has a moderate amount of LWD, averaging 104.4 pieces per mile. The reach downstream of Honcut Creek to the Yuba River contains a significantly higher amount of LWD, with 238.5 pieces per mile on average. The amount of LWD in the mile downstream of Honcut Creek is double the amount of LWD in the mile of river upstream of Honcut Creek, suggesting that Honcut Creek (free of major dams) is a major source of LWD. The reach of river downstream of the Yuba River has a low abundance of LWD (an average of 48.1 pieces of LWD per mile, over 28 miles). Long stretches of riverbank in this farthest-downstream reach have been hardened with levees for flood management or riprapped for bank protection, with consequent reductions in riparian vegetation and long stretches of riverbank devoid of vegetation.

Study results show that the characteristics of most of the LWD pieces were not readily identifiable due to submersion, inaccessibility, or the degraded condition of the piece. Of those pieces that were identifiable, orchard trees (64 percent) dominated, while cottonwoods and oaks made up another 20 percent. The remainder—willows and sycamores—were a minor component at just 4 percent. Coniferous LWD was not observed in the Feather River, although that does not preclude its presence.

Survey results state that of the LWD surveyed, approximately 10 percent of the pieces was classified as "large" diameter.[56] During the June 2005 FERC site visit, staff observed very few large pieces of LWD and saw no instances of LWD influencing channel morphology in this large channel. Study results indicate that virtually all of the pieces had a rootwad or a remnant of a rootwad, with only 6 percent lacking one.

The Oroville Facilities and the sediment wedges (see figure 9) currently block the upstream migration of anadromous salmonids into historical spawning habitat in upstream tributaries. Blocked access to historical spawning grounds in the upper watershed causes spring-run Chinook salmon to spawn in the same lowland reaches of the Feather River that fall-run Chinook salmon use as spawning habitat. The overlap in spawning sites, combined with a slight overlap in spawning timing (Moyle, 2002) and temporally adjacent runs, may be responsible for inter-breeding between spring-run and fall-run Chinook salmon in the Feather River (Hedgecock et al., 2001).

Low Flow Channel and High Flow Channel

The majority of in-river spring-run Chinook salmon spawning is concentrated in the uppermost 3 miles of accessible habitat in the Feather River downstream of the Feather River Fish Hatchery (DWR, 2001b). NMFS (2004) referred to the high flow channel as a migratory corridor for adult spring-run Chinook salmon because most adults do not hold or spawn there. However, in 2000 through 2003, surveyors found 16 to 26 percent of the spawned-out Chinook salmon carcasses in the high flow channel, compared to 75 to 84 percent in the low flow channel (DWR, 2004). The study plan report does not indicate whether or not some of the carcasses that were counted in the high flow channel had washed

[56] The range of diameters included in the large diameter size class is not provided in the study report.

down from the low flow channel, although that would be expected, and spring-run fish could not be distinguished from fall-run fish.

Physical habitat simulation analysis conducted by DWR in 2002 indicates that Chinook spawning habitat in the low flow channel reaches a maximum between 800 and 825 cfs, and in the high flow channel, it reaches a maximum at 1,200 cfs. The steelhead spawning habitat index in the low flow channel has no distinct optimum over the range of flow between 150 and 1,000 cfs. In the high flow channel, there is a maximum at a flow just under 1,000 cfs (DWR, 2004r).

Most of the natural steelhead spawning and rearing in the Feather River occurs in the low flow channel, particularly in the upper reaches near Hatchery Ditch, a side-channel located between RM 66 and 67 between the Table Mountain Bicycle Bridge and Lower Auditorium Riffle. Limited steelhead spawning also occurs downstream of the Thermalito afterbay outlet. The smaller substrate size and greater amount of cover (compared to the main river channel) also make these side-channels more suitable for juvenile steelhead rearing. Currently, this type of habitat comprises less than 1 percent of the available habitat in the low flow channel (DWR, 2001b).

Oroville Wildlife Area Ponds

The OWA contains more than 75 warmwater ponds and sloughs, along with complexes of emergent marsh and flooded cottonwood, willow, and sycamore trees, totaling about 12,000 acres (11,200 acres within the project boundary). The OWA pond water levels are replenished, in part, by the Feather River, which seeps through the porous levees and substrates, or floods into the OWA during high flow events. There are at least four overflow weirs into the OWA in Reach FR-10 between RM 53.5 and 64.0 (table 8).

After the Feather River floods in 1997, DWR repaired a levee in the OWA, Area D. The repairs included a levee notch to allow overflow during flood events; there is no direct surface water connection between the OWA and the Feather River. The outside (upstream side) of the repaired levee is bordered by a pond which discharges into the low flow channel of the Feather River. Sometime after the levee repair, beavers dammed the outlet and elevated the water level of the pond by several feet. This elevated water level then percolated through the levee and contributed to increased standing water elevations within that portion of the OWA (beaver dams within the OWA also contributed); however, this is not a permanent condition. High flows in 2006 altered the pond outlet channel and water elevations in the OWA have dropped correspondingly. Therefore, the pond elevations within this portion of the OWA are in dynamic transition as a result of both physical and biological events, and water surface elevations are not a fixed state. Invasive aquatic plants in the ponds, particularly water primrose (*Ludwigia peploides peploides*) are growing to densities that reduce the quality of, or eliminate, potential fish habitat.

Largemouth bass, channel catfish, white catfish, bluegill, green sunfish, and carp are all abundant in the OWA ponds, along with populations of black and white crappie. Electrofishing on Robinson Borrow Pond (also called Granite Pond) in April 2003 collected carp, Chinook salmon, largemouth bass, and Sacramento sucker.

The OWA ponds and wetland areas become too warm during the late spring to sustain salmonids, so any salmonids that are present at this time typically do not survive. The extent of this periodic salmonid presence and the stranding effect has not been determined.

The most significant issue affecting OWA fisheries in the last decade has been the invasion of water primrose (*Ludwigia peploides peploides*) in the OWA on the east side of the Feather River. The primrose has covered the perennial, fish-bearing ponds to depths of more than 1 meter above the pond surface. DWR biologists, DFG personnel, and anglers have estimated that 80 percent of the fish-bearing ponds in this area have been covered with water primrose, and this condition is increasing annually (DWR, 2005a, appendix G).

Fish Species Overview

This section presents brief overviews of fish species found in the project area. Two additional species, Chinook salmon and steelhead, are discussed in section 3.3.5, *Threatened and Endangered Species*.

Black Bass

Black bass species within the project area include spotted bass, largemouth bass, smallmouth bass, and redeye bass. None of these species of black bass are native to California; however, all are considered important recreational game fish. Bass are predators and prey on native fishes (Moyle, 2002).

Black bass spawn in the spring from March through June, with peak spawning activity in early May. All species prefer similar spawning habitat and are nest builders. Nest building begins at water temperatures around 54°F and spawning continues until water temperatures exceed 75.2°F (Aasen and Henry, 1981; Baylis et al., 1993; Davis and Lock, 1997; Graham and Orth, 1986; Miller and Storck, 1984; Wang, 1986). Black bass spawning occurs in water 1–4 feet deep near shore and has been observed as deep as 20 feet in clear water (Davis and Lock, 1997). In California, with changing reservoir levels, spawning has been observed at water depths up to 13.1 to 16.4 feet (Moyle, 2002).

Black bass species are found throughout the project area, including tributaries upstream of Lake Oroville (DWR, 2003c), Lake Oroville (DWR, 2003b), Thermalito forebay (DWR, 2003b), Thermalito afterbay, and the Feather River from the mouth of the Thermalito afterbay outlet to the confluence with the Sacramento River (DWR, 2003d). Black bass species are seldom observed in the low flow channel, probably due to colder water temperatures (DWR, 2003b).

Catfish

Two species of catfish are found in the project waters: channel catfish and white catfish. Neither species is native to California; however, both are popular game fish. When adult channel catfish are in a river environment, they are typically found in faster moving water, although both species do well in large reservoirs (Moyle, 2002). Both species of catfish are frequently observed in Lake Oroville (DWR, 2003b).

In California, channel catfish generally spawn from April through June, while white catfish spawn slightly later during June through July (Moyle, 2002). Channel catfish require water temperatures ranging from 69.8 to 84.2°F, with 78.8 to 82.4°F being the optimum water temperature range for spawning (Moyle, 2002). Channel catfish typically construct nests in cave-like structures, and such structures have been constructed in Lake Oroville to promote the channel catfish fishery (DWR, 1997b). In large impoundments, nests generally occur among rubble and boulders along protected shorelines at depths of 6.6 to 13.2 feet (McMahon and Terrell, 1982). White catfish construct nests in shallow depressions in sand or gravel near cover or use cave sites similar to channel catfish (Moyle, 2002).

Crappie

Both white and black crappie inhabit the project waters. Although neither species is native to California, both are popular game fish. Mature crappie seem to prefer water temperatures ranging from 80.6 to 84.2°F (Moyle, 2002). Black crappie are more frequently observed in Lake Oroville, but both species are present (DWR, 2003b).

Both species of crappie spawn in late spring and early summer, with white crappie tending to begin spawning a little earlier, although there is substantial overlap. Crappie spawn in water temperatures ranging from 62.6 to 68°F, at a depth of 3.3 to 23 feet (Moyle, 2002). Males of both species construct nests using vegetation in shallow depressions in mud or gravel substrate (Moyle, 2002).

Forage Fish

Two species of forage fish are found within the project area: threadfin shad and wakasagi. Neither species is native to California. Both were introduced to serve as forage fish for game species in California lakes and reservoirs. Wakasagi were introduced to Lake Almanor in 1959 to serve as forage for salmonids (Aasen et al., 1998). They have migrated downstream and are now found in Lake Oroville and are frequently observed in both Lake Oroville and Thermalito forebay (DWR, 2003b).

Wakasagi spawn after their first year during the spring in small tributaries where eggs adhere to rocks or submerged vegetation (Aasen et al., 1998). Few survive to spawn again in their second year. California wakasagi can tolerate a wide range of water temperatures, for both growth and reproduction (Moyle, 2002).

Threadfin shad are native to tributaries to the Gulf of Mexico and the Mississippi River, were introduced into California in 1953 as forage for game fishes (Moyle, 2002). Threadfin shad typically inhabit open waters of reservoirs, lakes, and large ponds, and they can tolerate high salinities, although high salinities may impair their reproduction. In reservoirs, these plankton feeders prefer areas near inlets of small streams or steep surfaces of dams (Moyle, 2002). Optimal growth occurs when summer temperatures exceed 72 to 75°F; however, prolonged periods of cold water (39°F) will cause mortality (Moyle, 2002). Threadfin shad are broadcast spawners,[57] and fertilized eggs adhere to submerged logs or vegetation. Threadfin shad have been infrequently observed in Lake Oroville since the early 1990s (DWR, 2003b).

Minnows

Four species of minnow are commonly found in the project area: Sacramento pikeminnow, hardhead, hitch, and Sacramento splittail. All four species are native to the Sacramento River drainage (Moyle, 2002).

Sacramento pikeminnow are a common species of native fish in the Feather River. Spawning generally takes place from April through June (Moyle, 2002). This species generally inhabits waters with summer temperatures between 64 to 82°F (Moyle, 2002). In reservoirs, pikeminnow have been observed spawning in very shallow water (a few inches deep), as well as in water as deep as the thermocline (Patten and Rodman, 1969). Pikeminnow are known predators of juvenile salmonids.

Hardhead was designated as a state species of special concern by DFG in 1995 and is listed as a Class 3 Watch List species, meaning that it occupies much of its native range but was formerly more widespread or abundant within that range (Moyle et al., 1995). Hardhead are common in the Sacramento River and lower main stems of the American and Feather rivers. Hardhead are frequently observed in the Feather River from the fish barrier dam downstream to the confluence with the Sacramento River (Moyle, 2002). Juvenile recruitment suggests that hardhead spawn from April through June in Central Valley streams, but the spawning may extend into August in the foothill streams of the Sacramento–San Joaquin drainage. Hardhead reportedly spawn in water temperature ranges from 55 to 75°F (Cech et al., 1990; Moyle, 2002; Wang, 1986).

Hitch is a Class 3 Watch List species as designated by DFG (Moyle, 2002). This species is a broadcast spawner and normally spawns between March and June. Spawning hitch select habitat and conditions similar to hardhead (Moyle, 2002). Hitch are frequently observed in the Feather River from the Thermalito afterbay outlet to the confluence with the Sacramento River (DWR, 2003d).

Sacramento splittail were designated as a threatened species under ESA by FWS on February 8, 1999 (64 FR 5,963–5,981). Splittail were listed as threatened throughout their entire range, which

[57] Broadcast spawners release their eggs in the water column.

includes the Feather River (64 FR 5,963–5,981). However, on September 22, 2003, FWS issued a Notice of Remanded Determination (50 FR (17):55,140–55,166), removing the Sacramento splittail from the endangered species list. DFG still considers them a species of special concern.

Sacramento splittail use the Feather River for spawning, egg incubation, and initial rearing from February through May. Splittail use shallow flooded vegetation for spawning and are infrequently observed in the Feather River from the confluence with the Sacramento River up to Honcut Creek. The majority of spawning activity in the Feather River is thought to occur downstream of the Yuba River confluence; the highest spawning density is in the Sutter bypass during high flow events.

No directed studies of splittail abundance have been conducted in the project area. However, there have been incidental observations of splittail in the Feather River (Seesholtz et al., 2003; FWS 1995a).

Spawning can occur between late February and early July, although peak spawning generally occurs in March and April (Moyle, 2002). Sacramento splittail spawning generally occurs in water with a depth of 3.0 to 6.6 feet over submerged vegetation (Moyle, 2002; Wang, 1986). This same habitat is used for initial juvenile rearing. Splittail have a wide thermal tolerance during this period, and temperatures may range from 48 to 75°F (Moyle, 2002; Sommer et al., 1997; Wang, 1986). Juvenile splittail begin appearing at the fish screening facilities for the Delta pumps in April and their numbers peak during late April and May, suggesting that most juvenile out-migration from the Feather River has occurred by the end of May (Daniels and Moyle, 1983; Sommer, 2003).

Sacramento Sucker

The Sacramento sucker is common in the project area and is native to California (Wang, 1986). Spawning occurs between late February and early June, with peak spawning during March and April (Moyle, 2002). Suckers prefer water temperatures for spawning between 53.6 and 64.4°F, with water depths of 11.8 inches or more (Moyle, 2002). Sacramento suckers are infrequently observed in Lake Oroville. They are common in Thermalito forebay (DWR, 2003b) and in the Feather River (Seesholtz et al., 2003).

Smelt

Two species of smelt, delta smelt, and longfin smelt, are native to California (Moyle, 2002) and common in the Delta. Neither of these species is found within the project area.

FWS listed delta smelt as a threatened species under ESA in March 1993 (58 CFR 12,854), and critical habitat for delta smelt has been designated within the Delta and adjoining waterbodies. Delta smelt also is listed as threatened under the California Endangered Species Act.

Striped Bass

Striped bass is an introduced game fish that spawns in the project area from April through June (Bell, 1991; Hassler, 1988; Hill et al., 1989; Moyle, 2002; Wang, 1986). Striped bass have also been reported in Thermalito forebay (DWR, 2003b), which may indicate a small landlocked breeding population.

Striped bass are broadcast spawners, with peak spawning activity occurring from April through June (Wang, 1986). Striped bass spawn in mainstem rivers and have shown little preference for substrate (Wang, 1986). Based on various studies, the water temperature range in which spawning occurs is reported to be about between 59 and 68°F (Bell, 1991; Hassler, 1988; Hill et al., 1989; Moyle, 2002).

Sunfish

Three species of sunfish, bluegill, green sunfish, and redear sunfish, are common in the project area. None of these species are native to California, although all are popular recreational gamefish (Moyle, 2002; Wang, 1986). All three sunfish species exhibit a similar life history, have a similar lifespan, and attain similar sizes; therefore, only the traits of bluegill are discussed herein. In California, spawning occurs throughout the summer, with peak spawning in June and July as water temperatures exceed 68°F (Wang, 1986). All three species generally inhabit small warm streams, ponds, and lake edges (Moyle, 2002). All of the sunfishes are frequently observed in Lake Oroville, and a small population of bluegill may exist in Thermalito forebay (DWR, 2003b). Bluegill, green sunfish, and redear sunfish are also common in the OWA ponds (DWR, 2003b) and in the Feather River (Seesholtz et al., 2003).

Tule Perch

Tule perch are native to California, including the Sacramento River System. Tule perch prefer moving-water habitats with temperatures less than 71.6°F and are reportedly not found in temperatures greater than 77°F (Moyle, 2002). Beds of emergent aquatic plants, deep pools, and banks with complex cover, such as overhanging bushes, fallen trees, undercutting, and riprap, provide the preferred environment for tule perch (Moyle, 2002). Tule perch are livebearers with females producing 25 to 60 young (Moyle, 2002). Young are released among tule marshes and other types of vegetation (Wang, 1986). A few tule perch have been observed in Thermalito forebay (DWR, 2003b), and they are common in the Feather River (Seesholtz et al., 2003).

American Shad

Native to the Atlantic coast, the anadromous American shad was introduced to the Sacramento River between 1871 and 1881 (Moyle, 2002). American shad are present in the Feather River from May through mid-December during the adult immigration, spawning, and emigration periods of their lifecycle (DWR, 2003d). The Sacramento River supports large runs of shad in late May and early June during their upstream spawning migration, and the Feather River is a main summer nursery area (Moyle, 2002). American shad are broadcast spawners and normally spawn over sand or gravel substrate in main river channels (Moyle, 2002). In the Sacramento River, American shad prefer water temperatures ranging from 62.6 to 75.2°F for spawning (Moyle, 2002), but elsewhere they have been reported to spawn in water temperatures between 46 and 79°F (Painter et al., 1979; FWS, 1995b; Wang, 1986). Emigration of juveniles from the spawning area takes place from July through December, generally peaking in August and September (Painter et al., 1979). Juveniles may spend up to 1 year in freshwater (Moyle, 2002).

Trout

Brown trout, brook trout, and lake trout are found within the project area. None of these species are native to California, and all were introduced to provide a recreational sport fishery. All three species have been stocked in either Lake Oroville or Thermalito forebay (DWR, 2001b). Brook trout and lake trout are not true trout but actually members of the char family.

Brook trout have not been stocked in Thermalito forebay since 2004. Lake trout were stocked in Lake Oroville during 1984 and 1985, and a few lake trout are still observed in Lake Oroville (DWR, 2003b), suggesting the possibility of a small breeding population. Brown trout were stocked in Lake Oroville as recently as 2000 (DWR, 2001b).

Adult trout are largely bottom-oriented pool dwellers in streams and rivers (Moyle, 2002). Escape cover (for adults and juveniles) is provided by overhanging and submerged vegetation, undercut banks, and instream objects such as debris piles, logs, and large rocks (Raleigh et al., 1986). The water

temperature tolerance range for trout is 32 to 80.6°F, although the preferred water temperature for trout is reportedly from 53.6 to 68°F (Raleigh et al., 1986).

All three species spawn in the fall or winter. In California, brook trout spawn from September through January, brown trout from November through December, and lake trout from September through November (Moyle, 2002). Brook trout normally spawn in small tributaries but have been observed spawning on the gravel bottom shallows of some lakes (Moyle, 2002). Brown trout spawn in small tributaries. Lake trout are one of the few salmonids that do not construct redds; instead, they broadcast spawn in deep cold water of lakes (Moyle, 2002).

Chinook Salmon

Chinook salmon are native to California rivers, including the Feather River, and have a varied life history. Within the Sacramento River system, four different runs and three ESUs of Chinook salmon are recognized based on the time of year that upstream migrations begin. The spring-run ESU salmon normally begin migration during March and continues through the beginning of September, holding in coldwater pools until ready to spawn. The spring-run ESU is listed as threatened under ESA, and is addressed in section 3.3.5, *Threatened and Endangered Species.*

Fall-run and late-fall-run Chinook salmon are part of the same Central Valley ESU (179 FR 50394). The fall-run fish begin upstream migration in the summer and last until December; late-fall-run fish migrate upstream October through April in the Sacramento River system (Yoshiyama et al., 1998). Fall-run Chinook salmon enter the Feather River in late summer and fall and typically spawn shortly after arriving on the spawning grounds in late September through December (Sommer et al., 2001; Yoshiyama et al., 1998).

A small winter-run of Chinook salmon also exists within the Sacramento River system, with upstream migration beginning in December (DWR, 2004f, 1982; 64 FR (179)50,394–50,415; Moyle, 2002; Sommer et al., 2001). However, the winter-run ESU does not occur in the project area, and is not addressed further.

In 1999, the Central Valley Chinook salmon ESU underwent a status review after NMFS received a petition for listing. NMFS found that the fall-run/late-fall-run did not warrant listing as threatened or endangered under ESA, but sufficient concerns remained to justify addition to the candidate species list. On April 15, 2004, NMFS published a notice in the Federal Register that included the announcement of the Central Valley fall-run/late-fall-run Chinook salmon ESU change in status from a candidate species to a species of concern. Therefore, the Central Valley fall-run/late-fall-run ESU now qualifies as a species of concern, rather than a candidate species (69 FR 19977). The late-fall-run portion of this ESU does not occur in the project area, and is not addressed further.

Before widespread European settlement, most of the major tributaries had both spring and fall Chinook salmon runs; streams that lacked adequate summer flows to support spring-run fish had a fall-run (Yoshiyama et al., 1998). In recent decades, the vast majority of Central Valley Chinook salmon production, including the Feather River, has been fall-run fish, heavily supported by hatchery production. Fall-run Chinook salmon have been less affected by hydropower development than spring and winter runs because the fall-run probably spawned at lower elevations in the valley floor and foothills, historically (Yoshiyama et al., 1998). At this time, Central Valley fall-run Chinook salmon are considered significantly depressed from historic levels, but relatively secure (Yoshiyama et al., 1998).

Coho Salmon

Coho salmon are native to California and while no wild populations currently exist in the Feather River, they are stocked in Lake Oroville (DWR, 2001b). The Central California Coast evolutionarily significant unit (ESU) of coho salmon was listed as threatened under ESA on December 2, 1996. Coho

salmon also is designated as a state species of special concern. However, these special-status species designations pertain only to coho salmon within their native habitats, and not to the coho stocked in project area waters. The coho salmon that occur in the project area are from stocking programs and are managed for their recreational importance only.

California coho salmon generally exhibit a 3-year life cycle with about half of their life cycle spent in freshwater and half in saltwater (Moyle, 2002). Coho salmon from central California enter rivers in late December or January and spawn immediately afterwards (Weitkamp et al., 1995). Coho salmon use similar spawning habitat as Chinook salmon and steelhead (Moyle, 2002).

Juvenile coho salmon show pronounced shifts in habitat with season, especially in California streams. During winter, juvenile coho salmon select habitats with low water velocity. During spring, juveniles are widely distributed through riffles and runs and during summer juveniles concentrate in deeper pools or runs (Moyle, 2002). Juvenile coho salmon tend to rear in cool tributaries in contrast to Chinook salmon, which reportedly stay in warmer main rivers. The diet of juvenile coho salmon consists mainly of aquatic insect larvae and terrestrial insects, although small fish are taken when available. Juvenile coho salmon rear for 12 to 24 months before beginning seaward migration as smolts (Moyle, 2002). The majority of coho salmon remain at sea for 16 to 18 months before returning to freshwater to spawn (Moyle, 2002). Some males may return as "jacks" after only 6 months at sea (Moyle, 2002).

Rainbow Trout/Steelhead

Rainbow trout are native to the upper Feather River and are the most popular and widely distributed gamefish in California (Moyle, 2002). Rainbow trout are currently stocked in the Thermalito forebay (DWR, 2001b), and naturally spawning populations of rainbow trout currently exist in the tributaries upstream from Lake Oroville (FERC, 2005). Rainbow trout were experimentally stocked in Lake Oroville by DFG during the 1970s and 1980s (DWR, 2001b).

Most wild rainbow trout generally spawn in the spring between February and June (Moyle, 2002). Rainbow trout normally spawn by constructing redds in coarse gravel substrate, 0.5 inch to 5.1 inches in diameter, in the tail of a pool or riffle (Moyle, 2002). Most spawning is observed when water temperatures are between 46 and 52°F in water flowing at from 0.2 foot/second to 3.6 feet/second (FWS, 1995b). Water temperatures above 63°F reportedly are lethal to developing rainbow trout embryos (Moyle, 2002). Eggs normally hatch in 3 to 4 weeks. For the first year of life, juvenile rainbow trout normally inhabit cool, fast-flowing streams and rivers where riffles predominate over pools and where riparian vegetation and undercut banks provide cover (Moyle, 2002). Older rainbow trout tend to move into deeper runs or pools (Moyle, 2002). Rainbow trout are reportedly found where daytime water temperatures range from 32°F in the winter to 80.6°F in the summer, although 73.4°F is reportedly lethal for unacclimated fish (Moyle, 2002).

Steelhead and rainbow trout are the same species (*O. mykiss*), with steelhead being the anadromous form. Additional discussion regarding Central Valley steelhead is provided in section 3.3.5, *Threatened and Endangered Species*.

Sturgeon

Two species of sturgeon, white sturgeon and green sturgeon, are found within the project area. White sturgeon are more commonly observed in the Feather River than green sturgeon (DWR, 2003d). Green sturgeon were listed as threatened under ESA in 2006 and are addressed in section 3.3.5, *Threatened and Endangered Species*.

Both species are native to California, and begin an upstream spawning migration between February and June, with spawning occurring between April and June (Beamesderfer and Webb, 2002; Moyle, 2002). Sturgeon passage may be impeded at Shanghai Bend (RM 25) and Sunset Pumps on the

Feather River, particularly at lower flows in the spring and fall. Sturgeon do not typically enter the mouth of the Feather River at flows lower than about 5,000 cfs (DWR, 2005b, appendix G).

White sturgeon are known to spawn in the Feather River (Moyle, 2002). A few white sturgeon have been observed in Lake Oroville.

The occasional capture of larval green sturgeon in salmon out-migrant traps suggests that green sturgeon spawn in the Feather River (Moyle, 2002); however, NMFS reports that evidence of green sturgeon spawning in the Feather River is unsubstantiated (70 FR 17,386). Sampling efforts using SCUBA and snorkel surveys, hook and line sampling, and larval traps during preparation of the Oroville Facilities studies were all unsuccessful in documenting their presence in the Feather River.

Both species begin an upstream spawning migration between February and June, with spawning occurring between April and June (Beamesderfer and Webb, 2002; Moyle, 2002). Sturgeon passage may be impeded at Shanghai Bench (RM 25) and Sunset Pumps on the Feather River, particularly at lower flows in the spring and fall. Sturgeon do not typically enter the mouth of the Feather River at flows lower than about 5,000 cfs (DWR, 2005b, appendix G).

Lamprey

Two species of lamprey, river lamprey and Pacific lamprey, are found within the project area. Pacific lamprey are more frequently observed in the Feather River than river lamprey (DWR, 2003d). Both species are native to California and are on the DFG Watch List (Moyle, 2002), and river lamprey is designated as a state species of special concern by DFG. Both species spend 3 to 4 years in freshwater as ammocoetes (larval form of lamprey) before the metamorphosis to the adult form takes place, at which time they migrate to the ocean (Moyle, 2002). The ammocoetes burrow tail first into soft mud or sand in low velocity and edgewater areas where they filter feed on organic matter and algae off the substrate (Moyle, 2002). Rapid or prolonged drawdowns that dewater edgewater habitat are the greatest risks to larval lamprey (Beamish, pers. comm. May 1994). High water temperatures, degraded water quality, and extremely high migration barriers are additional risk factors.

River lamprey congregate upstream of saltwater for 4 months as young adults, rapidly grow to 9.8 to 12.2 inches and enter the ocean in late spring (Moyle, 2002). After about 3 months in the ocean, river lamprey return to freshwater to spawn in the fall (Moyle, 2002). River lamprey hold in freshwater for up to 8 months until spawning from April through June. Lamprey construct gravel nests and spawn at water temperatures of 55.4 to 56.3°F (Wang, 1986).

Juvenile Pacific lamprey migrate to the ocean in the fall where they spend about 3.5 years in saltwater (Beamish, 1980). Pacific lamprey enter freshwater in April through June. By September, upstream migration is complete, and adults overwinter and spawn in the spring of the following year (Bayer et al., 2001; Beamish, 1980; Close et al., 2002). Crude nests are constructed in gravelly areas, and the water temperature range for Pacific lamprey spawning is 53.6 to 64.4°F (Moyle, 2002).

Fish Diseases

Fish diseases known to occur in the project area include IHN, ceratomyxosis, coldwater disease, bacterial kidney disease, and whirling disease. Each of these diseases has been shown to infect stocked species (brook trout, rainbow trout, and coho salmon) and native salmonids in the project area; however, these diseases are not known to infect non-salmonids. Of the fish diseases occurring in the Feather River basin, those that are main contributors to fish mortality at the Feather River Fish Hatchery (IHN and ceratomyxosis) are of highest concern for fisheries management in the region (DWR, 2004s).

Infectious Hematopoietic Necrosis

IHN is a major cause of mortality in Chinook salmon, sockeye salmon, and steelhead in freshwater (Noga, 1996). As high as 100 percent mortality can occur in these species when fish are less than 6 months old, while older fish have lower mortality and may not display clinical signs of the disease. Clinical signs include lethargy, abdominal distension and a darkening of abdominal tissue (Noga, 1996). Coho salmon, brown trout, brook trout, and cutthroat trout are generally considered immune to the disease (Noga, 1996). Noga (1996) reports that water temperature plays an important role in IHN epidemics with peak mortality occurring at 50°F (10°C), and lower mortality above 50°F (10°C). Noga (1996) did not report specific percentages of mortalities; however, he did cite Amend (1975) as stating that no documented mortalities above 59°F (15°C) have been reported. The Feather River hatchery uses water temperatures in excess of 59°F (15°C) to reduce mortalities during IHN outbreaks.

During epidemics, IHN is readily transmitted from one individual to another. Ectoparasites (e.g., leeches) and insects are considered reservoirs for the virus (Noga, 1996). Water disinfection and quarantine are currently the only proven methods of controlling IHN epidemics (Noga, 1996).

DWR contracted with University of California at Davis and FWS fish pathologists to examine the potential effects of the IHN virus on Feather River and other Central Valley salmonids. The study was conducted because of the severe IHN problems at the Feather River Fish Hatchery in 2000 and 2001. The genetic study showed that in the Central Valley, IHN has evolved from the original strain to several different strains, with the Feather River acting as the site of much of this activity. The strains did not appear to be developing into more virulent forms of the virus. Field surveys indicated that IHN was not present in juvenile salmonids or other fish in either the Yuba or Feather River watersheds. Adults returning to both watersheds were infected with IHN, with 28 percent (average of samples from 3 locations) and 18 percent, respectively, for the Yuba and Feather Rivers (Brown et al., 2004). There were no clinical signs of disease in these fish. Because stocking of Chinook salmon in the reservoir have been discontinued, no additional epizootics have been observed, although it is not known whether this measure will prevent future IHN outbreaks at the Feather River Fish Hatchery (DWR, 2004j).

Ceratomyxosis

Ceratomyxosis is caused by *Ceratomyxa shasta (C. shasta)*, an endemic myxosporean parasite that is lethal only to salmonids. The parasite is prevalent in both the waters of the Thermalito Complex and Lake Oroville (DWR, 2001b). Ceratomyxosis can cause up to 100 percent mortality among juveniles and is a cause of pre-spawning mortality in salmon (Noga, 1996). Rainbow trout, Chinook salmon, and chum salmon (*O. keta*) are the species most susceptible to ceratomyxosis, while coho salmon, brown trout, and brook trout are less susceptible (Noga, 1996). Transmission of the disease occurs when fish are exposed to the infectious stage of *C. shasta*. There is no known record of transmission between fish and the necessity of an intermediate host is strongly suspected (Noga, 1996).

Salmonid populations that are native to rivers where *C. shasta* naturally occurs appear to have developed varying degrees of resistance to infection (Noga, 1996). The strains of rainbow trout stocked in the Thermalito forebay are particularly sensitive to *C. shasta* infections.

Coldwater Disease

Another potential disease of concern for Oroville Facilities waters is coldwater disease (*Flavobacterium psychrophilum*). This disease exists at temperature of 65°F or less. More serious losses occur near the bacterium's growth optimum of about 60°F.

Flavobacterium psychrophilum is a bacterium known to affect wild and hatchery populations of virtually all salmonid species. This bacterium can cause mortality of up to 50 percent among young salmonids. Outbreaks of coldwater disease generally occur at temperatures below 61°F.

Bacterial Kidney Disease

Bacterial kidney disease is a chronic disease that is economically significant to hatcheries, particularly those raising Pacific salmon, because of its widespread distribution in both freshwater and saltwater environments. The disease is caused by *Renibacterium salmoninarium* and only occurs in salmonids. Although any age fish is susceptible to the disease, losses do not typically occur until the fish are over 6 months old (Noga, 1996). Even fish with severe infections may have no external signs (Noga, 1996). The disease is transmitted both horizontally and vertically.[58] Vertical transmission is particularly problematic because the bacterium resides within the yolk and is protected from antiseptics (Evelyn et al., 1984, as reported in Noga, 1996).

There are no proven methods to eradicate bacterial kidney disease infection in fish (Noga, 1996). However, injection of female broodstock with erythromycin can prevent vertical transmission of the disease (Moffitt, 1992). As mentioned above, the presence of bacterial kidney disease in source stock for coho prevented stocking of coho in Lake Oroville in 2004 and 2005.

Whirling Disease

Whirling disease, a European disease introduced into North America in the late 1950s, is caused by the metazoan parasite, *Myxobolus cerebralis*. To date, whirling disease has caused severe damage primarily to wild rainbow trout populations in Montana and Colorado, but it affects hatchery salmonids as well. *Myxobolus cerebralis* was first detected in California in 1966 and is now found in many Central Valley drainages, including the Feather River. Although present in several watersheds in California, no adverse effects on salmon or trout populations have been observed in California (Modin, 1998). Native North American salmonids are more susceptible than European salmonids to the disease. Brown trout, which originated in Europe, have developed some resistance and may carry the parasite without succumbing to the disease.

Currently, hatcheries can only eliminate whirling disease by water disinfection, quarantine, and re-population with pathogen free stock. Raising fish in concrete raceways is also a helpful prevention measure because the intermediate host for the organism is the sludge worm (*Tubifex tubifex*) (Noga, 1996).

Predation

Current fish stocking practices in the project area include stocking of catchable-size brook trout and rainbow trout in the Thermalito forebay and, when cleared of bacterial kidney disease, stocking coho salmon in Lake Oroville. These introduced fish have the potential to prey on fish species of concern in the project area and downstream from the project. An examination of available reports by DWR (DWR, 2004j) indicated that few stocked fish escape from the reservoirs in which they are stocked. A review of the literature on competition and predation with emphasis on the species that are stocked indicates that the potential for competitive or predatory interactions with fish species of concern in the Feather River are minimal, as current stocking practices minimize the likelihood of significant emigration of stocked fish from the reservoirs. For example, only catchable size fish are stocked in the Thermalito forebay, and the stocking protocols for coho salmon in Lake Oroville are designed to minimize the stocking of fingerlings during the spring when higher flows may cause significant numbers of fish to escape the reservoir over the spillway.

[58] Horizontal transmission occurs from fish to fish. Vertical transmission is from fish to egg.

Macroinvertebrate Populations

Aquatic macroinvertebrates consist primarily of insects, snails, clams, shrimp, and zooplankton. Aquatic macroinvertebrates and plankton are important components of the biological foodweb in any aquatic ecosystem. Many invertebrate species are important to the recycling of nutrients in aquatic systems. They also are an important food source for fish, and their community structure and diversity are important factors in determining general ecosystem conditions. DWR conducted studies to describe the condition of aquatic macroinvertebrate and plankton communities present in both the impounded and free-flowing freshwater habitats within the project boundary of the Oroville Facilities. Findings from DWR (2004t) are presented in tables 29 through 31.

Table 29. Metrics used to describe benthic macroinvertebrate samples collected following the California Stream Bioassessment Procedure. (Source: DFG, 2007)

Metric	Description	Expected Response to Impairment
Richness Measures		
Cumulative taxa	Total number of individual organisms	Decrease
EPT taxa	Number of taxa in the Ephemeroptera, Plectoptera, and Trichoptera insect orders	Decrease
Ephemeroptera taxa	Number of mayfly taxa (genera)	Decrease
Plectoptera taxa	Number of stonefly taxa (genera)	Decrease
Trichoptera taxa	Number of caddisfly taxa (genera)	Decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly, and caddisfly larvae	Decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly, and caddisfly larvae with tolerance values of 0 through 3	Decrease
Shannon Diversity Index	General measures of sample diversity that incorporates richness and evenness	Decrease
Tolerance/Intolerance Measures		
Tolerance value	Value between 0 and 10 weighed for abundance of individuals designated as pollution tolerant (lower values)	Increase
Percent intolerant organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1, or 2	Decrease
Percent tolerant organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9, or 10	Increase
Percent Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	Increase
Percent Baetidae	Percent of organisms in the mayfly family Baetidae	Increase
Percent Chironomidae[a]	Percent composition of midge larvae	Increase

Metric	Description	Expected Response to Impairment
Percent dominant taxa	Percent composition of the single most abundant taxon	Increase
Functional Feeding Groups		
Percent collectors	Percent composition of taxa that collect or gather fine particulate organic matter	Increase
Percent filterers	Percent composition of taxa that filter fine particulate organic matter	Increase
Percent scrapers	Percent composition of taxa that graze upon periphyton	Variable
Percent predators	Percent composition of taxa that feed on other organisms	Variable
Percent shredders	Percent composition of taxa that shreds coarse particulate matter	Decrease

[a] This metric is described as "percent 'true' fly family – Diptera" in DWR (2004t).

Aquatic Macroinvertebrates

Generally, macroinvertebrate diversity was consistent with expectations for large rivers in the watershed of the Sacramento–San Joaquin Rivers. The macroinvertebrate community at all the field stations included taxa that are important prey of the fish species in the river (DWR, 2004t). Immature life stages (larvae or nymphs) of true flies, mayflies, and caddis flies were the most prevalent organisms sampled from all sites combined, and collectors, filterers, and grazers were the most dominant functional feeding groups in the study area from all sites combined.

Generally, the highest taxa richness occurred in tributaries to Lake Oroville, while the lowest taxa richness occurred at the collection site in the Lake Oroville inundation zone, the Feather River site upstream of the Feather River Fish Hatchery, and at several Feather River sites between the Thermalito afterbay outlet and Honcut Creek (tables 30 and 31).

Phytoplankton and Zooplankton

Phytoplankton from 9 taxonomic groups were identified from 14 collection sites. Overall, phytoplankton communities sampled were dominated by diatoms (57 percent), green algae (16 percent), cryptomonads (9 percent), and blue-green algae (9 percent). Five other taxonomic groups accounted for the remaining 9 percent.

Diatoms were the most abundant algae type found in Lake Oroville, the Thermalito Complex, and the fish barrier pool, while green algae were dominant in the OWA. Zooplankton from three taxonomic groups were identified from six collection sites. Rotifers were the most prevalent group observed at all Lake Oroville stations, followed by copepods and cladocerans. Thermalito afterbay samples were dominated by copepods, followed by cladocerans and rotifers.

The benthic macroinvertebrate community downstream of the fish barrier dam and in areas upstream of Lake Oroville had high percentages of filterers, suggesting that the abundance of plankton (i.e., the preybase for filter feeders) is not a limiting factor either upstream or downstream of Oroville dam.

Table 30. Summary information by geographic area for macroinvertebrates collected by DWR and CSU-Chico with a kick screen and metal frame in fall 2002 and spring 2003. (Source: DWR, 2004t)

	Entire Study Area	Stream Reaches Upstream of Lake Oroville Inunda-tion Zone	Lake Oroville Inunda-tion Zone	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet[a]	Feather River Downstream from Thermalito Afterbay Outlet to Honcut Creek	Feather River Downstream from Thermalito Afterbay Outlet to Honcut Creek[a]	Oroville Wildlife Area	Lower Feather River downstream of Honcut Creek
Number of sites	33	7	1	6	8	3	4	1	3
Cumulative taxa	16–49	31–49	19	20–32	20–35	16–24	18–28	28	22–24
EPT taxa	4–29	12–29	4	7–11	6–14	7–13	8–13	10	10–15
EPT Index (%)	5–95	10–68	47	5–69	11–81	67–84	46–95	72	68–84
Shannon Diversity Index	0.9–2.7	2.0–2.7	1.8	0.9–2.4	1.5–2.2	1.6–2.0	1.7–2.1	2.3	1.6–2.1
Tolerance value	3.0–6.0	3.9–5.7	4.6	4.7–6.0	3.1–4.8	4.4–4.7	3.0–4.4	4.6	4.5–4.7
%Hydropsychidae	0–48	0–21	38	1–25	0–35	45–48	10–41	19	3–26
% Baetidae	3–57	3–27	7	1–42	7–55	14–31	11–47	30	42–57
% Chironomidae	3–83	9–54	30	10–83	3–54	8–18	3–48	14	8–24
% Collector	26–95	37–68	42	35–90	53–95	33–42	26–86	57	60–88
% Filterer	0–73	1–36	43	6–40	0–46	46–51	13–73	21	4–30
% Grazer	0–46	9–44	2	0–46	0–35	6–17	0–3	19	6–8
% Predator	0–12	0–12	12	3–10	0–2	1–2	not found	5	1–5
% Shredder	0–6	0–6	Not found	None found	0–2	Not found	0–4	Not found	Not found

[a] Data obtained from CSU at Chico in 2003.

Table 31. Summary information by geographic area for macroinvertebrates collected by DWR with a ponar grab in fall 2002 and spring 2003. (Source: DWR, 2004t)

	Entire Study Area	Low Flow Channel	Oroville Wildlife Area	Lower Feather River downstream of Honcut Creek	Sacramento and Yuba Rivers
Number of sites	6	1	1	2	2
Cumulative taxa	3–15	10	6	3	3–15
EPT taxa	0–3	1	1	0–1	0–3
EPT Index (%)	0–30	1	2	0–2	0–30
Shannon Diversity Index	0.5–1.8	1.3	1.0	0.5–0.8	0.7–1.8
Tolerance value	5.8–6.4	6.4	5.8	5.9–6.0	5.8–5.9
%Hydropsychidae	0–1	1	Not found	Not found	Not found
% Baetidae	Not found	Not found	Not found	Not found	Not found
% Chironomidae	1–79	1	61	13–37	19–79
% Collector	15–94	78	94	15–37	75–86
% Filterer	0–85	17	Not found	58–85	0–14
% Grazer	0–5	Not found	Not found	0–5	0–1
% Predator	0–24	5	6	Not found	0–24
% Shredder	Not found	Not found	Not found	Not found	Not found

3.3.3.2 Environmental Effects

This section discusses the effects of the Proposed Action on aquatic resources in the river reaches affected by project facilities, operations, flood control, and compliance monitoring. The effects of the Proposed Action on water quantity, water quality, channel geomorphology, and riparian habitat are discussed in other sections.

Several of the proposed measures are conservation measures that would benefit ESA-listed spring-run Chinook salmon and steelhead. These include the Gravel Supplementation and Improvement Program (Proposed Article A102), the Lower Feather River Channel Improvement Program (Proposed Article A103), and the Flow/Temperature to Support Anadromous Fish (Proposed Article A108). These measures are addressed in section 3.3.5.2*, Threatened and Endangered Species*.

Lower Feather River Structural Habitat Supplementation and Improvement Program (Proposed Article A104)

The Oroville dam blocks LWD in the watershed upstream of Lake Oroville from moving downstream into the Feather River, contributing to a reduction in structural habitat complexity in the Feather River, particularly the low flow channel. DWR's study results indicated that the low flow channel does not have sufficient LWD.

Under Proposed Action A104, *Lower Feather River Structural Habitat Supplementation and Improvement Program*, within 2 years of license issuance, DWR would develop and file for Commission

approval a Structural Habitat Supplementation and Improvement Program Plan to provide additional salmonid rearing habitat in the Lower Feather River. The Proposed Action would create additional cover, slow-water/edge-water habitat, and channel complexity in the Feather River through the addition of LWD, boulders, and other native objects. As proposed, the LWD would be multi-branched trees at least 12 inches in diameter at breast height and a minimum of 10 feet long and preferably at least 20 feet long or longer. At least 50 percent of the trees would have attached rootwads. A minimum of two pieces of LWD, boulders, or other material would be placed per riffle in the low flow and high flow channels from RM 54.2 to 67.2. Additional pieces may be placed as appropriate. The Structural Habitat Supplementation and Improvement Program Plan would also include a recreational safety analysis, addressed in section 3.3.6.2, *Recreational Resources*.

The plan, including a map of existing LWD, riparian habitat, and recruitment potential, would be developed in consultation with the Ecological Committee within 2 years of licensing and implemented within 2 years of Commission approval. Structural placements would be monitored after high flows (to be defined), or at least once every 5 years in the absence of high flows. An annual report would include monitoring and implementation results.

DWR (2005a) evaluated a LWD Recruitment Program; however, it did not include as many types of structural materials as the program outlined in Proposed Article A104, *Structural Habitat Supplementation and Improvement Program Plan*. Regardless, the concept of improved instream cover and increased channel complexity is consistent with the LWD program analyzed in the preliminary draft environmental assessment (DWR, 2005a). DWR determined the LWD supplementation would be beneficial and "likely to provide significant improvements in the quality and quantity of salmonid habitat in the Feather River with negligible adverse effects for warmwater species."

Staff Analysis

The Oroville Facilities have eliminated the upstream supply of LWD. The proposed LWD supplementation and boulder placements would benefit all aquatic resources by providing substrate for the algae and macroinvertebrates that are the basis of the foodchain, creating pools and structures that are velocity breaks during high flows, increased channel complexity (e.g., substrate sorting, gravel retention, cover, and pool development), and increased spawning habitat. Adult Chinook salmon and steelhead hold in large pools during spawning migrations; spring-run Chinook salmon hold in pools longer than fall-run fish; and all salmonids typically spawn in pooltail crests (the downstream end of a pool where it breaks into a riffle) that structural elements, such as LWD and boulders, create.

Pools formed by LWD and boulders are also important juvenile steelhead and resident fish habitat. Increased habitat complexity creates more cover and rearing habitat for territorial and piscivorous fishes, such as juvenile steelhead. Numerous studies show that high fish densities are associated with LWD. When anadromous fish populations thrive, the aquatic community benefits from the increased productivity and addition of marine-derived nutrients into the freshwater ecosystem.

The Proposed Action would require at least 50 percent of the trees to have attached rootwads to provide complex habitat with long-term stability. Study results indicate that 94 percent of the LWD observed in the Feather River had a rootwad or a remnant rootwad attached. These results indicate that the trees without attached rootwads would have a low probability of being retained and would have a high probability of being flushed downstream during high flows.

Given the current conditions in the low flow and high flow channels (i.e., low levels of LWD and no natural recruitment) and size of the river, the proposed minimum size of the supplemental LWD (i.e., 10 feet long) would likely be insufficient for substantial fisheries habitat enhancement or long-term retention. The proposed LWD supplementation is at the rate of a minimum of two pieces of LWD, boulders or other material per riffle. With an average of one to four riffles per mile, this translates to a minimum of two pieces to eight pieces per mile. At a minimum level of augmentation (two to eight

pieces per mile), fisheries habitat would not substantially improve over current conditions, unless certain steps are taken to limit LWD movement. Studies have documented downed, natural LWD traveling an average of 6 miles downstream in approximately 1 year (see section 3.3.1.1, *Affected Environment* in *Geology, Soils, and Paleontological Resources)*. Therefore, LWD with the proposed characteristics would likely move out of the low flow and high flow channels relatively quickly were it not arranged properly or integrated into existing LWD. The proposed monitoring and maintenance program every 5 years would enable DWR to assess the effectiveness of the proposed approach and to adjust the amount and size of LWD if the proposed approach is not adequate to achieve the intended habitation benefits.

Lower Feather River structural habitat supplementation would probably have no effect on green sturgeon, as they are not known to occur in the project area. If larval or juvenile sturgeon do use the project area, the proposed habitat improvements may be beneficial.

Water quality-related effects could occur during implementation of this measure, including sedimentation, turbidity and petrochemical contamination that have the potential to adversely affect all fish species. Best management practices would be implemented to minimize these potential adverse effects; however, short-term sediment and turbidity plumes would occur as a result of these activities.

Riparian and Floodplain Improvement Program (Proposed Article A106)

Historically, the Central Valley System, including the Sacramento River System, was the source of most of the Pacific salmon produced in California (Yoshiyama et al., 1998). The Central Valley System was typified by low gradient, complex channels, wetlands, and interconnected floodplains with extensive riparian vegetation.

The Feather River and its associated riparian vegetation have been affected by disruption of natural geomorphic processes, including disconnected floodplains, flow regulation that alters the timing, magnitude and duration of peakflows and baseflows, dams that block sediment transport, wetland and side-channel filling, hydraulic mining that creates coarse tailings, and streambanks that are riprapped to prevent channel migration (see section 3.3.1.1, *Affected Environment* in *Geology, Soils, and Paleontological Resources*).

Under Proposed Article A106, *Riparian and Floodplain Improvement Program*, within 6 months of license issuance, DWR would develop and file for Commission approval a plan for a phased program to enhance riparian and other floodplain habitats for associated terrestrial and aquatic species. The plan would address reconnecting portions of the floodplain in the low flow channel and the high flow channel within the OWA and specify areas where gravel could be extracted to improve fish and wildlife habitats. Higher priority would be given to projects that benefit a variety of resources. The effects on terrestrial species are discussed in section 3.3.4.2, *Environmental Effects* in *Terrestrial Resources*.

Riparian and floodplain improvement projects and gravel value and extraction processes would be developed, assessed, and recommended to the Ecological Committee within 1 year of licensing (Phase 1). Within 8 years of licensing, DWR would complete final designs and commence implementing the approved alternative (Phase 2). DWR would fully implement Phase 2 within 15 years of license issuance.

In addition, DWR would evaluate other feasible projects identified in Phase 1 and recommend an alternative for implementation (Phase 3) within 15 years of license issuance. DWR would implement the approved Phase 3 alternative within 25 years of licensing (Phase 4). The Riparian and Floodplain Improvement Program would be developed in consultation with the Ecological Committee. An annual report would include monitoring and implementation results.

DWR did not evaluate a Riparian and Floodplain Improvement Program in the preliminary draft environmental assessment (DWR, 2005a). However, the riparian, wetland, and floodplain study plan (DWR, 2002e) indicated that such a plan would be beneficial to native fishes.

Interior (on behalf of FWS), and DFG filed 10(j) recommendations consistent with Proposed Article A106, *Riparian and Floodplain Improvement Program*.

Staff Analysis

Implementing riparian habitat and floodplain connectivity projects would be beneficial to both warmwater and coldwater aquatic communities. Aquatic and terrestrial macroinvertebrates that are the prey base for many fish species depend on riparian vegetation during their life cycles so that an increase in riparian zone vegetation would increase macroinvertebrate production. Increased riparian vegetation would also provide: (1) streambank stability to reduce erosion and trap overland sediment before it enters waterways, (2) streamshade to moderate daily water temperature fluctuations, (3) LWD recruitment potential, (4) overhead cover, and (5) velocity breaks for juvenile and small fishes during high flow. Increased floodplain connectivity would decrease the force of peakflows that can displace fish downstream, scour redds, and erode streambanks. Floodplain connectivity also traps and stores sediment to replenish riparian vegetation and protect aquatic habitat. These effects would improve the abundance and health of fish populations.

Floodplain inundation provides more abundant and diverse warm, shallow-water habitat, and favorable water velocities than riverine habitat (Sommer et al., 2004; 2001a; 2001b). Sommer et al. (2004) found greater phytoplankton biomass and higher densities (up to an order of magnitude) of Diptera and other terrestrial macroinvertebrates in the Sacramento River floodplain than in the river. These trophic foodwebs respond quickly to floodplain inundation and even short periods of floodplain connectivity may provide ecosystem-level benefits (Sommer et al., 2004).

The most abundant group of Diptera found in the Sacramento River study was chironomids, which may be a "key link" to fisheries production, including Chinook salmon and steelhead (Sommer et al., 2004). Most young-of-the-year Chinook salmon emigrate from the project area within days of emergence. Sommer et al. (2001b) found floodplains represent one of the most important rearing habitats for juvenile Chinook during downstream migration; high densities of chironomids were determined to be a major reason for enhanced salmon growth and survival.

Chironomids are also a primary food sources for juvenile Sacramento splittail. Therefore, the frequency and duration of floodplain inundation may also be directly linked to the year class strength of splittail (Sommer et al., 1997). Feather River studies that show flow and duration of inundation are highly correlated with splittail year-class strength support these conclusions. The strongest year classes in 21 years are correlated to high flows; the weakest year classes are correlated with low flows (DWR, 2005j).

Dredger tailings form large piles of gravels and cobbles that unnaturally elevate the level of the floodplain, and coupled with the altered flow regime function to adversely affect inundation (and substrate) required for establishment and growth of riparian vegetation. These are important on-going processes that set the trends of current and future floodplain conditions. Flood/pulse flows that exceed the current bankfull stage are needed to restore and maintain floodplain connectivity, channel function, aquatic habitat (e.g., to break up armored substrate), and riparian vegetation, such as cottonwood, requires periodic scouring to regenerate and maintain a variety of age classes over time (see section 5.3.2.3, *Geology, Soils, and Paleontological Resources*).

Considering the quantity and quality of existing riparian, floodplain, and aquatic habitats and the time it would take for riparian vegetation to mature after project implementation, the proposed 25-year schedules for full implementation of the Riparian and Floodplain Improvement Program projects may not provide timely protection of beneficial uses, particularly anadromous fish habitat. Under the Proposed Action, riparian and floodplain conditions would remain degraded or continue to decline for at least 15 years until the first measures would be implemented.

High flow releases that increase nitrogen gas saturation, such as occurred at the Nimbus Fish Hatchery in 2006, can cause physiological stress and increase the risk of IHN, and sediments stirred up by increased flows may also spread IHN (Bacher, 2006). If so, increased incidences of IHN may occur as a result of flood/pulse flows, if such flows were implemented.

Lake Oroville Warmwater Fishery Habitat Improvement Program (Proposed Article A110)

Angling for non-native, warmwater game fish is an important component of Lake Oroville recreation mitigation (to compensate for loss of coldwater fisheries) under the current license. Proposed Article A110, *Lake Oroville Warmwater Fishery Habitat Improvement Program*, would be similar to the program DWR implements under the current license.

Under the Proposed Action, DWR would develop a plan to improve the warmwater fisheries habitat in Lake Oroville and file it for Commission approval within 1 year of license issuance. The plan, which would be developed in consultation with the Ecological Committee and specified consultees, would provide for constructing, operating, and maintaining projects to improve warmwater fisheries spawning and rearing habitat within the reservoir fluctuation zone. Boulders, Christmas trees, weighted pipes, riprap, LWD, native flood-tolerant woody vegetation, and annual grasses would be used to created structural habitat.

The projects would be implemented in 7-year intervals, except for the final interval, which would occur before the license expires. DWR would spend approximately $40,000 annually, or a total of $280,000 per each 7-year program interval. Of this amount, 75 percent would be spent to construct, operate, and maintain warmwater fisheries habitat improvements. The remaining 25 percent would be spent to monitor the success of fisheries improvements and to cover overhead expenses. An average of 15 habitat units ($2,000 expenditure is equivalent to one unit) would be constructed annually.

The monitoring program would include angler creel surveys, electrofishing, and spring snorkel surveys to measure the success of habitat improvements. Habitat units may be modified based on monitoring results, need, or technology improvements within annual cost limits. DWR could modify the implementation measures within the scope of the approved plan, in consultation with the Ecological Committee and specified consultees. The Commission would need to approve modifications outside the scope of the plan. DWR would file a report of monitoring, implementation, and maintenance results with the Commission annually and at the end of each 7-year interval. DWR (2002f) indicated continuing the current warmwater fisheries program with additional action items would benefit the Lake Oroville warmwater fish community.

Staff Analysis

Black bass, particularly largemouth bass, would be the target species that would benefit from the proposed habitat structures. The black bass species in Lake Oroville have stable or expanding populations. The focus of the Lake Oroville Warmwater Fishery Habitat Improvement Program would be to continue to increase existing bass habitat for these recreationally important game fishes. Brush shelters would be installed in clusters in back coves with shallow sloping banks where black bass commonly spawn. The shelters would be placed between elevation 775 to 875 feet msl because juvenile bass can be found down to a depth of 25-feet during the summer and fall, when the surface elevation of the lake typically ranges are 800 to 900 feet. These types of structures would protect bass nests from wave action and increase post-spawn survival.

Channel catfish typically spawn in cave-like structures; these types of structures have been constructed in Lake Oroville as part of the current program. In large reservoirs, nests generally occur at depths of 6.6 to 13.2 feet (McMahon and Terrell, 1982). Sections of 9 to 18-inch diameter concrete and PVC pipe would be used to create artificial channel catfish spawning habitat. Culverts, steel pipe,

buckets, rock rubble, and other items could also be used to create cave-like structures. These structures would be placed in the same areas and elevations described for the black bass brush shelters and would provide good channel catfish spawning habitat.

Native, flood-tolerant trees would be planted in the fluctuation zone between elevation 850 and 890 feet msl. Willow, buttonbrush, and other species can survive periodic inundation and subsequent drying, after they become established. Elevation 850 feet msl would be the lower limit due to the possibility of year-round inundation. The back coves and shallow slopes of the fluctuation zone that would be ideal fish habitat for planting are hot and dry when they are exposed from approximately mid-July to mid-October. During the first 2 years after the trees are planted, irrigation would be needed to significantly reduce mortality and improve growth rates. The trees that survive and become established would provide complex, long-term habitat and benefit the Lake Oroville warmwater recreational fishery.

Largemouth bass, smallmouth bass, striped bass, spotted bass, and other non-native, warmwater game fish that prey on native species of special concern, including Chinook salmon and steelhead, are common or expanding in the Feather River Watershed as the result of past stocking programs (see table 26). The Lake Oroville warmwater fishery is self-sustaining, and fish stocked in the lake escape downstream over the spillway at high flow and upstream when the tributaries are passable. Warmwater habitat has been created in the Feather River, in the OWA ponds, and in the tributaries upstream of Lake Oroville due to cumulative effects of the Oroville Facilities and other projects. The warmwater habitat and the transition zones between the warmwater and coldwater habitats favor predatory, warmwater game fish with adverse effects on native fishes and amphibians. Increasing the amount of warmwater fish habitat would increase the warmwater, non-native game fish populations, which in turn would increase the negative impacts on the coldwater fish community. The effects of introduced non-native, game fish predation on native amphibians are addressed in section 3.3.4, *Terrestrial Resources.*

Lake Oroville Coldwater Fishery Habitat Improvement Program (Proposed Article A111)

Lake Oroville does not have suitable habitat to support self-sustaining populations of coldwater sportfish that require cold, flowing water and clean spawning gravel; there is some seasonally accessible habitat with these characteristics in the tributaries above the lake. However, three species that are no longer stocked, rainbow trout, brown trout, and lake trout are still caught infrequently (DWR, 2003b).

Under Proposed Article A111, *Lake Oroville Coldwater Fishery Habitat Improvement Program*, a plan for a coldwater, recreational fishery in Lake Oroville would be developed and filed for Commission approval within 1 year of licensing. The plan would be developed in consultation with the Ecological Committee and other specified consultees.

The plan would provide for stocking 170,000 yearling salmon or equivalents per year, plus or minus 1 percent. The cost of the program would not exceed $75,000 annually. Of this amount, $68,000 would be spent on the stocking costs and $7,000 would be spent on monitoring.

The plan would focus on the first 10 years after licensing, and would be revised every 10 years. A report including monitoring and implementation results would be filed with the consultees for review and recommendations every 2 years.

Interior (on behalf of FWS) and DFG filed 10(j) recommendations consistent with Proposed Article A111, *Lake Oroville Coldwater Fishery Habitat Improvement Program*.

Other Recommendations

The Anglers Committee et al. letter dated December 12, 2005, recommends that a coldwater fish disease management plan be developed and implemented in Lake Oroville. The letter also recommends that DWR: (1) conduct studies to determine the source of disease(s) in rainbow trout stocked in the lake;

(2) prepare a coho monitoring, stocking, and sterilization plan; (3) develop a Chinook salmon and brown trout stocking program; and (4) upgrade the water sterilization system.

The Anglers Committee et al. also recommend that DWR conduct studies to determine the amount of silt deposited and the amount of silt that would be deposited for the life for the project in the North Fork arm downstream of Big Bend dam. The study would disclose and evaluate the effects of fish diseases related to sediment, among other things. The study would be submitted for public review and comment. A similar study would be conducted on the West Branch arm upstream of the Lime Saddle Marina. According to the Anglers Committee, the Commission would require DWR to remove the silt from all areas of the reservoir as determined by the Commission and other water quality enforcement agencies.

In its response to the recommendations, terms, and conditions, prescriptions, and settlement comments dated May 26, 2006, DWR states that the Anglers Committee et al. and Plumas County[59] concerns regarding coldwater fish diseases have been addressed by the Settlement Agreement.

Staff Analysis

Fish Diseases

The history of disease associated with the Feather River Fish Hatchery has been addressed in section 3.3.3.1, *Affected Environment*, in *Aquatic Resources*. Oroville Facilities and operations, including the fish hatchery and stocking program, have produced environmental conditions that are more favorable to pathogens than historical conditions.

Fish diseases in Feather River hatchery fish may have been influenced primarily by species and stock origin (DWR, 2004s). The combination of mixing fish species, stocking of fish species susceptible to disease, water quality conditions, and elevated water temperature in the summer may also increase the potential for disease outbreaks in Lake Oroville (DWR, 2004s).

Generally, hatchery fish are more susceptible to disease than wild fish because of crowded conditions in the hatchery. Other factors affecting fish diseases in project waters are water quality problems (e.g., high temperatures, low DO), introduction of new diseases from fish management practices, water transfers, and the fish barrier dam that concentrates spawning fish and increases their exposure to pathogens.

The DWR fish disease study (DWR, 2004s) evaluated the effects of ongoing and future project operations on the establishment, transmission, extent and control of IHN, bacterial kidney disease, and other significant fish diseases causing substantial losses to fish populations in the Feather River watershed. Endemic salmonid pathogens occur in the Feather River watershed that cause a number of diseases, including IHN, ceratomyxosis, coldwater disease, bacterial kidney disease, and whirling disease have infected stocked species (brook trout, rainbow trout, and coho salmon) and native salmonids in the project area; however, these diseases are not known to infect non-salmonids.

While these pathogens occur naturally, the Oroville Facilities, non-project reservoirs, water diversions, agriculture, and silviculture may have produced environmental conditions that are more favorable to these pathogens as compared to historic conditions (DWR, 2004s). For instance, impediments to fish migrations may have altered the timing and the duration of exposure of anadromous salmonids to certain pathogens. Fish management practices, such as introductions of exotic fish species, hatchery production, and out-of-basin transplants, have inadvertently introduced foreign diseases. Water management activities such as transfers, pumpback operations, and flow manipulation can result in water temperature changes and/or increased fish density, which potentially increase the risk of disease.

[59] We could not find any reference to disease concerns in the Plumas County filing.

Conversely, project facilities and their operations may also have reduced the transmission and extent of some fish diseases. During the late spring and summer, the project releases cooler water into the Feather River low flow channel than existed historically. This may have suppressed outbreaks of ceratomyxosis in the steelhead populations in the river, as cool water temperatures suppress the onset of ceratomyxosis. However, cool water temperatures can be favorable for other diseases such as IHN.

Little is known about diseases and pathogens of non-hatchery fish in the Feather River watershed. The Feather River fish disease study area extended from the confluence of the Feather and Yuba rivers, upstream to the impassable fish passage barriers above Lake Oroville (DWR, 2004s). Current information provides no evidence to suggest that disease outbreaks or disease-related fish kills have ever occurred downstream of the project. Moreover, fish that were captured at the screw traps in the lower Feather River downstream of the project did not indicate that captured fish were infected with significant diseases of concern, although several environmental stressors exist downstream of the project that potentially influence outbreak of fish diseases downstream.

Of the fish diseases occurring in the watershed, the main contributors to fish mortality at the Feather River hatchery are IHN and ceratomyxosis, and these diseases are of highest concern for fisheries management in the region. Although other pathogens associated with disease may occur in Feather River fish, they do not necessarily lead to significant fish mortality or threaten fish populations because many fish disease organisms co-exist with the host species and natural populations without causing regular or significant outbreaks, and/or wide spread mortality (Plumb, 2002, in DWR, 2004s). However, if environmental conditions become unfavorable for the host and some stressor(s) compromises individual immune systems or natural resistance, disease outbreaks may result.

IHN and ceratomyxosis are the main causes of fish mortality at the Feather River Fish Hatchery. DWR has implemented disease control procedures, such as cooler water temperatures, to minimize the outbreak of disease in the hatchery (DWR, 2004j) and stocking coho salmon instead of Chinook salmon or brown trout in Lake Oroville. DWR replaced the stocking of these species in 2002 and 2003 with coho salmon to reduce the risk of infecting native salmonids with IHN because they are less susceptible to the disease, although some coho salmon stocks are susceptible to ceratomyxosis.

Pumpback operations in the Thermalito Complex are generally thought to warm project waters during the May through August irrigation season. This may have reduced this incidence of IHN, which is limited by warmer water, but may be favorable to ceratomyxosis, which is more common in warmer temperatures. However, this mechanism is poorly understood in the project waters.

Ceratomyxosis and minor incidence of IHN have been reported from the Thermalito annex fish facility. The minor incidence of IHN was due to infected fish being transferred from the main Feather River Hatchery, and it is believed that the higher water temperature in the Thermalito annex fish facility has slowed the spread of IHN since the disease is more problematic at cooler water temperatures. The annex is also used to reduce overall fish density at the hatchery which results in reduced stress, enhanced growth, and generally fewer disease problems (DWR, 2004s). Warmer water also can reduce the probability of outbreaks of other diseases that are more virulent in colder waters, such as bacterial kidney disease.

Steelhead and rainbow trout mortalities due to ceratomyxosis at the annex were attributed to water from Thermalito afterbay (DWR, 2004s). It is possible that ceratomyxosis outbreaks at the hatchery were related to amplification of *C. shasta* in rearing waters due to the stocking of susceptible salmonid species and stocks in the Thermalito forebay and Lake Oroville tributaries (DWR, 2004s). The progression of ceratomyxosis is also influenced by water temperature. Rainbow trout and steelhead are normally highly susceptible to ceratomyxosis, while Chinook and coho salmon are less susceptible. Mortality generally occurs when water temperatures exceed 50°F (10°C); however, fish can become infected at temperatures as low as 39°F (3.9°C) (Bartholomew, 2001, in DWR, 2004s). Therefore, cooler water temperatures at the hatchery would reduce the risk of ceratomyxosis outbreaks. Because *C. shasta*

is found naturally in the Feather River, native salmonids exhibit some natural resistance to ceratomyxosis, and the risk of *C. shasta* transmission to fish populations in the Feather River below the hatchery is considered minimal (DWR, 2004s).

Under the Proposed Action, DWR would maintain current practices and stock 170,000 yearling salmon or equivalents in Lake Oroville. Coho salmon compete with and prey on other salmonid species, particularly Chinook salmon, steelhead, and cutthroat, and may be a major cause of mortality (Moyle, 2002). The more aggressive coho typically dominate in competitive interactions with these species. Fingerling coho have escaped over the spillway during high spring flows, although the potential for competitive or predatory interactions with other fishes in the Feather River is considered minimal because coho are not typically stocked in the spring when higher flows may cause significant numbers of fish to escape the reservoir over the spillway. However, if non-native coho continue to be stocked in Lake Oroville, this species may prey on other species in Lake Oroville as well as downstream.

Under the Proposed Action, DWR would analyze the feasibility of installing a new hatchery water disinfection system and continue to address disease issues associated with hatchery fish. The disinfection system would protect hatchery production from catastrophic disease loss.

The Feather River Fish Hatchery Improvement Program (Proposed Article A107) specifies that a new water disinfection system would be installed prior to any upstream releases of anadromous salmonids above the hatchery, or if the current system is determined to be insufficient to address disease issues. Providing a new water disinfection system would reduce the risk of a coldwater fish stocking program transmitting diseases to ESA-listed Chinook salmon and steelhead, and other native salmonids from the coho salmon that are stocked in Lake Oroville.

However, Lake Oroville is not a closed system and stocked fish could potentially spread diseases to wild, native salmonids despite management precautions. The sediment wedges in the tributaries could reduce the transfer of disease by decreasing the rate of immigration and emigration from the lake. Silt removal, as proposed by the Angler Committee et al., could actually increase the incidence of IHN and other fish diseases by facilitating fish passage and releasing pathogens stored in the sediment. Other potential effects of silt removal are discussed in section 3.3.1, *Geology, Soils, and Paleontological Resources*.

Genetic Introgression

Genetic introgression between introduced hatchery stocks and wild or naturally spawned fish (e.g., rainbow trout and steelhead) is also a concern. DWR cites University of California Davis and Oregon State University studies that determined Feather River steelhead may be "at least somewhat segregated" into hatchery and naturally spawning fish (DWR, 2005k).

The University of California Davis and Oregon State University studies cited by DWR also determined all Central Valley fall-run Chinook salmon are genetically identical and that Feather River spring-run and fall-run Chinook salmon are genetically similar and most closely related to Central Valley fall-run Chinook. The genetic introgression of these runs is probably the result of fisheries management and hatchery practices, and the current timing of these runs is probably a phenotypic rather than genetic difference (DWR, 2005k).

Under the Lake Oroville Coldwater Fishery Plan, DWR would identify primary and secondary sources of hatchery salmonids, including Chinook salmon, for lake stocking. The Anglers Committee et al. also recommend that DWR develop a lake Chinook salmon stocking program. Any future Chinook salmon stocking[60] would probably have no additional affect on genetic introgression. However, the genetics management plan that is part of the proposed Feather River Fish Hatchery Improvement Program

[60] Chinook salmon stocking is not proposed at this time.

(Proposed Article A107) and the Fish Weir Program (Proposed Article A105) would address the conservation and management of Feather River spring and fall Chinook salmon runs in more detail.

Non-native Species

Under the Proposed Action, DWR would continue to stock catchable-size brook trout in the Thermalito forebay. Naturalized brown trout from past stocking programs are also found in Thermalito afterbay. These non-native species probably escape from the forebay through the Thermalito pumping-generating plant to other project waters, and populations of brook trout and brown trout are currently widespread and stable in the watershed.

Under the Proposed Action, the Lake Oroville Coldwater Fishery Plan would also identify primary and secondary sources of hatchery salmonids, including brown trout, for lake stocking. The Anglers Committee et al. also recommend that DWR develop a lake and brown trout stocking program. Brook and brown trout prey on and compete with native salmonids, including ESA-listed Chinook salmon and steelhead. Brook and brown trout would prey on and compete with native salmonids, including ESA-listed Chinook salmon and steelhead if they were stocked in project waters. The effects of introduced trout predation on native amphibians are addressed in section 3.3.4, Terrestrial Resources.

Oroville Wildlife Area Management Plan (Proposed Article A115)

Proposed Article A115, *Oroville Wildlife Area Management Plan*, is discussed in detail in section 3.3.5, *Terrestrial Resources*.

The OWA contains more than 75 warmwater ponds and sloughs that have direct connections to the Feather River. Between RM 53.5 and 64.0, at least four overflow weirs flow into the OWA (see section 3.3.1, *Geology, Soils, and Paleontological Resources*). In the draft EIS, we suggested that there may be a direct connection between the Feather River and the OWA. However, based on DWR's comments, we now understand that there is no surface water connection between the lower Feather River and the OWA, except for a single culvert outlet in the high flow channel. The water draining out of the OWA at this area functions essentially as a very small tributary and is not screened. Salmonids could volitionally enter the OWA ponds through this culvert, but there is no evidence to suggest that this occurs or that it is a significant problem under normal (i.e. non-flood) conditions. Otherwise, salmonids only enter the OWA during extreme flow events that overtop levees separating the OWA from the river.

During extreme flow events, salmonid stranding and mortality in the OWA undoubtedly does occur, but this is beyond the licensee's control. The extent of salmonid trapping and mortality within the OWA as a result of flood events has not been determined; however, some Chinook salmon were found in Robinson Borrow Pond (also called Granite Pond) in the OWA during April 2003, and because of periodic flooding, it should be assumed that any species present in the adjacent section of the Feather River could also be found in the OWA (DWR, 2003b). There is no suitable coldwater fisheries habitat in the OWA because predation by non-native, warmwater fishes is high; high flows create ephemeral ponds with no outlets; and high, seasonal water temperatures would be lethal to salmonids.

Staff Analysis

Chinook and steelhead are found in the OWA ponds, and the inlets to the OWA are adjacent to or just downstream of the high flow and low flow channels that are the primary, existing anadromous fish habitat in the Feather River. However, the OWA Management Plan does not address the effects of these inlets on anadromous fish and other special status fish species.

3.3.3.3 Cumulative Effects

Past and present cumulative effects on aquatic resources in the Feather River Watershed result from hydropower development and operations, irrigation withdrawals, agricultural and urban development, extensive mining activities, recreational use and development, timber harvesting; road building and maintenance, sport and commercial fisheries, and hatchery management.

These actions have caused adverse water quality and aquatic habitat effects, such as increased erosion and sedimentation, chemical and bacterial contamination, decreased floodplain connectivity, decreased riparian zones and LWD recruitment potential, altered peakflows and baseflows, altered sediment transport, wetland and side-channel filling, riprapping to control channel migration, decreased aquatic habitat complexity, creation of migration barriers, changes in anadromous run timing and genetics, decreased MDN and productivity, and non-native fish and noxious/invasive weed introductions (see also *Cumulative Effects* in section 3.3.1, *Soils, Geology, and Paleontological Resources*).

The Settlement Agreement includes conservation measures to improve coldwater fisheries habitats and increase the populations of ESA-listed Chinook salmon and steelhead within the project area. These measures include the formation of an Ecological Committee, a Gravel Supplementation and Improvement Program, Channel Improvement Program, Structural Habitat Supplementation and Improvement Program, Fish Weir Program, Riparian and Floodplain Improvement Program, Feather River Fish Hatchery Improvement Program, Flow/Temperature to Support Anadromous Fish, and a Comprehensive Water Quality Monitoring Program that have been previously discussed. These fisheries conservation measures would reduce the cumulative effects associated with the operation of Oroville Facilities, and benefit all native, coldwater fishes (not just anadromous fishes) by improving the quality of coldwater habitat in the Feather River.

3.3.3.4 Unavoidable Adverse Effects

The dam will continue to block anadromous fish passage to higher quality spawning and rearing habitat in the upper watershed, and block the downstream transport of sediment and LWD from the upper watershed. Oroville Facilities operations alter natural flow regimes, adversely affecting the quality and quantity of coldwater fish habitat in the Feather River. Changes in the timing, magnitude, and duration of peakflows and baseflows, and loss of sediment and LWD recruitment from the upper watershed would continue to adversely affect channel morphology and aquatic habitat in the Feather River.

The proposed conservation measures would reduce some of these effects to varying degrees, particularly gravel and LWD supplementation, increased flows and decreased water temperatures, and riparian/floodplain restoration. However, many of the current adverse effects (e.g., migration barriers, introduced fish species and diseases, and loss of marine-derived nutrients in the upper watershed) would continue as unavoidable adverse effects, particularly on native, coldwater fishes.

3.3.4 Terrestrial Resources

3.3.4.1 Affected Environment

The Oroville Facilities are located within the Sacramento Valley and Sierra Nevada Foothills subregions of the California Floristic Province (Hickman, 1993). Broad vegetation patterns in this area correspond with elevational changes from the valley floor (elevation 100 feet at the lower end of the OWA) to the upper elevation of the mountain range (about 1,200 feet), ranging from valley grasslands to foothill woodlands (characterized by blue-oak /foothill pine woodlands with varying amounts of chaparral) to mixed conifer forests in the higher elevations.

Botanical Resources

A variety of factors influences botanical resources in the project vicinity. Vegetation patterns correspond with elevational changes and depend on precipitation, temperature, soils, aspect, slope, and disturbance history (SNEP, 1996). Unique geologic and geomorphic conditions exist that also determine plant habitats and species. The primary parent rock types around Lake Oroville are granitic, volcanic, metamorphic, and sedimentary. Unique formations include serpentine outcrops located within the West Branch and Upper North Fork arms of the reservoir and gabbro-derived soils located along the South Fork arm of the reservoir. Vernal pools and swale complexes are a common part of the valley grassland habitats downstream of Lake Oroville. These pools are of the northern hardpan type that occurs in areas of hummocky ground on terrace-alluvial derived Redding soils (DFG, 1998b). These formations tend to support a number of endemic and rare plant species.

Botanical field investigations included surveys for vegetation mapping, noxious weeds, special-status plant species, and riparian and wetland resources. Surveys were conducted during 2002, 2003, and 2004.

The study area for the vegetation community/land use mapping included the area with the project boundary, a 1-mile-area beyond the boundary, and the Feather River floodplain (within the Federal Emergency Management Area 100-year floodplain) downstream of the project boundary. Vegetation community/land use types and acreages are identified in table 32.

Table 32. Vegetation/land use within the study area. (Source: DWR, 2005a)

	Within FERC Project Boundary		**1 Mile Outside FERC Project Boundary**		**Feather River Floodplain**	
Community Type	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Upland forest/woodland	11,101	27	62,145	62	64	<1
Upland herbaceous	2,752	7	12,218	12	2,661	8
Upland shrub/scrub	232	<1	2,289	2	0	0
Agriculture	126	<1	10,063	10	16,174	51
Disturbed/urban/bare	2,328	5	10,333	10	3,084	8
Riparian forest/woodland	3,238	8	1,043	1	4,269	13
Riparian shrub/scrub	215	<1	286	<1	2,175	7
Wetland	912	2	348	<1	210	<1
Open water	19,796	48	767	<1	3,151	10
Aquatic/submerged	443	1	33	<1	90	<1
Totals	**41,143**[a]	**98**	**99,525**	**97**	**31,878**	**97**

[a] This value has been rounded to 41,540 elsewhere in this document.

Vegetation communities are broad categories that represent an assemblage of similar vegetation association types. Associations are typically defined by dominant or co-dominant species and are based in part on the classification systems of Sawyer and Keeler-Wolf (1995) and Holland (1986). In total, seven natural vegetative community types were identified in the study area: upland forest/woodland, upland herbaceous, upland shrub/scrub, riparian forest/woodland, riparian shrub/scrub, wetlands, and aquatic/submerged vegetation. Other areas were mapped based on land uses, such as disturbed, agriculture, urban or as rock outcrop, or open water. Nearly half (20,000 acres) of the 41,540 acres within the project boundary are surface waters.

The majority of vegetation around Lake Oroville and the Thermalito diversion pool consists of a variety of native vegetation associations including mixed oak woodlands, foothill pine/mixed oak woodlands, and oak/pine woodlands with a mosaic of chaparral. Open areas within the woodlands consist of annual grassland species. Downstream of Oroville dam and the Thermalito diversion pool, vegetation around open waters of the Thermalito Complex consists of emergent wetland types with annual grasslands on the surrounding slopes. Open cottonwood riparian forests occur throughout much of the OWA, with mixed riparian and willow scrub near the Feather River.

Two types of special-status species habitat are found within the study area. Vernal pools and serpentine/gabbro soils were not mapped as part of the vegetation communities but were mapped as associations during special-status species surveys. These unique communities were mapped using aerial photographs, soils and geologic maps, and field surveys.

Riparian and Wetland Habitat

Riparian Forest/Woodlands—About 3,238 acres of riparian forest/woodland occur within the project boundary. More than 2,450 acres of Fremont cottonwood forest occurs within the study area, most of which occurs in the OWA. Other riparian forest types in the OWA include valley mixed riparian (490 acres), mixed willow riparian (99 acres), and cottonwood/black willow riparian (117 acres). Eighteen acres of riparian vegetation dominated by valley oaks occur in and around the OWA.

A very small percentage of these habitat acreages occur upstream from the dam. Around Lake Oroville, native riparian habitats are restricted to narrow strips along tributaries, consisting mostly of alders, willows, and occasional cottonwoods and sycamores. A small amount of riparian vegetation occurs around the Thermalito Complex. The north shore of Thermalito forebay is lined with an about 50-foot-wide strip of mixed riparian species (mostly willows) with an understory of emergent wetland vegetation. Cottonwoods and willows occur in scattered areas around the high water elevation of Thermalito afterbay shoreline.

Riparian Shrub/Scrub—During relicensing studies, 215 acres of riparian shrub habitat were mapped within the study area. These shrub associations occur almost entirely along the Feather River directly upstream and downstream of the Thermalito afterbay outlet. They include a mix of species but are predominately Arroyo willow and sandbar willow. Non-native species, such as giant reed and scarlet wisteria, are prominent in the riparian shrub community along the Feather River upstream of the Thermalito afterbay outlet in the low flow channel.

Wetlands—A total of 912 acres of wetland vegetation were mapped in the study area (table 33), most of which occurs around Thermalito afterbay. Less than 7 acres of wetland vegetation occurs around Lake Oroville and the Thermalito diversion pool, mostly associated with seeps and springs that are a natural part of the landscape above the high water line. About 42 acres of emergent wetland vegetation occur along the edges of ponds in the OWA. Emergent wetland habitats are dominated by short, erect, rooted hydrophytes (e.g., cattail, tule, bulrush) and occur in waters less than 6 feet deep. Stands tend to be dense and structurally simple. Seasonal flooding restricts species diversity to those species adapted to anaerobic soil conditions. Emergent wetland habitat, ranging from strips less than 50 feet wide to areas over 0.5 mile wide, are found around Thermalito afterbay, Thermalito forebay, within dredger ponds in the OWA, and in backwater areas along the Feather River. Emergent wetlands are generally absent within the drawdown zone of Lake Oroville or within the steeper drainages upslope from the reservoir.

Table 33. Acreages of wetland vegetation types for major project features. (Source: DWR, 2005a)

	Thermalito Afterbay	Thermalito Forebay	Thermalito Diversion Pool	Lake Oroville	Oroville Wildlife Area
Bulrush	<1	0	0	0	0
Cattail	<10	0	0	0	<1
Mixed emergent	234	10	0	<1	42
Rush	381	<1	0	<1	0
Rush/verbena	201	0	0	0	0
Verbena	36	<1	0	0	0
Seep/wet area	0	0	<1	6	0
Totals	**852**	**11**	**<1**	**6**	**42**

Ninety-four percent of the wetland vegetation occurs around Thermalito afterbay, where a lower band of mixed emergent species is supported. Waterfowl brood ponds constructed in inlets of Thermalito afterbay support emergent vegetation along much of their shores.

Aquatic/Submerged—A total of 443 acres of aquatic/submerged vegetation, both the free-floating plant species that occur on small ponds and slow-moving or sheltered riverine backwaters and the submerged rooted vegetation common in the deeper ponds of the OWA, was mapped in the study area. About 400 acres consist of water primrose, which primarily occurs along the margins of ponds, waterways, and backwaters of the Feather River. Free-floating plants include mosquito fern, duckweed, and watermeal, which occur primarily in the smaller ponds or canals in the OWA.

Unique Habitat

Vernal Pools—Vernal pools are seasonally flooded depressions that are underlain by a substrate that limits drainage. They result from a combination of soil conditions, summer-dry Mediterranean climate, topography, and hydrology and support specialized plants and animals, including a large number of threatened and endangered species.

About 49 acres of vernal pools and ephemeral swales were mapped within the study area. These pools range in size from very small (less than 3 feet in diameter) to larger pools covering nearly an acre. Multiple-pool complexes range in size from 0.5 to 5 acres. The majority of pools are fairly shallow, although large deep pools also exist.

A total of 60 plant species was identified in vernal pools in the study area. Eleven of these species (18 percent) are non-native species. In comparison, 39 percent of the species found in the study area, excluding vernal pools and swales, are non-native species.

Serpentine and Gabbro-derived Soils—Vegetation types that occur on soils derived from serpentinitic and gabbroic rock types include sparse grassland, chaparral, and woodlands. These soil types support unique assemblages of plant species with many endemic species, including a high number of special-status plant species, and they support a high level of plant diversity. Serpentine and gabbro soils in the study area are potential and suitable habitat for the federally listed Layne's ragwort (*Senecio layneae*) (see section 3.3.5, *Threatened and Endangered Species*).

About 172 acres of serpentinite and serpentine-derived soils occur in the study area. Numerous northwest to southeast trending bands of serpentine occur in the Upper North Fork and West Branch arms of Lake Oroville. Vegetation typically consists of sparse foothill pines and scattered chaparral shrubs. These outcrops harbor many endemic species including two special-status plant species: cut-leaved ragwort (*Senecio eurycephalus* var. *lewisrose*i) and Butte County calycadenia (*Calycadenia oppositifolia*), which are discussed below.

About 64 acres of gabbro and gabbro-derived soils occur in the study area along the South Fork arm. Plant species composition is similar to surrounding vegetation, typically a mix of moderate to dense foothill or ponderosa pine and mixed oak woodland. One special-status species, Brandegee's clarkia (*Clarkia brandegeae*), was observed on gabbro soils and is discussed below.

Invasive and Noxious Weeds

Nearly all plant communities within the project vicinity have invasive and/or noxious weed species as a component. A noxious weed as defined by the California Department of Food and Agriculture means any "species of plant that is, or is liable to be, troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, and difficult to control or eradicate" (DFA, 2001). An invasive species is defined by the National Invasive Species Council under Executive Order 13112 as "a species that is (1) non-native (or alien) to the ecosystem under consideration, and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health" (Center for Invasive Plant Management, 2004).

Sixty-four species of noxious or invasive plant species listed by the California Department of Food and Agriculture, the California Invasive Plant Council, the U.S. Department of Agriculture, and the Plumas National Forest have potential to occur within the study area. During relicensing surveys conducted by DWR, all non-native species were identified in the study area and the distributions and densities of all listed species were mapped and recorded. Thirty-nine of the 64 target weed species were identified and mapped within the study area during 2002 and 2003 (table 34). Of these, 20 were the highest rated target weed species. Overall, 219 species of non-native plants, not all of which are classified as noxious or invasive weeds, were identified in the study area.

Table 34. Target weed species identified in the study area. (Source: DWR, 2005a)

Common Name ***Scientific Names***	**Cal-IPC List**[a]	**DFA List**[b]	**Around Lake Oroville**	**Downstream of Oroville Dam**
Tree of heaven *Ailanthus altissima*	A-2	--	x	x
Giant reed *Arundo donax*	A-1	--	--	x
Foxtail chess *Bromus madritenis* ssp. *rubens*	A-2	--	x	x
Yellow starthistle *Centaurea solstitialis*	A-1	C	x	x
Skeleton weed *Chondrilla juncea*	--	A	x	--
Pampas grass *Cortaderia selloana*	A-1	--	--	x
Scotch broom *Cytisus scoparius*	A-1	C	--	x

Common Name ***Scientific Names***	**Cal-IPC List**[a]	**DFA List**[b]	**Around Lake Oroville**	**Downstream of Oroville Dam**
Blue-gum eucalyptus *Eucalyptus globules*	A-1	--	--	x
Edible fig *Ficus carica*	A-2	--	x	x
Fennel *Foeniculum vulgare*	A-1	--	x	x
French broom *Genista monspessulana*	A-1	C	x	x
Purple loosestrife *Lythrum salicaria*	Red Alert	B	--	x
Pennyroyal *Mentha pulegium*	A-2	--	--	x
Parrot feather *Myriophyllum aquaticum*	B	--	--	x
Eurasian milfoil *Myriophyllum spicatum*	A-1	--	--	x
Himalayan blackberry *Rubus discolor*	A-1	--	x	x
Chinese tallow tree *Sapium sebiferum*	Red Alert	--	x	--
Bouncing-bet *Saponaria officinalis*	A-2	--	--	x
Scarlet wisteria *Sesbania punicea*	Red Alert	--	--	x
Spanish broom *Spartium junceum*	B	--	x	--
Medusahead *Taeniatherum caput-medusae*	A-1	C	x	x

Notes: -- – species not present in the study area or not on agency list
DBW – California Department of Food and Agriculture

x – species present in study area

[a] California Invasive Plant Council List of Exotic Pest Plants of Greatest Ecological Concern:
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
List Red Alert: Species with potential to spread explosively, infestation currently restricted.

[b] DFA List of Noxious Weeds:
List A: Most invasive wildland pest plants, eradication, containment, or other holding action at the state and county level
List B: Includes species less widespread and more difficult to contain, eradication, containment, control, or other holding action at the discretion of the Commissioner
List C: Weeds that are so widespread that the agency does not endorse state or county-funded eradication except in nurseries.

The numbers of weed species and infestations are substantially greater in lower elevation riparian and wetland areas than in upland communities, especially where some disturbance has occurred. Eighteen of the species were found downstream of Oroville dam in the OWA and in and around the Thermalito Complex. Eleven species were found around Lake Oroville.

Species of greatest concern near the Thermalito Complex include purple loosestrife, giant reed, tree of heaven, yellow starthistle, and scarlet wisteria. Within the surrounding grasslands, yellow starthistle and medusahead are most widespread. About 85 of the 852 acres of wetland/riparian margin of Thermalito afterbay contain varying densities of purple loosestrife.

Noxious weed species in the study area are most prolific in the OWA. The species of greatest concern to native riparian and wetland plant communities and wildlife habitat in this area include giant reed, tree of heaven, scarlet wisteria, parrots feather, and Himalayan blackberry. Tree of heaven is intermingled with the valley elderberry, habitat for the federally threatened valley elderberry longhorn beetle (discussed in section 3.3.5, *Threatened and Endangered Species*) in about 250 acres of the OWA.

Water primrose is an aquatic plant species that occurs along the margins of ponds, waterways and in backwaters of the Feather River. Both the native (ssp. *peploides*) and non-native (ssp. *montevidensis*) subspecies occur in the area. This perennial species grows in dense mats and has been increasing in abundance since the mid-1990s.

Numerous noxious weed species occur around Lake Oroville, primarily in disturbed areas near roads, trails, and facilities, and in the immediate vicinity of the spillway and the associated power facilities. The species identified as those of greatest concern are skeleton weed; French, Spanish, and Scotch brooms; Himalayan blackberry; and tree of heaven. Other species include edible fig and starthistle.

Special-Status Plant Species

Species identified as special-status species include rare plants that are currently listed by the Forest Service and/or BLM as Sensitive or Special Interest Species and taxa on the California Native Plant Society Lists 1, 2, and 3. Federally listed threatened or endangered species are discussed in section 3.3.5, *Threatened and Endangered Species*. All California-listed species with potential to occur in the project boundary are also federally listed species and therefore are discussed in section 3.3.5.

DWR developed a list of 51 special-status plant species with the potential to occur in the project boundary, based on information compiled from FWS (1999 and 2002); the DFG (2002/2003), California Natural Diversity Database records; the CNPS (2001); Plumas National Forest Sensitive and Special Interest Plant list (Forest Service, 2003); DFG's Special Plants List (DFG, 2001); and the Forest Service Pacific Southwest Region Sensitive Plant list (Forest Service, 1998). Botanical surveys were conducted in accordance with standard guidelines issued by DFG (2000), FWS (1996), and the CNPS (2001). The study area for these surveys included all lands that could be affected by project activities within the project boundary and the lower Feather River floodplain downstream of the fish barrier dam to the Sacramento River. Federal lands within the study area, adjacent federal lands outside the study area, and state lands within the study area adjacent to federal lands were surveyed for BLM and Forest Service sensitive and special interest species. Relicensing studies conducted by DWR identified the presence of suitable habitat within the project area for 41 vascular plant species, 2 bryophytes (mosses), and 1 lichen species (table 35).

DWR located 14 special-status plant species, identified in table 34, within the study area during relicensing studies. Five of these species were found within the OWA and Thermalito Complex. Four-angled spikerush and Sanford's arrowhead were found around the margins of Thermalito afterbay. Four-angled spikerush was also found bordering Thermalito forebay, small ponds in the OWA, and the larger One-Mile Pond in the OWA. Fox sedge was found bordering the Thermalito diversion pool. Columbian

watermeal was found in a number of ponds in the OWA. Ahart's paronychia was located along the margins of vernal pools south of Thermalito forebay.

Table 35. Special-status plant species with potential for occurring within the study area. (Source: DWR, 2005a)

Common Name ***Scientific Name***	**Status: FWS[a]/CNPS[b]/ Plumas National Forest[c]**	**Habitat (elevation)**	**Found in Study Area**
Vascular Plants			
Henderson's bent grass *Agrostis hendersonii*	SC/3/--	Valley and foothill grassland (mesic), vernal pools (70–305 meters)	
Jepson's onion *Allium jepsonii*	SC/1B/--	Cismontane woodland, lower montane conifer forest/ serpentinite or volcanic (300–1,160 meters)	
Sanborn's onion *Allium sanbornii* var. *sanbornii*	--/4/SI-1	Chaparral, cismontane woodland, lower montane conifer forest/ usually serpentinite, gravelly (260–1,410 meters)	
Large-flowered sandwort *Arenaria "grandiflora"*	--/4/SI-1	Granite sand on road banks and openings in woods (500–1,000 meters)	
Big-scale balsamroot *Balsamorhiza macrolepis* var. *macrolepis*	--/1B/SI-1	Chaparral, cismontane woodland, valley and foothill grassland / sometimes serpentinite (90–1,400 meters)	
Butte County calycadenia *Calycadenia oppositifolia*	--/1B/S	Chaparral, cismontane woodland, lower montane conifer forest, meadows and seeps, valley and foothill grassland/ volcanic or serpentinite (215–945 meters)	Yes
Butte County morning glory *Calystegia atriplicifolia* ssp. *buttensis*	SC/1B/--S	Lower montane conifer forest (600–1,200 meters)	
Dissected-leaved toothwort *Cardamine pachystigma* var. *dissectifolia*	--/3/SI-1	Chaparral, lower montane conifer forest/ usually serpentinite, rocky (255–2,100 meters)	Yes
Fox sedge *Carex vulpinoidea*	--/2/--	Marshes and swamps (freshwater), riparian woodland (30–1,200 meters)	Yes
Pink creamsacs *Castilleja rubicundula* ssp. *rubicundula*	--/1B/--	Chaparral (openings), cismontane woodland, meadows and seeps, valley and foothill grassland/ serpentinite (20–900 meters)	
Brandegee's clarkia *Clarkia biloba* ssp. *brandegeae*	--/1B/S	Chaparral, cismontane woodland/ often roadcuts (295–885 meters)	Yes
White-stemmed clarkia *Clarkia gracilis* ssp. *albicaulis*	--/1B/S	Chaparral, cismontane woodland/ sometimes serpentinite (245–1,085 meters)	Yes

Common Name *Scientific Name*	Status: FWS[a]/CNPS[b]/ Plumas National Forest[c]	Habitat (elevation)	Found in Study Area
Golden-anthered clarkia *Clarkia mildrediae* ssp. *lutescens*	--/4/SI-1	Cismontane woodland, lower montane conifer forest (openings)/ often roadcuts (275–1,750 meters)	
Mildred's clarkia *Clarkia mildrediae* ssp. *mildrediae*	--/1B/SI-1	Cismontane woodland, lower montane conifer forest/ sandy, usually granitic (245–1,710 meters)	
Mosquin's clarkia *Clarkia mosquinii*	SC[d]/1B/S	Cismontane woodland, lower montane conifer forest/ rocky, roadsides (185–1,170 meters)	Yes
Clustered lady's slipper *Cypripedium fasciculatum*	SC/4/S	Lower montane conifer forest, north coast conifer forest/ usually serpentinite seeps and stream beds (100–2,435 meters)	
Dwarf downingia *Downingia pusilla*	--/2/--	Valley and foothill grassland (mesic), vernal pools (1–445 meters)	
Four-angled spikerush *Eleocharis quadrangulata*	--/--/2/--	Marshes and swamps (freshwater) (30–500 meters)	Yes
Butte County fritillary *Fritillaria eastwoodiae*	SC/3/S	Chaparral, cismontane woodland, lower montane conifer forest (openings)/ sometimes serpentinite (50–1,500 meters)	Yes
Adobe-lily *Fritillaria pluriflora*	SC/1B/--	Chaparral, cismontane woodland, valley and foothill grassland/ often adobe (60–705 meters)	
Rose-mallow *Hibiscus lasiocarpus*	--/2/--	Marshes and swamps (freshwater) (0–120 meters)	
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	SC/1B/--	Valley and foothill grasslands (mesic) (30–100 meters)	
Red Bluff dwarf rush *Juncus leiospermus* var. *leiospermus*	--/1B/--	Chaparral, cismontane woodland, meadows and seeps, valley and foothill grassland, vernal pools/ vernally mesic (35–1,020 meters)	
Cantelow's lewisia *Lewisia cantelovii*	--/1B/S	Broadleaved upland forest, chaparral, cismontane woodland, lower montane conifer forest/ mesic, granitic, serpentinite seeps (385–1,370 meters)	
Humboldt lily *Lilium humboldtii* ssp. *humboldtii*	--/4/SI-1	Chaparral, lower conifer forest/ openings (30–1,800 meters)	Yes
Quincy lupine *Lupinus dalesiae*	--/1B/S	Chaparral, cismontane woodland, lower/ upper montane conifer forest, openings, often in disturbed areas (855–2,500 meters)	

Common Name *Scientific Name*	Status: FWS[a]/CNPS[b]/ Plumas National Forest[c]	Habitat (elevation)	Found in Study Area
Shield-bracted monkeyflower *Mimulus glaucescens*	--/4/SI-1	Chaparral, cismontane woodland, lower montane conifer forest, valley and foothill grassland/serpentinite seeps (60–1,240 meters)	Yes
Veiny monardella *Monardella douglasii* ssp. *venosa*	SC/1B/--	Cismontane woodland, valley and foothill grassland (heavy clay) (60–410 meters)	
Little mousetail *Myosurus minimus* ssp. *apus*	SC/3/--	Valley and foothill woodland, vernal pools (alkaline) (20–640 meters)	
Ahart's paronychia *Paronychia ahartii*	SC/1B/--	Cismontane woodland, valley and foothill grassland, vernal pools (30–510 meters)	Yes
Closed-throated beardtongue *Penstemon personatus*	SC/1B/S	Chaparral, lower/upper montane conifer forest, metavolcanic (1,065–2,120 meters)	
Bacigalupi's yampah *Perideridia bacigalupii*	--/4/SI-1	Chaparral, lower montane conifer forest/ serpentinite (450–1,000 meters)	
California beaked-rush *Rhynchospora californica*	SC/1B/--	Bogs and fens, lower montane conifer forest, meadows and seeps, marshes and swamps (freshwater) (45–1,010 meters)	
Brownish beaked-rush *Rhynchospora capitellata*	--/2/SI-1	Lower/upper montane conifer forest, meadows and seeps, marshes and swamps, mesic (455–2,000 meters)	
Sanford's arrowhead *Sagittaria sanfordii*	SC/1B/--	Marshes and swamps (assorted shallow freshwater) (0–610 meters)	Yes
Feather River stonecrop *Sedum albomarginatum*	--/1B/S	Chaparral, lower montane conifer forest/ serpentinite (260–1,785 meters)	
Cut-leaved ragwort *Senecio eurycephalus* var. *lewisrosei*	--/1B/S	Chaparral, cismontane woodland, lower montane conifer forest/ serpentinite (550–1,470 meters)	Yes
Butte County checkerbloom *Sidalcea robusta*	SC/1B/--	Chaparral, cismontane woodland (90–1,600 meters)	
Long-striped catchfly *Silene occidentalis* ssp. *longistipitata*	SC/1B/SI-1	Chaparral, lower/upper montane conifer forest (1,000–2,000 meters)	
Butte County golden clover *Trifolium jokerstii*	--/1B/SI-1	Valley and foothill grassland (mesic), vernal pools (50–385 meters)	
Columbian watermeal *Wolffia brasiliensis*	--/2/--	Marshes and swamps (assorted shallow freshwater) (30–100 meters)	Yes
Bryophytes			
Bolander's bruchia moss *Bruchia bolanderi*	--/2/S	Lower/upper montane conifer forest, meadows and seeps, damp soil (600–1,700 meters)	

Common Name *Scientific Name*	Status: FWS[a]/CNPS[b]/ Plumas National Forest[c]	Habitat (elevation)	Found in Study Area
Elongate copper moss *Mielichhoferia elongata*	--/2/SI-1	Cismontane woodland (metamorphic rock, usually vernally mesic) (500–1,300 meters)	
Lichens			
Waterfan *Hydrothyria venosa*	--/--/S	Attached to rocks in cool mountain brooks and streams; submerged	

[a] FWS: SC – federal species of concern.

[b] CNPS: List 1B – plants rare, threatened, or endangered in California and elsewhere
List 2 – plants rare, threatened, or endangered in California but more common elsewhere
List 3 – plants about which more information is needed
List 4 – plants of limited distribution

[c] Plumas National Forest: S – Sensitive
SI-1 – Special Interest Category 1 (Survey and recommend conservation measures).

[d] FWS recognizes two subspecies of *clarkia mosquinii*, ssp. *mosquinii* and ssp. *xerophila*, both as SC.

Surveys located nine special-status species in upland habitats around the Thermalito diversion pool and/or lands around Lake Oroville. These include Butte County calycadenia, dissected-leaved toothwort, Brandegee's clarkia, white-stemmed clarkia, Mosquin's clarkia, Butte County fritillary, cut-leaved ragwort, Humboldt lily, and shield-bracted monkeyflower.

Wildlife Resources

DWR conducted field investigations for relicensing in 2002, 2003, and 2004. These studies were conducted in the same study area as the vegetation mapping: the area within the project boundary, a 1-mile area beyond the boundary, and the Feather River floodplain (within the Federal Emergency Management Area 100-year floodplain) downstream of the project boundary.

Twenty-four habitat types (using the California Wildlife Habitat Relationships classification system) occur within the study area as listed on table 36. Principal wildlife habitat types include lacustrine (open water), montane hardwood, blue oak/foothill pine, valley/foothill riparian, montane hardwood/conifer, annual grassland, barren, freshwater emergent wetland, urban, and blue oak woodland. The dominant habitat type is lacustrine, which covers 19,851 acres (about 48 percent) of the study area. Tree-dominated habitats cover about 36 percent of the study area. Riparian woodlands along the Feather River that are dominated by cottonwoods and willows represent about 8 percent of the total wildlife habitat. The 12 least common habitat types, Douglas-fir, Sierra mixed conifer, dryland grain, montane riparian, deciduous orchard, valley oak woodland, evergreen orchard, irrigated hayfield, ponderosa pine, eucalyptus, pasture, and vineyard, occur on less than 1 percent of the study area.

The extensive riparian habitat present within the OWA is the largest remaining block of riparian habitat along the Feather River and provides breeding habitat for a variety of neotropical migrant birds. These habitats also serve as nursery areas for many wildlife species including two large mixed heron/egret rookeries.

Table 36. Summary of wildlife habitat acreages within the study area. (Source: DWR, 2005a)

California Wildlife Habitat Relationships Database Habitat Type	Total Acres Within Study area	Percentage of Study area
Lacustrine	19,851.9	48.2
Montane hardwood	3,295.0	8.0
Blue oak/foothill pine	3,518.8	8.6
Valley foothill riparian	3,398.1	8.3
Montane hardwood/conifer	3,179.8	7.7
Annual grassland	2,751.5	6.6
Barren	1,394.4	3.4
Freshwater emergent wetland	911.6	2.2
Urban	868.2	2.1
Blue oak woodland	793.3	1.9
Riverine	452.9	1.1
Mixed chaparral	234.3	0.6
Douglas-fir	169.6	0.4
Sierra mixed conifer	112.5	0.3
Dryland grain	98.3	0.2
Montane riparian	54.3	0.13
Deciduous orchard	11.0	<0.1
Valley oak woodland	9.8	<0.1
Evergreen orchard	8.1	<0.1
Irrigated hayfield	3.3	<0.1
Ponderosa pine	3.2	<0.1
Eucalyptus	2.6	<0.1
Pasture	0.7	<0.1
Vineyard	0.2	<0.1

The OWA, west of the city of Oroville, is managed by DFG for wildlife habitat and recreational activities. Habitats within the OWA include lacustrine, riverine, freshwater emergent, valley foothill riparian, and annual grassland and dryland grain/seed crops. This area includes 6,000 acres including and surrounding the Thermalito afterbay and the 5,000 acres adjacent to and straddling 12 miles of the Feather River.

Wildlife Species

DWR used the California Wildlife Habitat Relationships database was to predict wildlife species occurrence within study area habitats. DWR also made note of species observed during relicensing studies. Modeling results indicate that 334 wildlife species may occur within the size and density classes

of habitat types present within the study area, including 13 amphibians, 22 reptiles, 235 birds, and 64 mammals as well as 6 federally listed species, 1 candidate species, 14 non-native species, and 55 recreationally and/or commercially important species.

The study area provides seasonal or year-round habitat for a variety of commercially or recreationally important wildlife species. Fifty-five species classified as harvest species by DFG may occur within the study area. Black-tailed deer are an important recreational harvest species in eastern Butte County. The study area contains a portion of the winter range of two migratory deer herds (Bucks Mountain and Mooretown herds) as well as a small resident population. Numerous furbearers including badger, mink, beaver, raccoon, gray fox, weasels, muskrat, bobcat, and opossum may occur in the study area.

Waterfowl are the most productive commercial and recreational group of wildlife in the lower elevation areas of Butte County. Lands managed for commercial grain production or natural wetlands support high wintering densities of ducks, geese, swans, and shorebirds. These lands also provide waterfowl nesting and brooding habitat. Portions of the OWA within the project boundary are managed by DFG to provide habitat for nesting and wintering waterfowl. About 3 percent of the recreational use of this area is related to hunting. The Thermalito Complex provides resting and foraging habitat for open water and diving waterfowl species (ruddy duck, bufflehead, scaup, ring-necked duck, common goldeneye, and common merganser), which is generally lacking in surrounding agricultural areas. Habitat for nesting and brooding waterfowl and nesting grebes, however, is limited in the Thermalito afterbay due to water level fluctuations and recreational high-speed boat use.

As part of an agreement with DWR, DFG conducts a regular habitat enhancement program in the OWA that includes the planting of upland nesting cover and foraging vegetation for waterfowl, along with thinning/removal of vegetation around the Thermalito afterbay brood ponds and dredging ponds in the preserve. The thinning/removal activities are conducted to provide improved access for waterfowl. About 200 acres of land are tilled and planted each year and remain as suitable nesting/foraging habitat for about 5 years before beginning to revert to the existing grasses. In addition, DFG thins and removes vegetation in and around ponds and rock piles to provide recreational access to the various habitats.

Upland game species, including mourning dove, wild turkey, ring-necked pheasant, and several species of quail, are found within the study area and provide hunting opportunities on adjacent private lands as well as on some public lands, including the OWA.

Non-native Wildlife Species

Fourteen non-native vertebrate wildlife species may occur within the study area including six birds, seven mammals, and one amphibian (table 37). Several of these species were introduced by DFG as harvest species, or are currently managed as harvest species.

Table 37. List of non-native vertebrate wildlife potentially found within the study area. (Source: DWR, 2005a)

Common Name	Scientific Name	Status
Bullfrog	*Rana catesbeiana*	DFG Harvest
House sparrow	*Passer domesticus*	--
Bobwhite quail	*Colinus virginianus*	DFG Harvest
Ring-necked pheasant	*Phasianus colchicus*	DFG Harvest
Wild turkey	*Meleagris gallopavo*	DFG Harvest
Rock dove	*Columba livia*	--

Common Name	Scientific Name	Status
European starling	*Sturnus vulgaris*	--
Virginia opossum	*Didelphis virginiana*	DFG Harvest
Black rat	*Rattus rattus*	--
Norway rat	*Rattus norvegicus*	--
House mouse	*Mus musculus*	--
Muskrat	*Ondatra zibethicus*	DFG Harvest
Red fox	*Vulpes vulpes*	--
Feral pig	*Sus scrofa*	DFG Harvest

Note: -- – No status

Special Status Wildlife Species

Seven state-listed wildlife species may occur within the project vicinity (table 38). Species protected under both the state and federal ESAs (e.g., bald eagle, giant garter snake, and yellow-billed cuckoo) are addressed separately in section 3.3.5, *Threatened and Endangered Species*.

Table 38. State-listed wildlife species potentially occurring in the study area. (Source: DWR, 2005a)

Wildlife Species	Scientific Name	State Status
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Giant garter snake	*Thamnophis couchi gigas*	Threatened
Swainson's hawk	*Buteo swansonii*	Threatened
Greater sandhill crane	*Grus canadensis tabida*	Threatened
Bank swallow	*Riparia riparia*	Threatened
Peregrine falcon	*Falco peregrinus anatum*	Endangered
Yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Endangered

Other Special-Status Species—Several other special status species have the potential to occur within the project vicinity. These other special status wildlife species include state species of concern, federal species of concern, Forest Service sensitive species, and BLM sensitive species (see table 39).

Sixty-one special-status species have the potential to occur in the project vicinity, including 41 species classified as California species of special concern, 35 federal species of concern, 20 BLM sensitive species, and 7 Forest Service sensitive species. No specific surveys were conducted for these species on a project-wide basis; however, all sightings of these species during the course of other relicensing wildlife studies were recorded by DWR and entered into a geographic information system database. Further, more intensive surveys of all federal lands in the study area were completed for Forest Service and BLM sensitive species. Of the 61 special-status species with the potential to occur within the project vicinity, 30 species were observed within or adjacent to the study area, as indicated in table 39.

Table 39. Other special-status species with the potential to occur in the project vicinity. (Source: DWR, 2005a)

Special-Status Species	Scientific Name	Status	Found in the Study Area
American bittern	*Botaurus lentiginosus*	FSC	Yes
American white pelican	*Pelecanus erythrorhynos*	CSC	Yes
Barrow's goldeneye	*Bucephala islandica*	CSC	Yes
Bell's sage sparrow	*Amphispiza belli belli*	FSC, CSC	No
Black swift	*Cypseloides niger*	FSC, CSC	No
Black tern	*Chilidonas niger*	CSC	Yes
Black-crowned night heron	*Nycitcorax nycticorax*	BLM	Yes
California gull	*Larus californicus*	CSC	No
California horned lark	*Eremophila alpestris actia*	CSC	No
California spotted owl	*Strix occidentalis caurina*	FSC, CSC, FS, BLM	No
California thrasher	*Toxostoma redivivum*	FSC	No
Common loon	*Gavia immer*	CSC	No
Cooper's hawk	*Accipiter cooperi*	CSC	No
Double-crested cormorant	*Phalacrocorax auritus*	CSC	No
Ferruginous hawk	*Buteo regalis*	FSC, CSC, BLM	No
Golden eagle	*Aquila chrysaetos*	CSC, FSC, BLM	No
Lark sparrow	*Chondestes grammacus*	FSC	No
Lawrence's goldfinch	*Carduelis lawrencei*	FSC	No
Lewis's woodpecker	*Melanerpes lewis*	FSC	Yes
Loggerhead shrike	*Lanius ludovicianus*	FSC, CSC	Yes
Long-billed curlew	*Numenius americanus*	FSC, CSC	Yes
Long-eared owl	*Asio otus*	CSC	No
Merlin	*Falco columbarius*	CSC	No
Northern goshawk	*Accipiter gentilis*	FSC, CSC, FS	No
Northern harrier	*Circus cyaneus*	CSC	No
Nuttall's woodpecker	*Picoides nuttallii*	FSC	Yes
Oak titmouse	*Parus inornatus*	FSC	Yes
Osprey	*Pandion haliaetus*	CSC	Yes
Prairie falcon	*Falco mexicanus*	FSC, CSC	Yes
Purple martin	*Progne subis*	CSC	No
Red-breasted sapsucker	*Sphyrapicus rubber*	FSC	Yes
Rufous hummingbird	*Selasphorus rufus*	FSC	No
Sharp-shinned hawk	*Accipiter striatus*	CSC	Yes

Special-Status Species	Scientific Name	Status	Found in the Study Area
Short-eared owl	*Asio flammeus*	CSC	Yes
Tricolored blackbird	*Agelaius tricolor*	FSC, CSC, BLM	Yes
Vaux's swift	*Chaetura vauxi*	FSC, CSC	No
Western burrowing owl	*Athene cunicularia*	FSC, CSC, BLM	Yes
Western least bittern	*Ixobrychius exilis*	CSC	No
Yellow warbler	*Dendroica petechia brewsteri*	CSC	Yes
White-tailed kite	*Elanus leucurus*	FSC	Yes
White-faced ibis	*Plegadis chihi*	FSC, CSC	Yes
Yellow-breasted chat	*Icteria virens*	CSC	Yes
Foothill yellow-legged frog	*Rana boylii*	FSC, CSC, BLM, FS	Yes
Western spadefoot	*Scaphiopus hammondii*	FSC, BLM	No
California horned lizard	*Phrynosoma coronatum*	CSC, BLM	No
Northwestern pond turtle	*Clemmys marmorata marmorata*	FSC, CSC, FS	Yes
Western mastiff bat	*Eumops perotis*	FSC, CSC, BLM	No
Fringed myotis	*Myotis thysanodes*	FSC, BLM	No
Long-eared myotis	*Myotis evotis*	FSC, BLM	No
Long-legged myotis	*Myotis volans*	FSC	No
Marysville kangaroo rat	*Dipodomys californicus eximus*	FSC, CSC, BLM	No
Occult little brown bat	*Myotis occultus*	CSC	No
Pale big-eared bat	*Corynorhinus townsendii pallescens*	FSC, CSC, BLM, FS	No
Pallid bat	*Antrozous pallidus*	CSC	No
River otter	*Lontra canadensis sonorae*	CSC, BLM	No
San Joaquin pocket mouse	*Perognathus inornatus inornatus*	FSC, BLM	No
Small-footed myotis	*Myotis ciliolabrum*	FSC, BLM	No
Spotted bat	*Euderma maculatum*	FSC, CSC, BLM	No
Townsend's big-eared bat	*Corynorhinus townsendii townsendii*	CSC, FS, BLM, FSC	No
Western red bat	*Lasiurus blossevillii*	FS	No
Yuma myotis	*Myotis yumanensis*	BLM	No

Notes: BLM – BLM Sensitive Species
CSC – California Species of Special Concern
FSC – Federal Species of Concern
FS – Forest Service Sensitive Species

3.3.4.2 Environmental Effects

Various Measures Affecting Waterfowl and Grebe Habitat

The Thermalito Complex provides resting and foraging habitat for waterfowl. Water level fluctuations and recreational high speed boat use in the Thermalito afterbay, however, limit habitat quality and availability for nesting and brooding waterfowl and nesting grebes.

DWR proposes several environmental measures designed to provide habitat for waterfowl in the Thermalito afterbay portion of the OWA. DWR proposes to develop and implement a plan to construct four waterfowl brood ponds by creating a small earthen berm across an inlet in the Thermalito afterbay (Proposed Article A122, *Construction and Recharge of Brood Ponds*). This plan would be developed in conjunction with DFG and in consultation with the Ecological Committee, which includes FWS. One brood pond would be constructed every 5 years over a 20-year period beginning upon license issuance. Subsequently, DWR would maintain the brood ponds by filling them no later than April 15 of each year and ensure, through monitoring the ponds on a weekly basis, that the water surface level of the ponds would not fluctuate more than 1 foot throughout the primary waterfowl brooding season of April 15 through July 31. If fluctuations greater than 1 foot were found, DWR would report it to DFG within 48 hours and disclose what DWR has done or would do to remedy the situation. DWR would file an annual report with the Commission, DFG, and FWS with the water elevation monitoring.

DWR also proposes to provide upland food for upland game birds and wintering waterfowl by preparing and planting a total of 60 to 70 acres of upland cover/forage crops on an annual basis within the Thermalito afterbay portion of the OWA (Proposed Article A123, *Provision of Upland Food for Nesting Waterfowl*). Additionally, DWR proposes to actively manage 240 acres of waterfowl nest cover in Thermalito afterbay, including preparing and planting 60 acres and maintaining an additional 180 acres annually, on a rotational basis (Proposed Article A124, *Provision of Nest Cover for Upland Waterfowl*). These measures would be implemented in coordination with DFG. DWR also proposes to install and structurally maintain 100 wildlife nesting boxes within the OWA within 1 year of license issuance (Proposed Article A125, *Installation of Wildlife Nesting Boxes*).

The Explanatory Statement of the Settlement Agreement (DWR, 2006a) states that the proposed OWA Management Plan (Proposed Article A115) would include measures to: (1) minimize Thermalito afterbay water level fluctuation to minimize effects on nesting grebes and (2) maintain and enforce the existing 5-mile-per-hour boat speed limit in the Thermalito afterbay north of Highway 162 to minimize effects on lacustrine and wetland wildlife species.

Interior's (on behalf of FWS) 10(j) recommendation nos. 10, 16, 17, 18, and 19 and DFG's 10(j) recommendation no. 3 are consistent with these proposed articles.

Staff Analysis

Water level fluctuations up to 12 feet occur on a weekly basis in the Thermalito afterbay. Although the fluctuations expose mudflats, which provide habitat to a variety of migratory shorebirds, nesting and brooding waterfowl and nesting grebes can be negatively affected. Waterfowl nest and brood in the wetland margins and grebes' nests float on top of the water in shallow water areas. Waterfowl require emergent wetland cover in proximity to aquatic habitat. Sudden or periodic increases in water levels can flood waterfowl nests resulting in the loss of eggs and forcing nesting hens to establish new nests in upland locations. The existing upland nesting habitat has less nesting cover than that which exists within the wetland margin, potentially causing increased predation of nesting waterfowl that have been forced to use this habitat because of flooding.

To improve waterfowl brooding habitat in the Thermalito afterbay, DWR, DFG, the California Waterfowl Association, and other stakeholders constructed five waterfowl brood ponds in and around the

afterbay during the last 15 years. These brood ponds are not subject to Thermalito afterbay water level fluctuations and provide a more consistent water surface elevation with adjacent vegetative cover. The brood ponds are recharged directly from the Thermalito afterbay by raising the water level to a minimum surface elevation of 134.1 feet for a 12-hour period (DWR, 2004y). As water levels decrease within the brood ponds due to evaporation, seepage, and evapotranspiration, the distance between the aquatic habitat and adjacent vegetative cover increases, exposing waterfowl to predation. Brood ponds require recharge once every 3 weeks during the waterfowl brooding season (April 15 through July 31) for them to remain functional as brood habitat.

DWR proposes to develop and implement a plan to construct four additional waterfowl brood ponds within the Thermalito afterbay within 20 years of the issuance of any new license. Additionally, DWR proposes to maintain adequate water surface elevations within the existing and future brood ponds by filling them by the start of the brood season and recharging the ponds with a frequency that would ensure the surface water elevation would not fluctuate more than 1 foot throughout the brooding season. Increasing the amount of waterfowl brooding habitat and maintaining the ponds at the surface water elevation needed to provide the best habitat would replace brooding habitat lost as a result of Thermalito afterbay fluctuations.

The frequency of recharging the ponds is not established in DWR's proposal because brood ponds also provide habitat to the federally listed giant garter snake, which requires the ponds to be recharged less frequently (monthly as opposed to every 3 weeks) but for a longer period (April 1 through October 31 for the garter snake). The giant garter snake is further discussed in section 3.3.5, *Threatened and Endangered Species*. Recharging the brood ponds every 3 weeks within the waterfowl brooding season (April 15 through July 31) and monthly during the remainder of the time period required for the giant garter snake would maintain the appropriate habitat for all species.

DWR also proposes to provide upland food and nest cover for nesting waterfowl. DWR's proposal to plant and fertilize 240 acres of waterfowl nest cover within the Thermalito afterbay would improve upland waterfowl nesting cover from existing conditions. As such, it would replace high quality nesting habitat lost as a result of Thermalito afterbay water fluctuations. DFG currently plants and fertilizes wildlife forage crops (e.g., safflower, barley, or milo) in upland areas around the Thermalito afterbay for upland game species and migratory and resident waterfowl. Although DFG would continue this practice, DWR's proposal to plant 60 to 70 acres of upland cover and forage crops annually would increase the availability of cover and forage crops to upland game birds and wintering waterfowl. Increased availability of high-quality forage species would likely increase the density and productivity of these species. Additionally, installing and maintaining 100 wildlife nesting boxes would also provide nesting habitat for cavity nesting birds such as wood ducks.

Drawdowns of the Thermalito afterbay can strand floating grebe nests on mudflats, leading to an increased risk of predation or abandonment. Other effects on nesting grebes and other waterfowl include: (1) boat wakes swamping nests, (2) boating disturbance causing nest abandonment and displacement of incubating adults, and (3) direct mortality from ski, propeller, and boat strikes. Surveys conducted in 2003 indicated, however, that no abandonment or predation losses were identified and grebe production per pair in the Thermalito afterbay was the second highest level (1.41 young per brood) recorded in the statewide survey (DWR, 2004y). As such, the drawdowns of Thermalito afterbay do not appear to affect the overall grebe population in the project area. DWR's proposed OWA Management Plan would include provisions to continue to enforce a 5-mile-per-hour boating speed limit on the Thermalito afterbay north of Highway 162, which would limit the potential effects of recreational boating on nesting waterfowl.

Invasive Plant Management (Proposed Article A126)

Noxious and invasive species currently exist in nearly all plant communities within the project. These species crowd out native species, altering native ecosystems and potentially placing populations of

special-status plant species at risk. Project operations including water level fluctuations and maintenance activities can promote the proliferation of invasive plant species throughout the project boundary.

DWR proposes (in Proposed Article A126, *Invasive Plant Management*) and the Forest Service preliminary 4(e) condition no. 18 specifies that DWR develop and file with the Commission for approval within 1 year of license issuance a plan to manage and reduce native and non-native invasive species populations within the project boundary. The plan would be developed in conjunction with the Forest Service, BLM, DFG, and DPR, and in consultation with the Ecological Committee, including FWS. Prior to filing the plan with the Commission for approval, DWR would submit the portion of the plan to the Forest Service, BLM, DFG, and DPR that pertains to the land each entity owns. DWR would include with the filing of the plan copies of the comments and recommendations made during consultation and would implement the plan upon Commission approval. As part of the plan, DWR would: (1) specify areas/acreages, treatment/control methods, best management practices, needs for multiple-year treatments and monitoring, and annual inspection; (2) modify implementation measures contained within the plan without Commission approval to the extend the measures are within the scope of the approved plan; (3) file with the Commission for approval any modification to the implementation measures that are not within the scope of the approved plan; (4) coordinate the plan and ongoing efforts with applicable federal, state, and local agencies and take into consideration state and federally listed species; (5) re-evaluate the plan after 5 years since initial implementation in consultation with the Forest Service, BLM, DFG, and DPR to consider the need to treat other invasive plant species, as well as alternative or additional control methods that may be implemented; and (6) file a compliance report annually with the Commission that is prepared in coordination with the Forest Service, BLM, DFG, and DPR.

Interior's (on behalf of FWS) 10(j) recommendation no. 20 and DFG's 10(j) recommendation no. 11 are consistent with this provision.

Butte County, in its letter dated April 26, 2006, recommends that DWR's proposed invasive species plan include additional treatment areas designated by the Butte County Agricultural Commissioner for aquatic plants that originate within the project boundaries and then invade downstream irrigation canals and agricultural lands that are outside the project boundaries. Butte County also recommends that it be included as a consulted party in the development of the plan because the County has a strong interest in the regulation of these invasive plants. In its May 26, 2006, filing with the Commission, DWR states its opposition to the county's recommendation to include additional treatment areas outside the project boundary.

Staff Analysis

A total of 219 species of non-native plants, not all of which are classified as noxious or invasive weeds, were identified within the project boundary during surveys conducted in 2002 and 2003. Thirty-nine of these species are target species identified as noxious or invasive plants by the California Department of Food and Agriculture, California Invasive Plant Council, USDA, and the Plumas National Forest. Although noxious and invasive weed species are found throughout the project boundary, they are mostly concentrated in the OWA.

Noxious weeds and invasive species thrive in water fluctuation zones and areas of ground disturbance. The survey results presented in the *Project Effects on Noxious Terrestrial and Aquatic Plant Species* (DWR, 2004z) are consistent with this statement. In the project boundary, although a large number of invasive and noxious weed species occur in upland areas, the wetland margins and riparian areas tend to be the most heavily infested. Fluctuating water levels in the Thermalito Complex and Lake Oroville and managed flows in the low flow channel and Feather River encourage the proliferation of noxious and invasive species in the fluctuation zone and adjacent areas. In particular, the water level fluctuations in the Thermalito afterbay have created suitable conditions for purple loosestrife. This species occupies about 85 of the 852 acres of wetland/riparian margin (DWR, 2004z). The presence of

purple loosestrife and other noxious and invasive weeds limits the presence of native vegetation and reduces the amount of wintering waterfowl nesting habitat.

Noxious and invasive species also occur in areas with land disturbance. Around Lake Oroville, these species occur in areas near roads, trails, facilities, and in the immediate vicinity of the spillway and power facilities. Continuing and proposed project maintenance and land disturbing activities, including the proposed recreational facility enhancements discussed in section 3.3.6, *Recreation Resources,* the proposed aquatic habitat enhancements and fish weir installation discussed in section 3.3.3, *Aquatic Resources*, vehicular traffic, and recreational use would contribute to the spread of invasive and noxious species. The spread of noxious and invasive weeds within the project boundary could affect special-status plant and wildlife species by out-competing native vegetation and altering required habitat components, especially within the OWA where both invasive and special-status species are plentiful.

The invasive species plan proposed by DWR and specified by the Forest Service would control, manage, and reduce noxious and invasive species within the project boundary. The plan would target these populations in the Thermalito Complex, OWA, selected lands around Lake Oroville, and along the low flow channel with the goal to reduce target plant populations and when necessary replace them with appropriate native plant species. The plan would target those species with the greatest potential to affect native plant and wildlife populations, including purple loosestrife, giant reed, tree of heaven, scarlet wisteria, parrot feather, Himalayan blackberry, and aquatic water primrose within OWA ponds. Because the invasive species plan would target those areas and species with the greatest potential to affect native species including waterfowl and special-status plants and wildlife, the plan would likely improve habitat conditions for those species and limit future habitat loss.

One of the goals of the proposed invasive species plan would be to eradicate and/or control invasive and noxious species to reduce the number of seeds and/or plants that are flushed into downstream irrigation canals, the Feather River channel, and ultimately the San Francisco Bay delta that have the potential to invade other sensitive resources and habitats as well as downstream agricultural lands. As such, the proposed invasive species plan appears to satisfy Butte County's recommendation to add treatment areas for aquatic plants that originate within the project boundaries and then invade downstream irrigation canals and agricultural lands that are outside the project boundaries. During the public process of plan development, Butte County would have the opportunity to provide input on the invasive species plan.

Oroville Wildlife Area Management Plan (Proposed Article A115)

The OWA contains important habitat for waterfowl, special-status plants and wildlife, and a wide-variety of other species. Water level fluctuations, recreational use, and maintenance activities have the potential to affect OWA vegetation and wildlife.

DWR proposes to develop and file for Commission approval a management plan for the OWA (Proposed Article A115), including the Thermalito afterbay, within 2 years of license issuance. The plan would be developed in conjunction with the DFG and DPR and in consultation with the Ecological Committee, including FWS, NMFS, the Water Board, and the Regional Board. DWR would implement the plan including any changes required by the Commission, following Commission approval and obtaining all necessary permits. The plan would include the following elements: (1) conservation measures required by final federal biological opinions; (2) resource actions included in any license that may affect the OWA; (3) strategies to minimize current and future conflicts between wildlife and recreation; (4) wildlife management goals and objectives; (5) recreation management goals and objectives that are consistent with the recreation measures outlined in the Recreation Management Plan; (6) other best management practices, including fuel load management for the reduction of fire risk to nearby properties and human life; (7) certain common elements of the Lower Feather River Habitat Improvement Plan; (8) actions designed to improve conditions for special status species and their habitats; (9) an

implementation schedule; (10) monitoring and reporting requirements; (11) a provision for periodic updates to the plan as needed; and (12) agency management and funding responsibilities. This plan would be re-evaluated every 5 years in consultation with DFG. Additionally, the Recreation Advisory Committee would provide input to ensure the compliance with the Recreation Management Plan, discussed in section 3.3.6, *Recreation Resources*. DWR would notify the Commission if any changes to the plan are beyond the objectives, activities, or schedules identified in the plan. DWR would implement the plan upon Commission approval. Aspects of the proposed OWA Management Plan that address geology, threatened and endangered species, recreation, and land use are discussed in sections 3.3.1, 3.3.5, 3.3.6, and 3.3.7, respectively.

As discussed in section 3.3.1, *Geology, Soils, and Paleontological Resources*, DWR also proposes to develop and implement a Riparian and Floodplain Improvement Program to enhance riparian and floodplain habitats for associated terrestrial and aquatic species.

Butte County, in its letter dated April 26, 2006, recommends that it be included as a consulted party in the development of an OWA Management Plan because Butte County is responsible for law enforcement and public safety issues within the OWA, which are components of managing this area. In its May 26, 2006, filing with the Commission, DWR states its opposition to the county's recommendation that it be included as a consulted party in the development of an OWA Management Plan.

Staff Analysis

The OWA, including the Thermalito afterbay, provides diverse habitat to a variety of special-status plant and wildlife species and waterfowl. The margins of the Thermalito afterbay have extensive wetland vegetation and unique mudflat habitat. The OWA, includes approximately 11,000 acres of land, most of which is inside the project boundary. A large percentage of the OWA is covered with gravel and cobble spoil piles left behind by historical dredging. The hill/swale complex from the spoil piles along with vernal pools found within the OWA provide habitat for rare species such as the federally listed valley elderberry longhorn beetle, giant garter snake, vernal pool invertebrates, and several plant species, all of which are discussed in section 3.3.5, *Threatened and Endangered Species*.

DFG currently manages the OWA, with assistance from DWR, to maximize the amount and quality of habitat available for fish and wildlife while also allowing compatible recreational use. Project operations and maintenance (O&M) activities conducted by DWR, DFG, and DPR affect plant and wildlife within the OWA. As discussed previously, water level fluctuations in the Thermalito Complex and the Feather River affect waterfowl, grebes, invasive species, and riparian habitat. Spoil piles in the OWA currently are harvested for gravel, which can alter habitat to either the benefit or detriment of wildlife species. Maintenance activities by DWR and DFG within the OWA for things such as roads and parking lots, levees, trails, plantings for waterfowl, and fire suppression can remove or alter habitat, promote the establishment of invasive species, and cause the displacement or loss of wildlife.

Ongoing and proposed recreational use, including boating, hunting, fishing, off-highway vehicle (OHV) use, and camping, also affects vegetation and wildlife with the OWA. DWR proposes the modification, improvement, and expansion of recreational facilities within the OWA, as discussed in section 3.3.6, *Recreation Resources*. Specific locations include the Thermalito afterbay outlet camping area, and a day-use area near the Feather River at the OWA Thermalito afterbay outlet; numerous boat ramps would also be modified. Recreational activity can affect vegetation and wildlife either through direct loss of habitat, habitat modification, or displacement and disturbance.

The proposed OWA Management Plan would allow all continuing and proposed measures related to the OWA to be managed under one plan and integrated with the proposed Recreation Management and Lower Feather River Habitat Improvement plans. As proposed, the OWA Management Plan would ensure that the OWA is managed to the optimum benefit to vegetation, wildlife, riparian habitat, and special-status species, as well as recreation. Including Butte County as a consulted party in development

of the management plan would ensure that concerns with law enforcement, public safety, and local issues are considered.

The Riparian and Floodplain Improvement Program proposed by DWR would implement projects designed to improve riparian habitat and connect portions of the Feather River to its floodplain within the OWA. Riparian and floodplain habitat is important to wildlife because it provides habitat diversity, travel corridors, and cover to protect species from predation. Under this program, DWR would also identify where gravel harvesting can take place to improve wildlife habitat. DWR (2004aa) reports that the limited cottonwood recruitment in the Feather River is an effect of project operations that prevent initial seedling survival, longer-term establishment of seedlings, or both. The study results indicate that the frequent occurrence of scouring flows in the high flow channel also affects cottonwood survival. The proposed improvement program would identify and implement possible riparian/floodplain improvement projects. These measures would be designed to improve and expand riparian and floodplain habitat, including cottonwoods, benefiting wildlife.

Other Environmental Measures Affecting Terrestrial Resources

Project facilities and modifications proposed for aquatic and recreational resources also have the potential to affect terrestrial resources. Construction, expansion, and improvements of aquatic and recreational facilities could result in the disturbance and loss of vegetation. Conversely, some proposed fishery enhancement measures have the potential to benefit riparian and wildlife habitat.

Fisheries measures proposed by DWR, as discussed in section 3.3.3, *Aquatics Resources*, that have the potential to affect terrestrial resources include: (1) Channel Improvement Program (Proposed Article A103); (2) Structural Habitat Supplementation and Improvement Program Plan (Proposed Article A104); and (3) Fish Weir Program (Proposed Article A105). Recreation measures proposed by DWR,[61] as discussed in section 3.3.6, *Recreation Resources*, that have the potential to affect terrestrial resources include: (1) the modification, improvement, and/or expansion of campgrounds; (2) improvements to boat ramps; (3) improvements and development of day-use areas; and, (4) trail and trailhead improvements.

Staff Analysis

Construction of two fish barrier weirs would have minor short-term and long-term effects on vegetation and wildlife because of necessary vegetation clearing. Clearing vegetation and disturbing soils would also create a favorable environment for the introduction and proliferation of invasive weed species. The construction of two fish weirs in the low flow channel would result in the permanent loss of less than 1 acre of riparian vegetation. No special-status species are known to occur in the area of the proposed fish weirs, so no effects on special-status species would be expected.

Construction activities to improve Moe's and Hatchery ditches and create five side channels (Proposed Article A103, *Channel Improvement Program*) would temporarily disturb vegetation. Placing LWD and boulders in the channel (Proposed Article A104, *Structural Habitat Supplementation and Improvement Program Plan*) would result in the temporary disturbance of some vegetation, but, overall, this program would likely benefit riparian and wetland vegetation. LWD would trap sediment, which would potentially allow new areas of riparian vegetation to become established. Additionally, LWD could prevent scouring of existing riparian vegetation by providing protection from high flows.

Several recreational measures could also result in the loss of vegetation and increase the risk of establishing and spreading invasive plant species. The two recreational measures that would result in the most vegetation loss are the proposed modifications at Bidwell Canyon and Loafer Creek recreation

[61] DWR proposes specific recreational measures in the Settlement Agreement Recreation Management Plan, dated March 2006.

areas. Enhancements at the Bidwell Canyon Recreation Area would require the removal of approximately 7 acres of vegetation—2 acres of open/disturbed blue oak/foothill pine woodland and 5 acres of dense mixed oak/foothill pine. Loafer Creek recreation area enhancements would require the removal of approximately 10 acres of mixed oak/foothill pine vegetation. Proposed modifications at the Enterprise boat ramp, Foreman Creek, Saddle dam, Thermalito diversion pool, Thermalito forebay, and Thermalito afterbay would require the removal of less than 1 acre of vegetation at each location. The loss of large areas of vegetation, as at Bidwell Canyon and Loafer Creek recreation areas, would likely have minor effects on wildlife from loss of habitat and displacement; however, these areas have already been heavily modified by extensive recreation, which has lessened their habitat value. The vegetation lost at the remaining areas is minimal and would be unlikely to affect wildlife.

3.3.4.3 Cumulative Effects

Riparian communities in the Sacramento Valley have been adversely affected by the development of numerous hydroelectric and reservoir projects, mining, water diversions, channelization, and levee construction. Project facilities and operations contribute to the loss of riparian communities downstream of the project by reducing sediment discharge and floodflows.

Flow management and project maintenance, along with recreational use, land development, agriculture, and fire suppression contribute to the loss of upland plant communities and wetlands and the spread of invasive species. Loss of vegetation would occur, as a result of the proposed project aquatic and recreational measures, as well as non-project related land management, development, and agriculture. Water level fluctuations and project recreational use contribute to the loss of waterfowl and grebe nesting habitat; however, the proposed brood ponds and improved cover and forage habitat, in addition to existing activities by the DFG, would be a beneficial effect on Sacramento Valley waterfowl.

Existing and proposed activities, in addition to management and development of lands adjacent to the project boundary, would also increase the potential for invasive species proliferation. The proposed invasive species plan, however, would result in a cumulative beneficial effect on native plant communities and wildlife because it would manage for, control, and eradicate invasive species, particularly in areas of special-status species and commercially and recreationally important species.

3.3.4.4 Unavoidable Adverse Effects

More than 20 acres of vegetation would be permanently lost as the result of proposed aquatic and recreational measures. As a result, some wildlife would be displaced, and small, less mobile species could be lost.

3.3.5 Threatened and Endangered Species

3.3.5.1 Affected Environment

Fish Species

Central Valley Spring-run Chinook Salmon

On September 19, 1999, NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened under ESA, and the listing was reaffirmed on June 28, 2005. The Central Valley spring-run Chinook salmon ESU is also listed as endangered under the California Endangered Species Act. The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as fish from the Feather River Hatchery spring-run Chinook program. NMFS' Central Valley Technical Recovery Team believes that the existing spring-run population in the Feather River, including the hatchery fish, may be the only

remaining representative of this important ESU component and that the Feather River Hatchery spring-run Chinook stock may play an important role in the recovery of spring-run Chinook in the Feather River Basin as efforts progress to restore natural spring-run populations in the Feather and Yuba rivers (70 FR 37,160).

A final critical habitat designation was published on September 2, 2005, with an effective date of January 2, 2006. NMFS identified the Feather River downstream of Oroville dam as critical habitat for Central Valley spring-run Chinook salmon. NMFS further ruled that it is premature to include areas upstream of Oroville dam until ongoing recovery planning efforts in the central valley identify above-dam unoccupied areas that are essential for conservation of these ESUs (70 FR 52,630).

Historically, spring-run Chinook salmon were reported to have ascended to the very highest streams and headwaters in the Feather River Watershed while they completed gonadal maturation (DFG, 1998a). The fish barrier dam downstream of Oroville dam now denies fish passage to historical spawning grounds at higher elevations (DFG, 1998a). As previously stated, the Oroville Facilities and seasonal sediment wedges (see figure 9) currently block the upstream migration of anadromous salmonids into historical spawning habitat in upstream tributaries. Blocked access to historical spawning grounds in the upper watershed causes spring-run Chinook salmon to spawn in the same lowland reaches of the Feather River that fall-run Chinook salmon use as spawning habitat. The overlap in spawning sites and in spawning timing (Moyle, 2002) may be responsible for inter-breeding between spring-run and fall-run Chinook salmon in the Feather River (Hedgecock et al., 2001).

In the Feather River, it has been reported that adult spring-run Chinook salmon enter the river from March through June (Sommer et al., 2001), and spawn from August through October (DFG, 1998a; DWR and BOR, 2000; Moyle, 2002). Fall-run Chinook salmon typically spawn in late September through December. Suitable water temperatures for spawning are 42 to 58°F (5.6 to 14.4°C). Incubation may extend through March; suitable incubation temperatures are 48 to 58°F (8.9 to 14.4°C) (DWR, 2006). Feather River spring-run and fall-run Chinook salmon appear to migrate out of the project area within days of emergence.

Water temperature strongly influences the timing of adult Chinook salmon spawning activity. When daily average water temperatures decrease to about 60°F, female Chinook salmon begin to construct nests (redds) into which their eggs (simultaneously fertilized by the male) are eventually released. Fertilized eggs are subsequently buried with streambed gravel. Spawning activity in the Feather River occurs from late August through December and generally peaks in mid to late November (Myers et al., 1998). Most juvenile Chinook salmon emigrate from the Feather River within a few days of emergence, and 95 percent of the juvenile Chinook have typically emigrated from the Oroville Facilities area by the end of May. Chinook exhibiting the typical spring-run life history are found holding at the Thermalito afterbay outlet and the fish barrier dam as early as April.

Water temperatures reported to be optimal for rearing of Chinook salmon fry and juveniles are between 45 and 65°F (NMFS, 2002; Rich, 1987; Seymour, 1956). Juvenile fall-run Chinook salmon normally rear for 1 to 7 months in freshwater before migrating to the ocean (Yoshiyama et al., 1998), and normally spend 4 to 5 years in the ocean (Moyle, 2002). Juvenile Chinook salmon in the Feather River have been reported to emigrate from about mid-November through June, with peak emigration occurring from January through March (DWR, 2002c; Painter et al., 1977).

Central Valley Steelhead

Steelhead are native to California rivers. On March 19, 1998, NMFS listed the naturally spawned Central Valley steelhead as threatened under the ESA (63 FR 13,347). In June 2005, NMFS determined that hatchery stocks are to be included in a steelhead Distinct Population Segment if they are no more than moderately diverged from local, native populations in the watershed(s) in which they are released.

In its final listing determination published January 6, 2006 (71 CFR 834), NMFS concluded that the threatened Central Valley Steelhead Distinct Population Segment includes all naturally spawned populations of steelhead (and their progeny) below natural and manmade barriers in the Sacramento and San Joaquin rivers and their tributaries. The listing excludes steelhead from San Francisco and San Pablo bays and their tributaries, and includes steelhead from Feather River Fish Hatchery.

Critical habitat for Central Valley steelhead was designated by NMFS in September 2005 (70 FR 52,488), and includes the Feather River downstream of Oroville dam.

Most of the natural steelhead spawning in the Feather River occurs in the low flow channel, particularly in its upper reaches near Hatchery Ditch, a side-channel located between RM 66 and 67. Limited steelhead spawning also occurs below the Thermalito afterbay outlet. Soon after emerging from gravel, a moderate percentage of the fry appear to emigrate. The remainder of the population rears in the river for at least 6 months to 1 year. Studies have confirmed that juvenile rearing and probably adult spawning are associated with secondary channels within the low flow channel (DWR, 2005a). The lower velocities, smaller substrate size, and greater amount of cover (compared to the main river channel) likely make these side-channels more suitable for juvenile steelhead rearing.

Currently, this type of habitat comprises less than 1 percent of the available habitat in the low flow channel (DWR, 2001b). Juvenile steelhead in the Feather River emigrate from about February through September, with peak emigration occurring from March through mid-April. However, empirical and observational data suggest that juvenile steelhead potentially emigrate during all months of the year in the Feather River.

Southern DPS North American Green Sturgeon

Following completion of a comprehensive ESA status review and update for the North American green sturgeon, NMFS published a Proposed Rule to list the Southern DPS of green sturgeon, including the Feather River subpopulation, as threatened on April 6, 2005. NMFS issued a Final Rule to list the Southern DPS as a threatened species on April 7, 2006 (71 FR 17757). NMFS is currently considering issuance of protective regulations to provide for the conservation of the species and soliciting information that may be relevant to the analysis of protective regulations and to the designation of critical habitat.

As previously stated in section 3.3.3.1, *Aquatic Resources, Affected Environment*, green sturgeon are anadromous and begin an upstream spawning migration between February and June; spawning occurs between April and June (Beamesderfer and Webb, 2002; Moyle, 2002). Spawning occurs in deep pools (probably deeper than 3 meters) in large, turbulent rivers, and the preferred substrate is probably large cobble with crevices to trap eggs (DWR, 2006). Adults enter the Sacramento River when water temperatures are between 46 and 57°F (7.8 to 13.9°C). Sturgeon eggs have been found in the Sacramento River from mid-February through July. Eggs are slightly adhesive, adhering to substrate and each other; silt is known to prevent adherence. Water temperatures greater than 68°F (20°C) may be lethal to embryos. Larval and juvenile sturgeon remain in freshwater up to 4 years before migrating to the ocean.

Restricted access to potential spawning areas is considered the primary factor for the decline of the Southern DPS green sturgeon (DWR, 2006). The Biological Review Team for listing of the Southern DPS green sturgeon concluded that a viable spawning population no longer exists in the Feather River and was probably lost due to construction of Oroville dam that blocks access to upstream habitat, other upstream passage barriers, and the thermal barrier associated with Thermalito afterbay. Sturgeon passage may be impeded at Shanghai Bend (RM 25) and Sunset Pumps on the Feather River, particularly at lower flows in the spring and fall. Sturgeon do not typically enter the mouth of the Feather River at flows lower than about 5,000 cfs (DWR, 2005b, appendix G).

The occasional capture of larval green sturgeon in salmon out-migrant traps suggests that green sturgeon spawn in the Feather River (Moyle, 2002); however, NMFS reports that evidence of green

sturgeon spawning in the Feather River is unsubstantiated (70 FR 17386). The goal of SP-F3.2 Task 3A was to determine the distribution, spawning locations and timing, habitat usage, residence time, and emigration patterns of sturgeon in the lower Feather River (DWR, 2005r). However, angling and fyke netting did not capture any sturgeon for the 2003 radio telemetry study and the fyke trap used in the 2004 study season, and the egg and larval survey during the 2003 season did not capture any sturgeon.

However, several sturgeon were seen breaching downstream of Shanghai Bend from June 1-10, 2004, when flows ranged from 3,691 to 5,577 cfs (DWR, 2005r). DWR concluded it was possible, given the size of the individuals and the leaping behaviors observed, that spawning occurred downstream of Shanghai Bend. This area was comparable with other known sturgeon spawning habitats given that it consisted of deep, high velocity waters; however, water temperatures, averaging between 66.6°F (19.2°C) and 71.4°F (21.9°C), were warmer than preferred temperatures indicated by the literature for spawning sturgeon (DWR, 2005r). DWR also concluded that flows above 5,100 cfs seemed unlikely to have prevented passage (DWR, 2005r).

Delta Smelt

The federally threatened delta smelt occur only in the Sacramento-San Joaquin Estuary and have been found as far upstream as the mouth of the American River on the Sacramento River. Delta smelt are found in brackish water and spawn in fresh water. Delta smelt do not occur within the project boundary or within the Feather River.

Plant Species

DWR compiled a list of federally listed plant species with the potential to occur in the study area based upon rare plant descriptions and distributions obtained from California Natural Diversity Database records, a review of CNPS (2001), *Manual of the Vascular Plants of Butte County California* (Oswald, 1994), *The Jepson Manual* (Hickman, 1993), other state and/or county biological survey records, web-based and printed articles, and discussions with local authorities.

DWR conducted botanical surveys during 2002, 2003, and 2004 in accordance with standard guidelines issued by DFG (2000), FWS (1996), and the California Native Plant Society (CNPS, 2001). Surveys were conducted during the time of year when the target species were identifiable. Field investigations were conducted in a manner that emphasized all potential habitats for the target threatened and endangered plant species (i.e., vernal pools/valley grasslands and serpentine/gabbro soils). Areas surveyed included valley grasslands around Thermalito afterbay and Thermalito forebay, serpentine soils along the West Branch and Upper North Fork arms, and gabbro soils along the South Fork arm. All plant species encountered during these surveys were identified to the lowest taxonomic status possible.

Relicensing studies indicate that potentially suitable habitat exists within the study area for seven federally listed and state-listed plant species (table 40). No federally listed or state-listed plant species were found within the study area during the 2002, 2003, and 2004 surveys. Although no federally listed plant species were found within the study area, potentially suitable habitat does exist for all of the seven listed species.

Table 40. Federally listed plant species with potential to occur in the study area. (Source: DWR, 2005a)

Common Name ***Scientific Name***	**Status FWS/ State**	**Habitat (elevation)**	**Found in Study area**
Butte County meadowfoam *Limnanthes floccosa* ssp. *californica*	Endangered/ endangered	Valley and foothill grassland (mesic), vernal pools (50–90 m)	No
Hairy Orcutt grass *Orcuttia pilos*	Endangered/ endangered	Vernal pools (55–200 m)	No
Hartweg's golden sunburst *Pseudobahia bahiifolia*	Endangered/ endangered	Cismontane woodland, valley and foothill grassland/clay (15–150 m)	No
Greene's tuctoria *Tuctoria greenei*	Endangered/ rare	Vernal pools (30–1,070 m)	No
Hoover's spurge *Chamaesyce hooveri*	Threatened	Vernal pools (25–250 m)	No
Slender Orcutt grass *Orcuttia tenuis*	Threatened/ rare	Vernal pools (35–1,760 m)	No
Layne's ragwort *Senecio layneae*	Threatened/ rare	Chaparral, cismontane woodland/ serpentinite or gabbroic (200–1,000 m)	No

Butte County Meadowfoam

This winter annual herb is federally listed as endangered and appears in late March to early May in ephemeral drainages, vernal pool depressions in ephemeral drainages, and occasionally around the edges of isolated vernal pools at elevations of 165 to 197 feet msl.

Sixteen of the eighteen remaining known populations of Butte County meadowfoam occur on private land and are subject to urban development, agricultural land conversion, and highway widening or realignment. There are four occurrence records for Butte County meadowfoam from about 5 miles north of the Thermalito afterbay in the vicinity of Shippee, California.

Relicensing surveys conducted by DWR did not locate Butte County meadowfoam in the study area. About 49 acres of vernal pools, ephemeral drainages, and pool/swale complexes occur in the study area in the grasslands around the Thermalito Complex. Many of the ephemeral drainages could potentially support Butte County meadowfoam. White meadowfoam is a common early successional inhabitant of ephemeral drainages and depressions within the study area. This species is closely related to the listed Butte County meadowfoam and occurs in similar habitat.

Hairy Orcutt Grass

This annual grass species is federally listed as endangered and occurs in drying vernal pool habitat along the eastern margin of California's Central Valley at elevations ranging from 100 to 400 feet msl. This late season species grows in vernal pool bottoms and along edges of pools.

Of the original 40 known populations of hairy Orcutt grass, 12 are thought to have been extirpated due to agricultural land conversion, urbanization, and intensive cattle grazing. One occurrence of hairy Orcutt grass is documented within 8 miles of the study area.

DWR did not locate any occurrences of hairy Orcutt grass during relicensing surveys within the study area. Many of the larger and deeper vernal pools are associated with clay soils that form a nearly impermeable pool bottom and are suitable habitat for this species.

Hartweg's Golden Sunburst

This annual herb in the sunflower family is federally listed as endangered and closely associated with mima mound topography in annual grasslands and blue oak woodlands.

The type locality for this species historically occurred in Yuba County along the bank of the Feather River near the confluence with the Yuba River. This type locality has been extirpated. Currently, this species occurs in two general areas in eastern San Joaquin County. The extirpated Yuba County location is more than 26 miles south of the project boundary.

No occurrences or potential habitat for Hartweg's golden sunburst were found downstream of the study area along the Feather River floodplain. The vernal pools in the grasslands around Thermalito forebay and Thermalito afterbay contain areas of mounded ground that could be potential habitat for this species.

Greene's Tuctoria

Greene's tuctoria is federally listed as an endangered species and is a state-listed rare species. This species occurs from May to July along the eastern margin of the California Central Valley. Greene's tuctoria occupies small or shallow vernal pools or the margins of deeper pools.

Forty-one occurrences have been documented from Fresno to Shasta counties. However, 19 of these populations, from Fresno, Madera, Stanislaus, Tulare, and San Joaquin counties, are thought to have been extirpated. The remaining populations occur in Butte, Glenn, Merced, Shasta, and Tehama counties. All populations are on private lands except one population at the Sacramento National Wildlife Refuge. One occurrence of Greene's tuctoria is within 150 feet of the project boundary, 1 within 5 miles and another within 10 miles of the project boundary.

DWR did not locate any occurrences of Green's tuctoria during relicensing surveys in the study area. Potentially suitable habitat exists in the larger, deeper vernal pools that are associated with impermeable clay soil bottoms.

Hoover's Spurge

This prostrate annual herb is federally listed as threatened and grows in the bottom of drying vernal pools on the eastern margin of California's Central Valley. This species typically inhabits larger, deeper pools in areas otherwise barren of vegetation.

According to the current California Natural Diversity Database, 4 of the 30 occurrences of Hoover's spurge have been extirpated. The 26 extant occurrences are distributed along remnant alluvial terraces and fans, mostly along the eastern edge of the Central Valley in Tulare, Merced, Stanislaus, Butte, Glenn, and Tehama counties, where it occurs below elevation 820 feet msl. The majority of occurrences are located near the Butte-Tehama county line in the northern Sacramento Valley. The occurrence of Hoover's spurge that is closest to the project is about 8 miles north of the project boundary.

Although suitable habitat exists within the study area, no occurrences were found within the study area during relicensing surveys.

Slender Orcutt Grass

This annual grass species is federally listed as threatened and is found most often in the drying bottoms of large, deep vernal pools. It is restricted to Northern California and occurs in disjunct

populations from Siskiyou County to Sacramento County. Two occurrences of slender Orcutt grass occur within 1 mile of the study area.

Large, deep vernal pools with clay soils that form a nearly impermeable pool bottom occur in the study area. These deep pools are suitable habitat for this species. Slender Orcutt grass was not found in the study area during relicensing surveys conducted by DWR.

Layne's Ragwort

This perennial herb is federally listed as threatened and found in open rocky areas of serpentine and gabbroic derived soils within chaparral and chaparral/open pine or oak woodlands at elevations of 660 to 3,300 feet.

There are 43 extant occurrences of Layne's ragwort identified in the California Natural Diversity Database from El Dorado, Tuolumne, and Yuba Counties. Two of the 43 records are in Yuba County, about 5 miles southeast of the South Fork arm.

About 172 acres of serpentine and serpentine-derived soils and 64 acres of gabbro and gabbro-derived soils occur in the study area around Lake Oroville. These serpentine- and gabbro-derived soils with sparse vegetation cover are potential habitat for Layne's ragwort. DWR did not find Layne's ragwort in the study area during relicensing studies.

Wildlife Species

DWR compiled a list of federally listed wildlife species with the potential to occur in the project boundary based upon identification of potential habitats and compilation of information, species occurrence, and life histories from the California Wildlife Habitat Relationship database and the California Natural Diversity Database for the study area and within a 1-mile radius as well as other national, state, and/or county biological survey records and databases, web sites, printed articles, and discussions with local wildlife agency staff.

DWR delineated potential habitats by converting vegetation mapping for the study area (as discussed in section 3.3.4, *Terrestrial Resources*) to the California Wildlife Habitat Relationship habitat classification system. DWR conducted surveys of potential habitats for threatened and endangered species as well as visual surveys for the occurrence of the species in 2002 (valley elderberry longhorn beetle and California red legged frog, bald eagle), 2003 (bald eagle and vernal pools) and 2004 (bald eagle and vernal pools) in accordance with applicable DFG or FWS protocols, where appropriate.

FWS issued a letter on January 28, 2004, which listed species that potentially may occur in the project vicinity. Seven wildlife species protected under the ESA have the potential to occur within the project vicinity: vernal pool tadpole shrimp, Conservancy fairy shrimp, vernal pool fairy shrimp, bald eagle, giant garter snake, California red-legged frog, and valley elderberry longhorn beetle (see table 41). No designated or proposed critical habitat occurs within the project boundary for federally listed species. Surveys conducted during relicensing located the presence of or occurrence of potentially suitable habitat within the study area for the seven species identified by FWS in its letter issued January 28, 2004.

DWR entered into informal consultation with FWS to resolve terrestrial listed-species issues prior to the initiation of formal consultation. FWS recommended several measures for early implementation (under the existing FERC license) to minimize or avoid take of a federally listed species related to ongoing project activities. Species-specific measures are discussed below; however, in addition, DWR has designated a listed-species coordinator within DWR to implement and regulate implementation of conservation measures.

Table 41. Federally listed species occurring in the project vicinity. (Source: DWR, 2005a)

Wildlife Species	Scientific Name	Federal Status
Vernal pool tadpole shrimp	*Lepidurus packardi*	Endangered
Conservancy fairy shrimp	*Branchinecta conservatio*	Endangered
Vernal pool fairy shrimp	*Branchinecta lynchi*	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Giant garter snake	*Thamnophis couchi gigas*	Threatened
California red-legged frog	*Rana aurora draytonii*	Threatened
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	Threatened

Bald Eagle

Bald eagles historically nested throughout California near sea coasts, major rivers, and lakes. More than 160 pairs currently nest in California (up from 28 pairs in 1978) while hundreds of additional bald eagles migrate into California during the winter.

Nesting habitat is described as old-growth trees and snags in remote mixed stands near water (Zeiner et al., 1990). In a 1979 survey of 95 bald eagle nest sites in Northern California, 87 percent were in dominant or co-dominant ponderosa pine or sugar pine (Lehman, 1979). Associated stands were generally open (less than 40 percent canopy cover) and within 1 mile of a water body. About one-third of the nest sites were within 0.1 mile of a water body, and 85 percent of the nests had an unobstructed view of the water body. Seventy percent of the nests were associated with reservoirs.

Four active bald eagle nest territories currently exist within the project boundary, with one additional active nest territory present on the North Fork upstream of the project boundary. Three active nests are along the shoreline of Lake Oroville and one is on the Feather River in the southwest portion of the OWA. Population monitoring (2002 through 2004) indicates that reproduction (1.0 fledgling/active nest) meets the FWS' Bald Eagle Pacific Recovery Plan goals (FWS, 1986). Winter bald eagle surveys indicate that Lake Oroville receives extensive wintering use by both adult and immature eagles; however, other project aquatic habitats receive relatively minor wintering bald eagle use (DWR, 2004bb).

DWR has implemented conservation measures as a result of the draft programmatic biological assessment. These include measures designed to protect bald eagle nesting territories by prohibiting human activity near the nests. These measures include the following: (1) administrative closure of land and shoreline areas to human entry during the nesting season around the four bald eagle nest territories; (2) signage, patrol, and enforcement of closure; (3) nest and population surveys; (4) habitat improvement measures; and (5) limitations on current and future habitat disturbance. DWR also has prepared and implemented bald eagle territory management plans for the four bald eagle territories currently active on or within 0.25 mile of project lands.

Giant Garter Snake

The giant garter snake is endemic to the wetlands of the Central Valley of California. Historical range is believed to include valley floor wetlands from the vicinity of Butte County south to near Bakersfield. Historically, giant garter snakes were found in natural wetlands associated with flood basins.

Thirteen sub-populations of giant garter snake have been identified. The northern extent of the current range of this species is described as Sacramento and Contra Costa counties (Fox, 1951) to near Gridley (Hansen and Brode, 1980) and to the vicinity of Chico (Rossman and Stewart, 1987). In addition

to natural wetlands, giant garter snakes are now found in agricultural wetlands (rice), managed wetlands (duck clubs and state and federal refuges), agricultural drains, ponds, and other artificial waterways.

The Giant Garter Snake Recovery Plan (Miller and Hornaday, 1999) describes the essential habitat components for this aquatic reptile as follows: (1) adequate water during the snakes' active season (early spring through mid-fall) to support dense populations of prey; (2) the presence of emergent herbaceous cover (cattails and tules) for escape cover and foraging habitat; (3) grassy upland habitat adjacent to waterways for basking; and (4) higher elevation upland habitat for flood flow refuge. This species is absent from larger rivers, riparian woodlands, and wetlands with sand, rock, or gravel substrates (Miller and Hornaday, 1999).

Suitable giant garter snake habitat was identified within portions of Thermalito forebay, Thermalito afterbay, the OWA, and lands subject to rice agriculture adjacent to the Thermalito afterbay but outside the project boundary. About 4,280 acres of suitable habitat have been identified within the study area. DWR observed no giant garter snakes during the course of the relicensing studies. DWR conducted habitat surveys in the areas of potential project affects near recreational developments and other project facilities, and non-protocol level field surveys were conducted during 2 weeks in August 2002 (DWR, 2004bb). However, unconfirmed sightings of this species have been received historically from biologists working near Robinson Borrow Pond (adjacent to the project boundary), Cherokee canal (2 miles west of Thermalito afterbay), and within Thermalito afterbay. No suitable habitat is present at Lake Oroville. Several small, isolated patches of backwater habitats along the Feather River within the project boundary provide suitable habitat. The rice fields and canals along the western border of Thermalito afterbay have suitable habitat for giant garter snake. These canals are located primarily on private property and outside of the project boundary. Rice fields and agricultural ditches provide habitat for most of the existing populations of the giant garter snake (FWS, 1997), and these areas are expected to have populations of giant garter snake. Further, these canals offer dispersal channels for giant garter snake to eventually move into the OWA waters that have potentially suitable habitat. State Route 99 serves at least as a partial barrier to this dispersal habitat.

California Red-Legged Frog

The California red-legged frog can occur from sea level up to about elevation 5,000 feet msl, with most known populations occurring below elevation 3,500 feet msl. This species uses a variety of aquatic habitats for reproduction including streams, deep pools, backwaters, ponds, marshes, sag ponds, dune ponds, and lagoons (FWS, 2000). Breeding adults are generally associated with deep (greater than 2 feet), slow moving water bordered by dense, low riparian or emergent vegetation (FWS, 2000). Upland areas near breeding locations can also be used extensively during the summer (FWS, 2000). The California red-legged frog has been extirpated from about 70 percent of its former range with only two known populations remaining east of the Coast Range.

The California red-legged frog is not currently known to exist within the project boundary. However, the largest remaining population within the Sierra Nevada range is within 1 mile of the project boundary in the North Fork drainage. DWR conducted California red-legged frog habitat surveys during 2 weeks in August 2002. All accessible wetland areas within the Oroville facilities boundary were surveyed on foot and wetlands within 1-mile of the project boundary without access permission were surveyed using binoculars and a spotting scope. The results of these survey efforts were submitted to FWS for review and comment, and FWS suggested that documentation of potential habitat was adequate for effect assessment (DWR, 2004bb). Suitable California red-legged frog habitat was identified by DWR within portions of Thermalito forebay, Thermalito afterbay, and the OWA. Neither Lake Oroville nor the portion of the reservoir's tributaries within the study area contain suitable habitat.

Vernal Pool Invertebrates

The study area is known to be within the range of three federally listed eubranchiopod species: the vernal pool fairy shrimp, Conservancy fairy shrimp, and vernal pool tadpole shrimp.

The tadpole shrimp is federally listed as an endangered species. This tadpole shrimp species is found in vernal pools throughout the Sacramento Valley and reportedly occurs in Butte County. The tadpole shrimp, an omnivorous species, generally forages on the bottoms of pools in dense vegetation. Tadpole shrimp tend to be slow growing and usually produce eggs after the vernal pool has been ponded for 30 days.

The Conservancy fairy shrimp is federally listed as an endangered species. This species reportedly occurs in large (>1.2 acres) and deep (>6 inches) turbid alkaline pools. This species of fairy shrimp has an extremely disjunct distribution, known to occur in Tehama and Butte Counties, the northern part of the Sacramento Valley, Solano County at the Jepson Prairie, Merced County, the San Joaquin Valley near Haystack Mountain, and an isolated occurrence from northeastern Ventura County (Eriksen and Belk, 1999). No suitable habitat for this species occurs within the project boundary.

The vernal pool fairy shrimp is federally listed as a threatened species. This shrimp species is found in vernal pools throughout the Central Valley and western Riverside County in California, and near Medford, Oregon (Eriksen and Belk, 1999). This fairy shrimp species lives in neutral to slightly alkaline vernal pools throughout the Central Valley and in rock outcrop pools along the Interior Coast Ranges, south of the Sacramento River Delta.

Typical habitat for fairy shrimp and tadpole shrimp in California includes vernal pools, ponded areas within vernal swales, rock outcrop ephemeral pools, playas, alkali flats, and salt lakes (Eng et al., 1990). Pool volume is important in determining potential shrimp habitat because deeper pools with a large surface area have more stable DO levels. Further, deep pools will pond long enough to allow the shrimp to complete their life cycle.

None of these three invertebrate species are known to occur within the study area. Vernal pool fairy shrimp, however, are documented to occur at two locations immediately adjacent to the project boundary (DFG, 2004). According to FWS's biological opinion (letter dated April 9, 2007), 72.3 acres of suitable vernal pool fairy shrimp and vernal pool tadpole shrimp habitat occur within the project boundary, mainly occurring in the grasslands around Thermalito afterbay and Thermalito forebay. DWR currently conducts vernal pool surveys in the spring of each year, and will continue to do so until 2009 at which point DWR will conduct surveys every other year for the length of its license.

DWR has implemented conservation measures as a result of the draft programmatic biological assessment. These measures are designed to protect vernal pool invertebrate habitat, including the following: (1) signage and fence maintenance to prevent illegal OHV use in areas containing vernal pools; (2) implementation of actions to prevent sediment or contaminate discharge into vernal pools; and (3) monitoring to determine conservation measure effectiveness. The sediment-trapping program uses various measures (e.g., gravel, rock, silt fencing, silt-screening, hay bales, wattles, coconut mats) to reduce and/or prevent sedimentation into vernal pool habitat. Initially, this is an experimental program. DWR plans that, through adaptive management over time, the best-performing measure(s) will then be selected and routinely (at least annually checked and repaired) implemented, as necessary, over the life of the FERC license. Additionally, DWR abandoned and then revegetated, one road segment located near vernal pools that DWR determined is no longer necessary and needed to facilitate project operations or management.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle's known distribution has greatly increased through additional survey efforts, which have located additional populations since its initial listing in 1980. FWS

now identifies the species range as throughout the Central Valley and up to 3,000 feet in elevation on the eastern edge of the valley and to the Coast Range watershed divide along the western side of the valley (FWS, 1984).

The beetle primarily inhabits riparian habitat and adjacent uplands. The valley elderberry longhorn beetle depends on its host plant the elderberry throughout its life cycle. Valley elderberry longhorn beetles, which spend most of their 2-year life cycle boring within the stem in a larval stage, emerge from March through June as adults to lay eggs, completing the life cycle (Barr, 1991).

DWR mapped and surveyed elderberry bushes using the FWS protocol within 100 feet of all project features within the project boundary, including roads, levees, campgrounds, and trails. No protocol level surveys were conducted within the portion of the OWA bordering the Feather River and downstream of the Feather River. In these areas, elderberry shrubs were mapped, and the valley elderberry longhorn beetle's presence was assumed based on prior sampling (DWR, 2004bb). Elderberry bushes are one of the most common shrub species in high terrace habitats within the portion of the OWA bordering the Feather River. More than 90 acres of elderberry shrubs have been mapped on project levees in this area. Elderberry shrubs are rare at Lake Oroville, Thermalito forebay, and Thermalito afterbay. Several small patches of elderberry shrubs are present within the study area between Oroville dam and Table Mountain Boulevard.

3.3.5.2 Environmental Effects

Fish Species

Gravel Supplementation and Improvement Program (Proposed Article A102)

DWR's studies indicate that the Oroville dam traps an estimated 97 percent of all sediment, including gravels. As a result, the current spawning habitat in the low flow channel has deteriorated due to a lack of suitable spawning gravel. In response to the current situation, DWR would plan for and implement gravel supplementation within 5 years after license issuance (Proposed Article A102, *Gravel Supplementation and Improvement Program*). At least 8,300 cubic yards of gravel suitable for spring-run Chinook salmon and steelhead would be distributed at up to 15 locations in the low flow or high flow channels.

Within 2 years of license issuance, DWR would develop a gravel supplementation and improvement program for the ongoing and future management of the Feather River. DWR would conduct a physical assessment of the spawning riffles between RM 54.2 and 67.2 and develop a sediment budget for the low flow channel. At 5-year intervals after the initial supplementation period, DWR would monitor and maintain a minimum of 10 of the 15 riffle complexes on a rotating basis in the low flow channel so that approximately 80 percent of the spawning gravels randomly sampled in the riffle complexes would be in the median size range preferred by Chinook salmon or steelhead. If and when the need arises, but no sooner than ten years after license issuance, DWR, in consultation with the Ecological Committee, would determine the need for additional gravel supplementation activities to be conducted in the high flow channel and DWR would prepare a gravel budget for supplementation activities in the high flow channel.

DWR evaluated the effects of the Gravel Supplementation and Improvement Program in the preliminary draft environmental assessment (DWR, 2005a) and determined it would be beneficial because an increase in the quantity and quality of suitable spawning habitat downstream of the fish barrier dam would be expected to reduce the rates of redd superimposition and associated egg mortality, as well as reduce competition for spawning habitat.

Staff Analysis

Historically, Chinook salmon and steelhead spawning occurred upstream of the Oroville dam; however, the Oroville Facilities prevent their access to higher quality spawning habitat in the upper watershed. As a result, all Chinook salmon and steelhead spawning currently takes place downstream of the fish barrier dam, where competition for spawning is unnaturally concentrated and there is no spatial segregation of the spring-run and fall-run Chinook salmon. In addition to redd superimposition/egg mortality, there is increased pre-spawning mortality and interbreeding between the Chinook salmon spring and fall runs.

From 2000 through 2003, there were high annual Chinook salmon pre-spawning mortalities in the low and high flow channels (42.5 and 39.7 percent, respectively). In September, pre-spawn mortality rates ranged from 70 to 100 percent (DWR, 2005l). The study report attributes the high mortalities to stress from elevated water temperature, low river flows, disease, high spawning returns of hatchery progeny (competition), and recreational angling. Elevated water temperature, low river flows, and disease are addressed later in this section in our analysis of Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*.

Currently, the majority of the natural Chinook salmon spawning takes place in the low flow channel, downstream of the fish barrier dam, with the balance taking place in the high flow channel. The low flow channel has been managed to comply with the term of the October 2004 NMFS Biological Opinion (see section 3.3.2.1, *Water Quality*), and this reach has the coldest water temperatures, which makes it most suitable for Chinook salmon spawning. Competition for limited spawning habitat disproportionately affects the earlier spawning spring-run Chinook salmon due to redd imposition by the later spawning, fall-run Chinook salmon.

Steelhead spawning occurs in the winter from December to March, and peaks in late January when temperatures are suitably cold everywhere in the lower Feather River. Incubation extends from December through May, and highest egg survival occurs when water temperature is under 55°F (12.8°C) (DWR, 2006). Most of the natural steelhead spawning also takes place in the low flow channel, particularly near the Hatchery Ditch side-channel (RM 66 to 67); limited steelhead spawning also occurs downstream of the Thermalito afterbay outlet. The best explanation for the distribution of steelhead spawning appears to be affinity for the Feather River Fish Hatchery and/or for upstream areas (DWR, 2004cc).

The colder water temperature in the low flow channel, and the smaller substrate size and greater amount of cover (compared to the main river channel) make Hatchery Ditch more suitable for juvenile steelhead rearing. DWR snorkel surveys (SF-F10, Task 3B) conducted from March through August in 1999, 2000, and 2001 indicate that the majority of young-of-year steelhead was in the upper mile of the low flow channel. Less than 1 percent of the young-of-year steelhead were observed downstream of the Thermalito afterbay outlet (DWR, 2004cc). Between RM 64 and 68, the Feather River has a confined, bedrock-controlled channel with cobble and boulder substrate (see section 3.3.1 *Soils, Geology, and Paleontological Resources*). Approximately 10,000 cubic yards of spawning gravel have been placed in this reach since the mid-1980s, but effectiveness monitoring has been anecdotal. It is likely that proposed gravel supplementation in this reach would have a limited, long-term, beneficial effect in this reach because sediment is rapidly transported through this type of channel.

Gravel supplementation would be likely to have long-term, beneficial effects for anadromous salmonids, particularly if it were implemented in conjunction with the Channel Improvement Program (see Proposed Article A103, *Channel Improvement Program*, below). Most of the natural anadromous spawning in the Feather River occurs in the upper low flow channel, particularly near the Hatchery Ditch side-channel. Hatchery Ditch is also heavily used by rearing juvenile steelhead. High flow velocities are lower in side-channel habitat than in the main channel, so gravel retention time would be higher in these

locations. Therefore, Hatchery Ditch and the other side-channels would be good locations for gravel supplementation.

A minority of steelhead and Chinook salmon also spawn in the mainstem of the high flow channel. The high flow channel is less confined than the mainstem of the low flow channel, so gravel retention would be more likely in this location (see section 3.3.1, *Geology and Geology, Soils, and Paleontological Resources*).

Consultation with the Ecological Committee during development of the plan and effectiveness monitoring would determine the best locations to provide long-term benefits from the proposed gravel supplementation. This would result in less competition between spawning adult salmonids, less redd imposition, and improved egg survival over time.

As proposed, placing a minimum of 8,300 cubic yards over 5 years, would have limited and short-term channel morphology/spawning habitat benefits because of a high rate of downstream sediment transport. The level of enhancement proposed (average 550 cubic yards per each of the 15 riffle sites) would be greater than under existing conditions. For more information, see section 3.3.1, *Geology, Soils, and Paleontological Resources*.

The substrate is coarsening downstream of Oroville dam due to capture of sediment upstream of the dam. Some of the riffles downstream of the dam currently exceed the DFG criteria for Chinook salmon spawning habitat because more than 30 percent of the surface particles are cobble size or larger (i.e., $\geq$64 mm diameter). There are a variety of definitions of optimum particle size that would benefit salmon and steelhead. This measure would be most effective if a common definition were developed to guide implementation.

Gravel supplementation, in combination with increased minimum flows, would provide some additional quality Chinook salmon spawning substrate over current conditions. Increased flows would reduce the redd superimposition problem that currently exists in the low flow channel because the dam blocks upstream migration to historical spring-run spawning habitat and concentrates Chinook salmon spawning below the dam.

Pacific and river lamprey are also anadromous species, spawning and rearing in freshwater. The females build crude nests in gravel substrate. The proposed gravel supplementation, in combination with the proposed side-channel habitat improvements and additions (A103) would benefit Pacific lamprey and river lamprey by providing additional spawning habitat. There is no slow velocity, edgewater habitat with sand or mud substrate for larval lamprey in the low flow channel; the side-channels may provide these habitat conditions. Lamprey use smaller spawning substrate than Chinook salmon or steelhead, so there would be no direct competition for spawning habitat.

Gravel supplementation would have no effect on green sturgeon which spawn in large, deep pools, and are not known to occur within the project area. Water quality-related effects could occur during implementation of this measure including sedimentation, turbidity, and petrochemical contamination and have the potential to affect all fish species. Best management practices would be needed to minimize these effects; however, short-term sediment and turbidity plumes would occur as a result of these activities.

Channel Improvement Program (Proposed Article A103)

Oroville dam, the sediment wedges, and associated project facilities block anadromous fish migration to approximately 67 miles of higher quality spawning and rearing habitat in the upper watershed (see figure 9). DWR (2002g) identified small side-channels in the Feather River as primary rearing habitat for juvenile steelhead. Under the Proposed Action, a Channel Improvement Program would be developed within 3 years of license issuance to increase the quality and complexity of salmonid spawning and rearing habitat in two existing side-channels. The program would also require DWR to

develop five additional side-channels (total 2,460 feet) within 10 years of license issuance. The side-channels would be created adjacent to existing riffle-glide complexes and would have flows between approximately 10 and 75 cfs. All side-channels would be monitored for target species utilization, primarily steelhead and incidentally spring-run Chinook salmon. DWR would submit annual reports to the Ecological Committee for review and consultation.

DWR evaluated the Moe's Ditch and Hatchery Ditch Channel Improvement Program in the preliminary draft environmental assessment (DWR, 2005a) and determined that it would be beneficial. In their respective comment letters, Interior (on behalf of FWS) and DFG state that the side-channel improvements would increase in the quality and quantity of Chinook salmon and steelhead spawning and rearing habitat.

Staff Analysis

Side-channel habitat is currently less than 1 percent of the available habitat[62] in the low flow channel (DWR, 2001b). Improvements at Moe and Hatchery ditches would increase side-channel habitat by 800 linear feet. Improving an additional five side-channels would further increase available side-channel habitat by a minimum of 2,460 linear feet, for a total side-channel improvement of 3,260 (or more) linear feet.

DWR's studies confirm that adult steelhead spawning and juvenile rearing are associated with the side-channels adjacent to the low flow channel, particularly in Hatchery Ditch between RM 66 and 67 (DWR, 2005m; 2005n). Nearly half of all steelhead redds were constructed in this area and had a density of 36 redds per mile, 10 times more than any other section of river.

The smaller substrate and abundant instream and overhead cover in Hatchery Ditch provide better juvenile steelhead rearing habitat than the main channel. We assume that gravel supplementation would be incorporated into the side-channel improvements and construction to benefit steelhead by enhancing and/or creating more of this type of habitat.

The highest percentage of Chinook salmon spawning also occurs in the low flow channel. The side-channels may provide additional spawning habitat and juvenile Chinook salmon rearing habitat.

Lamprey ammocoetes spend 3 to 4 years in freshwater where they burrow into soft sand or gravel substrate in low velocity areas and filter feed. The proposed side-channel habitat improvements and additions would also benefit Pacific lamprey and river lamprey by providing more low velocity, rearing habitat than currently exists.

The side-channel improvement and construction would probably have no effect on green sturgeon, which are not known to occur within the project area. If larval or juvenile sturgeon do use the project area, the proposed habitat improvements would be beneficial since sturgeon use low velocity areas with fine substrate.

Water quality-related effects could occur during implementation of this measure including sedimentation, turbidity, and petrochemical contamination that have the potential to adversely affect all fish species. Best management practices would be needed to minimize these potential adverse effects; however, short-term sediment and turbidity plumes would occur as a result of these activities.

[62] DWR does not provide the measured amount (linear feet) of habitat that comprises the 1 percent of available habitat. This does not allow direct comparison between the existing and proposed amount of habitat (about 3,260 linear feet).

Structural Habitat Supplementation and Improvement Program (Proposed Article A104)

Actions taken under Proposed Article A104, *Structural Habitat Supplementation and Improvement Program*, would benefit the entire aquatic ecosystem, including ESA-listed spring-run Chinook salmon and steelhead, and are discussed in section 3.3.3, *Aquatic Resources*.

Fish Weir Program (Proposed Article A105)

Yoshiyama et al. (1998) attribute the extensive decline of California Central Valley Chinook salmon runs to several factors: overfishing; blockage and degradation due to mining; and reduction of habitat and streams flows due to dams and water diversions. Historically, different run timing and habitat use were part of the success and environmental plasticity of this species.

Habitat access prior to the development of the hydroelectric dams on the Feather River and its tributaries allowed for spatial separation of the spring and fall Chinook salmon runs (DWR, 2001b; 2002l; 2002m; 2002n). Spring-run fish returned to the river earlier than fall-run fish and were able to access suitable spawning habitat higher in the watershed.

Oroville dam, the other dams upstream, and their associated facilities block the passage of migratory fishes, including Chinook salmon and steelhead. Consequently, spring and fall-run Chinook now spawn in the same habitat downstream of the fish barrier dam and are no longer spatially separated creating the potential for the spring and fall-runs to interbreed at an increased level than would naturally occur. Recent genetic studies indicate Feather River spring-run Chinook salmon genetically overlap with fall-run fish but may have some distinct spawning characteristics. Inbreeding may affect genetic integrity and inherent life history plasticity of the stocks (i.e., spawn timing and locality).

Competition for limited spawning habitat in the Feather River disproportionately affects the earlier spawning, spring-run Chinook salmon due to redd imposition by the later spawning, fall-run Chinook salmon and may increase pre-spawn mortality.

In a phased approach, DWR would construct an anadromous fish-monitoring weir upstream of Thermalito afterbay to monitor the timing of Chinook salmon and steelhead runs in the low flow channel (phase 1) and construct a fish barrier weir that would spatially separate the spring-run and fall-run Chinook salmon in the low flow channel (phase 2). DWR would develop the Fish Weir Program and monitoring plan in consultation with the Ecological Committee and would develop an annual report that would include monitoring and implementation results. The weir plan would be consistent with project biological opinion(s) and the plan would include a recreational safety plan that is addressed in section 3.3.6.2, *Environmental Effects* in *Threatened and Endangered Species*.

The fish-monitoring weir would be constructed within 3 years of license issuance. Data collected from the monitoring weir, carcass surveys, and other fish counts would be used to determine the timing and abundance of the early-returning fish. This information would be used to monitor the success of programs to improve spawning and rearing habitat, as well as development and installation of the segregation weir. In the interim, the monitoring weir may be used for spatial or temporal separation of the runs.

The segregation weir would be built within 12 years of license issuance as part of Phase 2. Phase 2 would also evaluate installing an egg-taking station to collect fall-run Chinook salmon eggs for the Feather River Fish Hatchery.

DWR evaluated a fish barrier weir to segregate the spring and fall Chinook salmon runs, similar to the Phase 2 segregation weir proposed in the Settlement Agreement. It did not evaluate a monitoring weir (Phase 1). They determined the segregation weir would be beneficial in terms of reducing interbreeding, redd superimposition and prespawning mortality.

Staff Analysis

The Feather River Fish Hatchery has attempted to reproductively isolate or maintain the genetic integrity of the spring and fall-run Chinook salmon stocks. Recently, DFG initiated a program to mark all the early returning adults (fish that arrive in May and June) and is using only those fish in the hatchery's spring-run Chinook salmon stock. Tagged Chinook salmon returning after September 15 are considered to be fall-run fish.

The Central Valley spring-run Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries, including the Feather River. NMFS (2004) and the University of California Davis and Oregon State University studies cited by DWR also conclude that Feather River spring-run and fall-run Chinook salmon are genetically similar and most closely related to Central Valley fall-run Chinook salmon. Therefore, the current timing of these runs is probably a phenotypic rather than a genetic difference (DWR, 2005k).

Recent results indicate a significant percentage of the early run Feather River Fish Hatchery fish spawn naturally in the low flow channel. The Phase 1 monitoring weir data and the Feather River Genetic Management Program (a component of Proposed Article 107, *Feather River Fish Hatchery Improvement Program*, see section 3.3.3, *Aquatic Resources)* would determine the potential benefit, if any, that a segregation weir could have on the conservation of the Central Valley spring-run Chinook salmon ESU in the Feather River. DWR would develop the Phase 2 segregation weir plan in consultation with the Ecological Committee, which includes NMFS, as new genetic information becomes available Completion of the segregation weir would not be required until 12 years after licensing. If a segregation weir were identified as an important component of preserving Feather River spring-run Chinook salmon genetics, a more timely implementation would be needed to ensure the likelihood of success.

Currently, the Central Valley spring-run Chinook salmon are listed as threatened and fall-run Chinook salmon populations are significantly depressed from historical levels; however, the Feather River contains a Chinook salmon population that well exceeds pre-project levels. The fall-run Chinook salmon in the Sacramento River System, including the Feather River, have been heavily influenced by hatchery production, and all Central Valley fall-run Chinook salmon are genetically identical. An egg-taking station would be used for artificial propagation, if needed, to perpetuate Feather River fall-run Chinook salmon stock.

The fish weirs would have no effect on green sturgeon, which are not known to occur in the low flow channel.

The monitoring and segregation weir would operate during the Chinook salmon spawning season (late summer/fall), and would not be expected to affect other species.

Riparian and Floodplain Improvement Program (Proposed Article A106)

Proposed Article A106, *Riparian and Floodplain Improvement Program*, would benefit the entire aquatic ecosystem, including ESA-listed spring-run Chinook salmon and steelhead, and is discussed in section 3.3.3, *Aquatic Resources*.

Feather River Fish Hatchery Improvement Program (Proposed Article A107)

The Feather River Fish Hatchery began operation in 1967 to mitigate for habitat lost from constructing and operating the Oroville Facilities. As many as 8,000 to 20,000 spring-run Chinook salmon adults may have occupied the Feather River above the current Oroville dam annually prior to European settlement (Moyle, 2002). Annual estimates of spring-run Chinook salmon run in the lower Feather River were down to 500 to 4,000 fish between 1946 and 1963, prior to Oroville dam construction (DWR, 2006). After the dam was built, between 1992 and 2002, the average number of Chinook salmon returning to the hatchery by September (assumed to be spring-run fish) was 4,727 (DWR, 2006).

The hatchery is one of five major Central Valley hatcheries producing fall-run Chinook salmon; one of three producing steelhead; and the only hatchery producing spring-run Chinook salmon (DWR, 2005a). The low tagging rates of Feather River Chinook in the salmon coded wire tag recovery program does not provide quantitative data on the number of tagged fish in the spawning population, so it is not possible to obtain reliable estimates of the hatchery percentage of the spawning run. However, DFG estimates 30 to 50 percent of the Feather River runs are fish produced by the hatchery; a smaller, also unquantifiable percentage are fish from other Central Valley hatcheries (DWR, 2005k).

The Feather River hatchery, managed by DFG in close collaboration with DWR, has been successful in meeting coldwater fisheries production goals and the conservation of Feather River fall-run Chinook salmon and steelhead stocks. For example, the 1998 Feather River fall-run Chinook salmon cohort contributed an estimated 90,000 fish to the ocean's recreational and commercial fisheries from 2000 through 2003 (DWR, 2005k). Smolts released from this brood-year into San Pablo Bay represented 13.3 and 9.3 percent of the coastal recreational and commercial fisheries, respectively.

However, hatchery operation and the Oroville Facilities have adversely affected Chinook salmon through genetic mixing of spring-run and fall-run stocks, altered run timing, caused a loss of spawning habitat, and created high spawning fish densities downstream of the fish barrier dam. As a result, Feather River spring Chinook salmon are genetically similar to fall-run Chinook salmon.

Hatchery operations may affect water quality such as temperature, dissolved oxygen, and pH, which may affect the incidence or severity of fish disease occurrences in the hatchery and in the Feather River (DWR, 2005a). DWR (2005a) states that fish species, holding densities, and the presence and amount of pathogens in the environment may also be related to the frequency and severity of occurrence and spread of fish diseases, and hatchery-produced fish have the potential to adversely affect naturally spawning salmonid runs through competition for food and habitat, potential transmission of diseases, predation, and genetic introgression. The following elements of Settlement Agreement Article A107 are proposed to address current hatchery facilities and management issues.

Hatchery Fish Production Program—DFG, which currently operates the Feather River Fish Hatchery in conjunction with DWR, has been successful in meeting production goals under the current license. Under the Proposed Action, DWR would continue to operate the Feather River Fish Hatchery in cooperation with DFG for the production of anadromous salmonids, such as spring and fall-run Chinook salmon, steelhead, and other salmonids. These fishes may be stocked from license issuance until completion and implementation of the Feather River Fish Hatchery Improvement Program.

Hatchery Water Temperature—Upon license issuance, DWR would seek to achieve the pre-facility modifications temperatures (see section 3.3.2.2, *Water Quality*). The temperature objectives are maximum mean daily temperatures that would be measured year-round at the hatchery intake/aeration tower. The proposed interim[63] temperatures objectives are lower than the temperature objectives evaluated in the preliminary draft environmental assessment (DWR, 2005a).

DWR would implement operational changes and would consider releases from the river valve up to a maximum of 1,500 cfs to meet the temperature objectives, provided these flows not exceed the actual flows in the high flow channel. In no event would the high flow channel flows be less than the flows specified in the Flow/Temperature to Support Anadromous Fish Plan (Proposed Action A108). However, DWR would not be in violation of the license article if operational changes were to be implemented and the temperature objectives were not met prior to completion of the proposed facility modifications.

DWR would complete facility modifications within 10 years of license issuance. When the facilities modifications are completed, the post-facilities water temperature objectives, as discussed in

[63] The interim period refers to the time between license issuance and either the point in time when facility modifications are completed or 10 years thereafter, whichever occurs first.

section 2.2.2, *Proposed Project Operations* (also see section 3.3.2.2, *Water Quality*), would become requirements, except in conference years. During conference years, DWR would consult with FWS, NMFS, DFG, and the Water Board to determine the proper temperature and disease management goals.

The licensee may develop a new table of hatchery temperature requirements that are at least as restrictive as the temperatures shown in the fish hatchery temperature table in section 2.2.2, *Proposed Project Operations*, when the facilities modifications are completed. The new temperatures would be developed in consultation with FWS, NMFS, DFG, the Water Board, and Regional Board for the Commission's approval.

Hatchery Management Program—A Feather River Hatchery Plan would be developed within 2 years of license issuance. The plan would be developed in consultation with the Ecological Committee, the Regional Board, and the Feather River Technical Team.[64] Development of the plan would include a review and consideration of the recommendations for the hatchery in the *Joint Hatchery Review Committee Final Report on Anadromous Salmonid Fish Hatcheries in California* (referenced in the Settlement Agreement Proposed Article A107.3b).

The plan would include:

- Hatchery and genetics management plans for each anadromous fish species;
- Adaptive management protocols for hatchery production including egg taking, spawning, incubation, hatching, rearing, and stocking;
- A methodology to implement appropriate form(s) of tagging or marking for the hatchery artificial propagation programs and recovery methods;
- A methodology to study hatchery management effects on salmonids, and the interaction between natural and hatchery produced salmonids;
- A methodology to study phenotypic (physical) or genotypic (genetic) traits that may be lost due to management actions or the adverse effects of the facilities if existing literature does not sufficiently address these topics;
- Development of a disease management methodology to reduce the incidence of disease outbreaks in the hatchery, and monitoring and reporting requirements;
- A methodology to work with other Central Valley hatcheries to improve integrated operations, marking/recovery, and data management;
- A methodology to minimize straying of hatchery produced fish;
- A methodology to for the release of spring and fall-run Chinook salmon; and
- A methodology to use the results of studies, monitoring, and other information to make changes in hatchery operations.

Within a year of plan approval, DWR would annually collect data, including information related to new disease control measures, and report results to the Ecological Committee. DWR and the consultees would re-evaluate the program every 5 years. Adaptive management would be used for spring-run Chinook salmon until the Hatchery Genetics and Management Plans are completed. An annual hatchery management report would be issued beginning in the year following licensing.

Hatchery Water Supply Disinfection System—DWR would install a new water disinfection system prior to any upstream releases of anadromous salmonids above the hatchery, or if the current

[64] We cannot find an explanation of what entities constitute the Feather River Technical Team.

system is determined to be insufficient to address disease issues. The new system would be developed in consultation with FWS, NMFS, DFG, the Water Board, and Regional Board. The Proposed Article A107, *Feather River Fish Hatchery Improvement Program*, states that the Commission reserves the right to make changes to the plan.

Feather River Fish Hatchery Annual Operation and Maintenance—DWR would complete a comprehensive facility assessment within 2 years of licensing along with a subsequent assessment at least once every 5 years. The results would be included in the annual Lower Feather River Habitat Improvement Plan Report (Proposed Article A101, *Lower Feather River Habitat Improvement Plan*).

DWR evaluated an adaptive management program for the hatchery and a disease management and marking program (an element of Alternative 2) in the preliminary draft environmental assessment (DWR, 2005a). DWR determined that these programs would be beneficial.

Interior (on behalf of FWS) and DFG filed 10(j) recommendations consistent with Proposed Article 107, *Feather River Fish Hatchery Improvement Program*.

Other Recommendations

The Anglers Committee et al. letter dated December 12, 2005, recommends that DWR develop and implement a coldwater fish disease management plan in Lake Oroville. The letter also recommends DWR conduct a study to determine the source of disease(s) in rainbow trout stocked in the lake; develop Chinook salmon and brown trout stocking programs; and upgrade the water sterilization system. These recommendations are addressed under Proposed Article A111, *Lake Oroville Cold Water Fishery Habitat Improvement Program*, below.

In its response to the recommendations, terms and conditions, prescriptions, and settlement comments dated May 26, 2006, DWR states that the Anglers Committee et al. and Plumas County[65] concerns regarding coldwater fish diseases are addressed in the Settlement Agreement.

Staff Analysis

Continuing current hatchery operations until the Feather River Fish Hatchery Management Plan is completed is expected to meet coldwater fisheries production goals and conserve Feather River Chinook salmon and steelhead stocks.

Hatchery Water Temperature—The interim temperature objectives are the same temperature objectives required in the current project license and are the upper (warmer) limits of the 1983 agreements between DWR and DFG. Generally, the water temperature data recorded at the hatchery comply with the objectives in the 1983 agreements. Historical data indicate that when the fish hatchery temperature objectives are met, Robinson Riffle objectives are almost always met.

The proposed Fish Hatchery Improvement Program would benefit coldwater fishes in the long-term by implementing more restrictive (cooler) water temperatures requirements than the current baseline conditions. Changing the temperature objective measurement from a maximum mean daily value to an hourly value would also ensure that cooler water would be delivered to the fish hatchery on a continuous basis.

Cooler water is one of the most important methods of regulating diseases at the hatchery, and possibly in the Feather River. Therefore, a reliable supply of cooler water would reduce the incidence and spread of diseases that are caused by physiological stress due to elevated temperatures (e.g., ceratomyxosis and IHN).

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[65] We could not find any reference to disease concerns in the Plumas County filing.

Cooler temperatures are also correlated with better growth and survival rates of coldwater species due to improved physiological conditions.

Hatchery Management Program—The proposed Genetics Management Plan would aid in the preservation of the Feather River spring-run Chinook salmon stock, unless the genetic differences between the spring and fall stocks have already been lost due to historical hatchery practices. To be effective, this plan would need to be coordinated and implemented concurrently with the monitoring weir, and completed prior to the implementation of a spring and fall-run segregation weir (Proposed Article A105, *Fish Weir Program*) to determine if a segregation weir is needed.

Proposed Article A105, *Fish Weir Program*, does not specify when the individual components of the Feather River Fish Hatchery Management Program would be implemented, and the hatchery facilities modifications would not likely occur until 10 years after licensing. The open timetable for implementation of the plan elements and a number of optional adaptive management protocols in the plan, such as a new water supply disinfection system, may not provide adequate and timely protection for anadromous salmonids and other fisheries managed by the hatchery.

Flow/Temperature to Support Anadromous Fish (Proposed Article A108)

Oroville dam, other project facilities, and associated operations have altered instream flow and water temperature, adversely affecting anadromous salmonids in the Feather River. Elevated water temperatures in the low and high flow channels in the late summer have had adverse effects on anadromous salmonids and other coldwater fishes. In general, water temperatures have met the terms of the NMFS Biological Opinion (NMFS, 2004) that specify mean daily temperatures not exceed 65°F from June 1 to September 30 in the low flow channel at Robinson Riffle. However, during July and early August, temperatures have ranged from 61 to 69ºF in the low flow channel and 71 to 79ºF in the high flow channel.

Under Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*, operational changes would increase the minimum instream flow from the current 600 cfs to 700 cfs in the low flow channel during most of the year to increase the amount of available anadromous spawning habitat and decrease water temperatures. During the Chinook salmon spawning season, September 9 through March 31, the minimum instream flows in the low flow channel would be increased to 800 cfs (bulleted item titled Low Flow Channel—Instream Flow in section 2.2.2, *Proposed Project Operations*, and section 3.3.2, *Water Quality*).

The proposed minimum flow in the high flow channel would be based on the preceding April to July unimpaired runoff, as it was and would continue to be, as specified in the 1983 DWR and DFG agreement. The preceding year's unimpaired runoff will be reported in the Licensee's Bulletin 120, *Water Conditions in California, Fall Report*. "Normal" in this case is defined as the April through July 1911-1960 mean, unimpaired runoff near Oroville of 1,942,000 acre-feet. The high flow channel minimum flows would be maintained as long as the releases to meet flow objectives would not cause Lake Oroville to draw down below elevation 733 feet msl. The proposed temperature objectives are lower than current water temperature requirements at Robinson Riffle, which would also result in decreased water temperatures at the hatchery prior to the implementation of the facilities modification(s).

If the pre-facility modification temperatures (see low flow and high flow channels table in section 2.2.2, *Proposed Project Operations*) were not attained, operations would be modified as specified in Proposed Article A108.1(b) to try to achieve temperature objectives. However, DWR would not be in violation of the license article if temperature objectives were not met prior to facilities modifications, so long as operations comply with other requirements listed in Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*. Upon completion of the facilities modifications, meeting the temperature objectives in the low flow channel would become a license requirement. Meeting the temperature objectives in the high flow channel would not be a license requirement.

DWR would also develop a Feasibility Study and Implementation Plan to find the most cost effective way to improve water temperatures for spawning, egg incubation, juvenile rearing, and holding habitat for anadromous fish in the low flow and high flow channels. The plan would include recommended temperatures for the high flow channel based on preliminary modeling. DWR would attempt to meet, but would not be required to meet the high flow channel water temperature objectives under the license.

Although not specifically stated in the proposed article, the explanatory statement indicates that facility modifications would, if approved by the Commission, be completed within 10 years of license issuance. A 5-year testing period would follow the facilities modifications to test the adequacy of modifications to achieve water temperature objectives, and the test period may be extended with approval of the Commission. During the testing period, DWR would not be in violation of the license if flow and temperature requirement were not met.

After completion of the facilities modifications, DWR would consult with the Ecological Committee and prepare strategic plans to meet water temperature objectives prior to May 1 during any year the Oroville Temperature Management Index is equal or less than 1.35 million acre-feet. These conditions would constitute a "Conference Year" when DWR would not be in violation of the license if water temperature objectives were not met.

If DWR were unable to meet temperature objectives due to an event or circumstances beyond reasonable control, DWR would file a notice with the Commission describing the situation. If the Commission finds there is a pattern of exceedances that could result in adverse effects on coldwater fisheries, DWR may be required to file a plan that identifies feasible measures or modifications to the license requirements to address exceedances.

DWR evaluated year-round minimum instream flows of 600 cfs[66] and 800 cfs[67] in the low flow channel in the preliminary draft environmental assessment (DWR, 2005a). Minimum instream flows included in Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*, represent a compromise between the settling parties to meet resource goals and project operations. The settling parties concluded the agreed-upon measures would substantially benefit anadromous fishes.

Interior (on behalf of FWS) and DFG filed 10(j) recommendations consistent with Proposed Article A108, *Flow/Temperature to Support Anadromous Fish*.

Staff Analysis

Chinook Salmon and Steelhead

DWR's instream flow investigations using instream flow incremental methodology and physical habitat simulation models determined that current minimum instream flows of 600 cfs in the low flow channel, where most Chinook salmon and steelhead spawning occur, provide most but not all of the maximum area of suitable spawning habitat for Chinook salmon. DWR determined that the maximum weighted useable area for Chinook salmon spawning would occur at approximately 800 cfs (figure 17).

Therefore, increasing minimum instream flows to 800 cfs during Chinook salmon and steelhead spawning, in combination with the spawning gravel supplementation plan (Proposed Article A102, *Gravel Supplementation and Improvement Program*) would maximize the amount of suitable Chinook salmon and steelhead spawning habitat in the low flow channel. Ramping rates established in the 1983

[66] This flow was part of the proposed action analyzed in the PDEA (DWR, 2005a).

[67] This flow was part of Alternative 2 analyzed in the PDEA (DWR, 2005a).

agreement between DWR and DFG are expected to minimize potential beach stranding of juvenile salmonids.

Water temperature is a key factor in the timing of anadromous spawning migrations. Under current conditions, project operations primarily control cooler water in the lower river. Coolwater holding habitat is particularly important for early run, spring Chinook salmon that sought out cooler water, higher in the watershed prior to construction of the fish barrier dam. Spring-run Chinook salmon migrate into freshwater and hold in large, deep pools in freshwater longer than other anadromous fishes prior to spawning while they complete gonadal maturation. Oroville studies found that during 2003, approximately 66 percent of the mean water temperature profile in 15 pools in the Feather River exceeded an index value of 60ºF. In another 11 pools, 48 percent of the temperature profile exceeded an index value of 64ºF. Nine percent of the temperature profile in 10 pools exceeded an index value of 68ºF (DWR, 2005p). These index values were defined by various detrimental biological effects that could occur due to elevated temperatures.

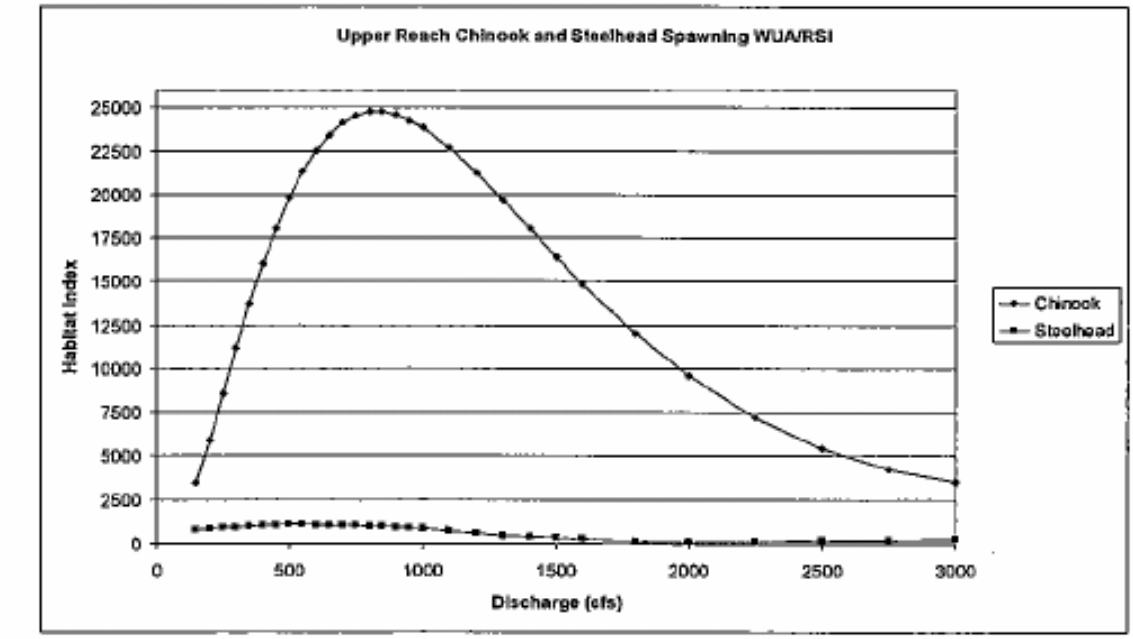

Figure 17. Low flow channel Chinook salmon spawning weighted useable area. (Source: DWR, 2005a)

As previously stated in section 3.3.2 *Water Quantity and Quality*, Feather River temperatures generally meet Basin Plan objectives for the high and low flow channels. The average monthly water temperatures in the low flow reach (fish barrier dam to the Thermalito afterbay outlet) range from 47°F (8.3°C) in winter to 65°F (18.3°C) in the summer (DWR, 2003f). Water temperatures in the high flow channel (below Thermalito afterbay outlet) are generally warmer, with the maximum mean daily water temperature at the Thermalito afterbay outlet reaching approximately 70°F (21.1°C) in the summer (DWR, 2003f).

In SP-F10, Task E, water temperatures used by pre-spawning adult Chinook salmon in the Feather River were compared to a recommended migration temperature of 60.8°F (16°C) and an estimated maximum thermal limit of 68°F (20°C) to determine the frequency in which they were exceeded (DWR, 2005p; 2004f). Chinook salmon radio telemetry and water temperature archival tag data from 2003 indicated water temperatures used by individual fish (sample size = 6) ranged from 55 to 69.4°F (12.8 to 20.8°C), but most of the six observations occurred between 60.8 and 68°F (16 to 20°C). Five of the six fish were typically found in waters between the recommended migration temperature and a

suggested upper water temperature limit, while one fish regularly frequented waters that were cooler than the recommended migration temperature. Three of the six fish were recorded in water above the estimated maximum thermal limit 3 to 6 percent of the time. Overall, the tagged Chinook salmon traveled in waters between temperatures of 12.8-20.8ºC.

The 2003 and 2004 gaging station data illustrated that the Robinson Riffle compliance point in the low flow channel fell within recommended water temperatures. However, at Thermalito outlet and Gridley in the high flow channel recommended water temperatures were exceeded approximately 3 to 5 percent and 10 to 16 percent of the time, respectively. In June of both years, the water temperatures at Gridley exceeded the suggested maximum thermal limit until flows exceeded 5,500 cfs. In 2003, over 90 percent of the final Chinook salmon locations and assumed spawning sites occurred upstream of Gridley (DWR, 2004f).

The thermograph data that DWR collected in the Feather River show water temperatures that may increase incidence of disease and mortality, in-vivo egg mortality, and developmental abnormalities occurring during spawning migrations and pre-spawning holding in some areas of the river during part of the immigration and holding periods (DWR, 2005p). DWR attributes high annual Chinook salmon pre-spawning mortalities in the low and high flow channels to stress caused by elevated water temperature, low river flows, disease, high fish densities, and angling pressure (angling is concentrated at Thermalito afterbay outlet). The proposed recreation enhancements have the potential to increase recreational angling and adversely affect listed salmonids (DWR, 2006).

DWR also reports that the effects of increased water temperatures on rearing salmonids range from behavioral modifications to physical/physiological changes and decreased disease resistance to increased vulnerability to predation to mortality (numerous studies cited in DWR, 2005o). The type and severity of effects are related to the magnitude and duration of exposure to elevated water temperatures. The Proposed Action would provide increased flow and cooler water in the Feather River compared with current conditions. As a result, the rate of Feather River fish straying into the Sacramento River (DWR, 2005p) may decrease; the quality of pre-spawning, holding habitat for anadromous fish would be improved; and pre-spawn mortalities related to low flow, high temperatures, and disease would decrease, and the amount of suitable spawning habitat would increase.

Elevated water temperatures during incubation can cause larval fish to emerge from the gravel prematurely (DWR, 2005q). Fish with a smaller size at emergence are more likely to succumb to predation and have reduced competitive fitness. Providing optimal water temperatures, as proposed, would likely increase survival rates by producing larger, earlier out-migrating smolts that are better able to compete and avoid predation.

In 2003, juvenile steelhead grew faster in the lower section of the low flow channel than in the upper section. DWR suggests that the slightly warmer temperatures in the lower section during this time provided better growing conditions and that Feather River Fish Hatchery and naturally spawned steelhead prefer temperatures between 62 and 68ºF (DWR, 2005q). However, the recorded water temperatures were approaching the limits of steelhead physiologic tolerance.

In 2003 no juvenile steelhead were observed in the high flow channel below Thermalito afterbay outlet where maximum daily water temperatures reach 70ºF (21.1ºC) in the summer months (DWR, 2003f). High summer water temperature is the most likely limiting factor, and as a result, the amount of steelhead rearing habitat has been reduced in the lower river.

We expect the proposed measures in the Flow/Temperature to Support Anadromous Fish Program (Proposed Article A108) would improve water quality except under the most extreme conditions (see section 3.3.2.2, *Water Quality*). The proposed increases in minimum flow and the decreased maximum temperature objectives would benefit coldwater fishes and meet the spawning requirements for ESA-listed Chinook salmon and steelhead.

Green Sturgeon

Green sturgeon are not known to occur within the project boundary. Although it is possible they occasionally occur within the Feather River, downstream of the project, DWR studies indicate low flows and channel modifications, unrelated to the Oroville Facilities, may be migration barriers at Shanghai Bench and Sunset Pumps. These sites are passable at higher flows; however, the proposed project would not increase flows at Shanghai Bench and Sunset Pumps. The proposed increase in minimum flows to benefit anadromous salmonids in the low flow channel would have no effect on the minimum flows in the high flow channel or on flows downstream of the project. As such, the project would have no effect on green sturgeon downstream of the project.

Delta Smelt

Delta smelt do not occur within the project boundary or within the Feather River. The proposed project would not affect surface water quantity in the Sacramento-San Joaquin Estuary, where delta smelt occur. As a result, the proposed project is not likely to adversely affect the delta smelt.

Other Coldwater Fishes

Increased minimum instream flows would also increase the quantity of coldwater fisheries habitat in the Feather River for other species. Lamprey ammocoetes burrow into edgewater habitat where they are especially vulnerable to rapid and prolonged changes in water levels. Increased year-round minimum instream flows would increase the amount of habitat available to Pacific and river lamprey ammocoetes in the low flow channel. If monitoring results indicate there is a potential benefit to green sturgeon from increased minimum flows in the low flow channel, then it is likely that white sturgeon would also benefit.

Reservation of Section 18 Authority (Proposed Article A109)

Proposed Article 109, *Reservation of Section 18 Authority*, reserves authority for NMFS and Interior to prescribe the construction, operation, and maintenance of fishways at Lake Oroville, including measures to determine, ensure, or improve the effectiveness of prescribed fishways that may be part of a future DWR and PG&E Habitat Expansion Agreement.

Interior (on behalf of FWS) and DFG filed 10(j) recommendations consistent with Proposed Article A109, *Reservation of Section 18 Authority*.

Plumas County in its March 15, 2006, Motion to Intervene is concerned that the draft Habitat Expansion Agreement cited in Proposed Article A109, *Reservation of Section 18 Authority*, would direct anadromous fisheries restoration efforts upstream of Lake Oroville without consulting the County.

The Anglers Committee et al. in their letter dated December 12, 2005, recommend that DWR fund and comply with the NMFS recommendations to restore spring-run Chinook salmon and steelhead populations in the North Fork and Middle Fork of the Feather River upstream of Oroville dam.

Staff Analysis

The draft *Habitat Expansion Agreement for Central Valley Spring-Run Chinook Salmon and Central Valley Steelhead*[68] is for settlement discussion purposes only (DWR, 2006a). A final habitat expansion agreement would be subject to DWR and PG&E reaching a separate license relationship

[68] The draft Habitat Expansion Agreement is included in appendix F of the Settlement Agreement (DWR, 2006a).

agreement, and the Signatories would be PG&E, DWR, NMFS, FWS, DFG, the Forest Service, Arthur G. Baggett,[69] American Rivers, and the State Water Contractors, Inc.

Any anadromous habitat expansion agreement would have to be finalized, signed, and submitted to the Commission before the Commission acts on this article. Therefore, the draft habitat expansion agreement for anadromous habitat above Lake Oroville is not within the scope of this analysis.

Plant Species

No federally listed plant species were located during surveys conducted in 2002, 2003, and 2004; however, potentially suitable habitat does exist for all of the seven listed species that were identified to potentially occur in the project area. Five of seven of these species, Butte County meadowfoam, Hoover's spurge, Green's tuctoria, hair Orcutt grass, and smooth Orcutt grass, occur in vernal pool habitats. Hartweg's golden sunburst occurs in upland grasslands, with only land that has a low potential to provide habitat found in the study area in the hummocks bordering vernal pools. Potential habitat for the remaining species, Layne's ragwort, is found in serpentine and gabbro substrates around Lake Oroville.

DWR does not propose any specific environmental measures that would directly protect or enhance federally listed plant species; however, it proposes several measures for vernal pools, discussed below under *Vernal Pool Invertebrates*, that are designed to protect or enhance potential habitat for vernal pool invertebrates. According to the draft biological assessment, presence/absence surveys would be conducted prior to any future actions in areas of potential habitat. If any future actions could affect federally listed plant species, DWR would consult with FWS prior to implementing these actions.

Staff Analysis

Project activities could potentially affect potential federally listed plant species' habitat. Project O&M, such as the use of herbicides, water fluctuations, soil disturbance leading to sedimentation, OHV and other recreational uses, and upland habitat enhancements for waterfowl, could affect vernal pool habitat. DWR has implemented several conservation measures and proposes to implement several additional conservation measures, which are included in the draft programmatic biological assessment. These conservation measures are designed to protect vernal pool invertebrate habitat and therefore would protect federally listed plant habitat. The effects of the project on vernal pools and the proposed measures are discussed more thoroughly below under *Vernal Pool Invertebrates*. Because none of the federally listed plant species were found within the project boundary and because of recently implemented and proposed vernal pool conservation measures, the project would have no effect on the federally listed plant species that occur within or adjacent to vernal pools.

Many of the areas of potential habitat for Layne's ragwort have steep slopes that are infrequently accessed by hikers and boaters; however, potential habitat is also found near Nelson Bar car top boat launch, Lime Saddle recreation sites on the West Branch arm and Springtown car-top boat launch on the south side of Lake Oroville, all of which have roaded access. There is also potential habitat along the north side of the North Fork arm by a dirt road that is open to public use. In these areas, OHV and other recreational use, and vegetation maintenance activities could affect potential habitat. Fluctuations of Lake Oroville water level could also affect potential habitat that occurs near the high water level by causing erosion. Under the Proposed Action, the Nelson Bar and Springtown car-top boat launches and the Lime Saddle recreation site would be modified. During these construction activities, vegetation would be removed and soil would be disturbed, potentially affecting Layne's ragwort habitat. However, because Layne's ragwort was not located during botanical surveys conducted in 2002, 2003, and 2004,

[69] Mr. Baggett would sign the Anadromous Habitat Expansion Agreement as a recommendation to the Water Board, not as a Party to the Agreement.

there would be no effect on this species. DWR's proposal to conduct additional surveys prior to any future activities that could affect federally listed plant species and consult with FWS would ensure that if any of these species become established in the future, appropriate protection activities would be considered.

Wildlife Species

Bald Eagle

Five bald eagle nesting territories are located partly or wholly within the project boundary: (1) Crystal Hill nesting territory located on the Middle Fork arm of Lake Oroville; (2) Potter Ravine nesting territory located along the southern shore of Potter Ravine, approximately 1.3 miles north of the Oroville dam; (3) Bloomer nesting territory located along the western shore of the North Fork of Lake Oroville approximately 3.5 miles north of the Oroville dam; (4) Thermalito diversion pool nesting territory located on the southern ridge of the Thermalito diversion pool south of the Morris Ravine cove; and (5) Palm Avenue nesting territory located on the Feather River within the OWA. Human disturbance to bald eagle nests could affect bald eagle productivity; however, exclusion zones around the nests during nesting season could potentially limit or eliminate these effects.

Under Proposed Article A118, *Minimization of Disturbances to Nesting Bald Eagles*, DWR would implement conservation measures required by FWS's biological opinion and file any bald eagle nest territory plans with the Commission for approval. DWR would implement the plans, including any changes required by the Commission, evaluate the conservation measures in accordance with the biological assessment, and implement modifications deemed necessary. Modifications outside the scope of the biological opinion would be filed with the Commission for approval prior to implementation. These conservation measures (FWS, 2007) include (1) the development and adoption of bald eagle nest territory management plans for all active nest territories; (2) annual written notice to other land management agencies of the conservation measures contained in each nest territory management plan; (3) disclosure of new bald eagle nest territories to DFG and FWS within 10 working days of discovery; (4) development of draft bald eagle nest territory management plans within 30 calendar days of discovery of a new nest territory and submittal to DFG and FWS; (5) one interagency meeting annually to evaluate and discuss the effectiveness of conservation measures contained in bald eagle nest territory management plans, including DFG, DPR, the Forest Service, FWS, BLM, and other agencies or organizations with a direct interest in bald eagle management; (6) annual evaluations of bald eagle nesting success and the effectiveness of conservation measures contained in the nest territory management plans, including active searches for new bald eagle nest territories and a written summary to DFG and FWS of annual bald eagle production; (7) survey of mid-winter bald eagle every other year in coordination with statewide and nationwide mid-winter counts and submit results to DFG and FWS; and (8) enhancement of foraging conditions around each active bald eagle nesting territory by installing a fish habitat structure in the reservoir within foraging areas as defined in the management plan for the nesting territory. Bald eagle nest territory management plans are currently implemented for all known bald eagle nest territories in the project boundary. Interior's (on behalf of FWS) 10(j) recommendation no. 12 and DFG's 10(j) recommendation no. 9 are consistent with Proposed Article A118, *Minimization of Disturbances to Nesting Bald Eagles*.

FWS, in its April 9, 2007, biological opinion makes a conservation recommendation that any transmission lines constructed as part of the project should be constructed in a manner to prevent raptor electrocution and existing transmission lines should be modified to prevent raptor electrocution using methods recommended in the Avian Power Line Interactions Committee's Suggested Practices for Raptor Protection on Powerlines: The State of the Art in 2006 (APLIC, 2006).

Staff Analysis

Bald eagles are highly susceptible to human disturbance during nesting season (February through August), which can lead to abandonment of nests and failure to fledge young. Project-related recreational activity near nests or foraging areas during nesting season near Lake Oroville and in the Thermalito Complex and OWA could cause disturbance, especially at the Potter Ravine nesting territory where a hiking trail is located within 0.33 mile of the nest. Primary and secondary zones have been established, as part of the bald eagle nest territory management plans, within all five nesting territories, limiting activities during nesting season and year-round. Human activity, including recreational activity, has been prohibited during nesting season within the primary zones within the Crystal Hill, Potter Ravine, and Bloomer nesting territories.

The primary bald eagle foraging areas in the project area include Potter Ravine, Spillway Cove, Foreman Creek, the area within 1 mile of the Oroville dam and Thermalito diversion pool, Middle Fork arm, McCabe Creek on the South Fork arm, Sycamore Creek, Kennedy Ravine, Bloomer Cove, Feather River, and Thermalito afterbay (DWR, 2004m). Many of these areas have high levels of seasonal recreation use, which appears to be tolerated by the eagles based upon their successful reproduction. Increased recreation and a temporary increase in human disturbance during the construction of waterfowl brood ponds and habitat improvements could discourage bald eagles from foraging in these areas; however, foraging habitat is plentiful in the project area and project-area bald eagles seem to be acclimated to some human disturbance. Initial monitoring has not indicated recreational activity affects nesting or foraging bald eagles in the Thermalito diversion pool and Palm Avenue nesting territories; however, the bald eagle nest territory management plans indicate recreational closures would occur if future monitoring indicates it were warranted.

Approximately 11.3 miles of 230-kV transmission lines lie within the project boundary. The lines associated with the project are spaced greater than the 5-foot spacing recommended by Avian Power Line Interaction Committee guidelines to minimize potential raptor electrocution (DWR, 2004m), which limits the risk of bald eagle electrocution. The vertically configured transmission lines could pose a collision hazard to bald eagles; however, raptors rarely collide with transmission lines because they have good vision, they are adept flyers, and their flight is relatively slow. The transmission lines near the shoreline of the Thermalito diversion pool pose the greatest collision risk because the lines are near the shoreline and in some cases cross over the water. Occurrences of bald eagles being electrocuted or colliding with transmission lines in the project boundary have not been documented (DWR, 2004m). Transmission lines of this voltage typically do not pose a hazard to raptors. If unforeseen electrocutions occur, the standard reopening clause would be used and raptor protection measures could be implemented at that time.

All five nesting territory plans prohibit major habitat manipulations such as tree removal, road, trail, and levee construction or maintenance, and new recreational developments within the primary zones around the nests. Within the primary zones at all five nesting territories, all proposed activities would have to be reviewed by FWS, DFG, DPR, BLM, and PG&E, and then DWR would need to consult with FWS, to determine compatibility with bald eagle management. Under Proposed Article A118, *Minimization of Disturbances to Nesting Bald Eagles*, DWR would identify any new bald eagle nesting territories as well as any project-related effects on existing or newly located nesting territories. Any newly identified bald eagle nests would therefore receive the same level of protection as the existing nests and management practices would be altered to reduce any observed project-related effect on all nesting bald eagles.

Managing other resources would not affect bald eagles because the bald eagle nest territory management plans all prohibit activities that would alter habitat within nesting territories or disturb nesting eagles. All construction-related activities would be scheduled after nesting season. Expanded recreational developments would not be located within the primary zones around the bald eagle nests.

Some aquatic measures would benefit bald eagles. Fish habitat improvement measures, discussed in section 3.3.3, *Aquatic Resources*, and waterfowl brood, cover, and forage habitat improvements, described in section 3.3.4, *Terrestrial Resources*, would increase bald eagles' prey base, improving foraging conditions.

The bald eagle nest territory management plans provide protection and monitoring actions, which would be beneficial to bald eagle productivity. Overall, however, the project, with the proposed measures, may be likely to adversely affect the bald eagle.

Giant Garter Snake

Giant garter snakes were not found in the project boundary during surveys conducted in 2002; however, potentially suitable habitat occurs in the Thermalito Complex, and giant garter snakes are known to occur in proximity to the project. Rice fields and canals on the western border of the Thermalito afterbay, outside the project boundary, offer suitable habitat and habitat connectivity to potentially suitable habitat in the OWA and Thermalito Complex. Large stands of emergent vegetation adjacent to exposed basking areas and rodent burrows for refugia provide habitat in the Thermalito afterbay and forebay; waterfowl brood ponds in the eastern portion of the Thermalito afterbay also provide suitable habitat. Recreational activity in the Thermalito forebay, high water fluctuations within the Thermalito afterbay and high densities of invasive species within the OWA such as Eurasian milfoil and aquatic primrose could limit the suitability of this habitat for giant garter snakes.

Under Proposed Article A119, *Protection of Giant Garter Snake*, DWR would implement conservation measures required by FWS's biological opinion and DWR would, in consultation with FWS, annually evaluate and report the effectiveness to the Commission. The conservation measures would be revaluated in the spring every other year for the term of any new license. If the conservation measures are deemed to be unsuccessful in protecting giant garter snake habitat, DWR would coordinate with FWS to develop and implement additional or alternative conservation measures to protect the giant garter snake habitat. Modifications outside the scope of the biological opinion would be filed with the Commission for approval prior to implementation. The conservation measures (FWS, 2007) include: (1) notification and consultation with FWS prior to initiating any activities in certain areas of the OWA that would significantly affect the quality or extent of giant garter snake wetland habitat; (2) minimization of activities that disturb, destroy, fragment, or otherwise modify habitat in upland habitat within 200 feet of giant garter snake wetland habitat; (3) avoidance of rodent control activities of any kind in designated giant garter snake wetland habitat, except in certain circumstances; (4) restricted removal of non-native or noxious weeds; (5) a continuing public education program would be developed and implemented with a goal of preventing giant garter snakes from being intentionally harmed or killed; and, (6) restriction of dog-training field exercises in the Thermalito afterbay. In addition, if giant garter snake habitat is affected by the proposed project, DWR would compensate for the effects by either purchasing credits from a conservation bank or conducting onsite habitat preservation. DWR also proposes to develop and implement an OWA Management Plan which, according to the Explanatory Statement (DWR, 2006a), would include the public education and dog-training restrictions mentioned above. Interior's (on behalf of FWS) 10(j) recommendation no. 13 and DFG's 10(j) recommendation no. 9 are consistent with Proposed Article A119, *Protection of Giant Garter Snake*.

DWR also proposes to construct and recharge waterfowl brood ponds in the Thermalito afterbay, as described in section 3.3.4, *Terrestrial Resources*. These ponds would also provide habitat for giant garter snakes. DWR would construct four brood ponds within the afterbay and recharge existing and proposed ponds at least monthly for the giant garter snake between April 1 and October 31 of each year and more frequently, every 3 weeks, within the waterfowl nesting season of April 15 through July 31.

Staff Analysis

Several project-related activities could potentially affect giant garter snake habitat. Project maintenance could affect potential giant garter snake habitat by disturbing soil, clearing vegetation, and applying herbicides and pesticides. Water level fluctuations in the Thermalito Complex expose large expanses of mudflats, which isolate aquatic foraging habitat from emergent and upland vegetation cover. Increasing the distance between forage and cover could increase predation. Elevated water levels also inundate shoreline basking habitat and could flood the rodent burrows used for escape cover. Existing recreational use could also degrade giant garter snake cover by trampling vegetation, crushing rodent burrows, and compacting soil. Finally, gravel mining in the OWA could degrade giant garter snake habitat in the immediate area of the mining and displace any snakes present. As part of the existing license, DWR planned to review, by December 31, 2006, all of its existing gravel-mining operations, which are in or within 200 feet of giant garter snake habitat and identify modifications necessary to be more garter snake "friendly."

Several measures proposed by DWR for the protection and enhancement of aquatic, terrestrial, and recreational resources could affect giant garter snake habitat. Proposed aquatic measures, described in section 3.3.3, *Aquatic Resources*, such as the Gravel Supplementation and Improvement Program (Proposed Article A102), Channel Improvement Program (Proposed Article A103), and Fish Weir Program (Proposed Article A105) would occur within or adjacent to giant garter snake habitat and could destroy or degrade habitat and displace individual snakes during construction. The Riparian and Floodplain Improvement Program (Proposed Article A106) could also degrade giant garter snake habitat by increasing dense riparian vegetation, which would limit emergent vegetation and decrease basking habitat due to the increase in shade. The proposed Structural Habitat Supplementation and Improvement Program (Proposed Article A104), however, could improve giant garter snake habitat by providing more cover in the low flow channel.

Proposed terrestrial measures to construct additional brood ponds, recharge existing and future brood ponds (Proposed Article A122, *Construction and Recharge of Brood Ponds*), and conduct invasive species control (Proposed Article A126, *Invasive Plant Management*), described in section 3.3.4, *Terrestrial Resources*, could affect giant garter snake habitat. The existing waterfowl brood ponds provide a more stable water elevation than the Thermalito afterbay and provide giant garter snake cover adjacent to aquatic habitat which reduces predation. The construction of four additional proposed brood ponds would increase the amount of suitable giant garter snake habitat in the Thermalito afterbay where fluctuating water levels decrease the suitability of existing shoreline habitat. Recharging all brood ponds by raising afterbay water levels with a frequency needed to keep brood pond water elevations close to the adjacent cover is necessary for these ponds to continue to provide habitat. DWR proposes to recharge existing and proposed brood ponds by April 15 of each year and every 3 weeks between waterfowl brooding season (April 15 through July 31) and at least monthly for the giant garter snake between April 1 and October 31. As such, the existing and proposed brood ponds would provide beneficial giant garter snake habitat. Implementing measures to control invasive species could benefit giant garter snake habitat by reducing the species that limit the quality of potential habitat. Invasive species control measures could also degrade habitat by introducing pesticides and herbicides to giant garter snakes' environment.

Increased recreational use as a result of proposed recreation measures, described in section 3.3.5, *Recreation Resources*, could result in habitat degradation and loss of individual giant garter snakes, if they are present. Development of additional facilities at the Thermalito North Forebay aquatic center, construction of additional trails at the Thermalito forebay, and the development of a swim beach at the Larkin Road car-top boat ramp adjacent to the Thermalito afterbay could all result in vegetation trampling, crushing of rodent burrows, and soil compaction both during construction and from increased recreational use.

Proposed giant garter snake protection measures would minimize or eliminate many of the proposed project's effects on giant garter snake habitat. Under Proposed Article A119, *Protection of Giant Garter Snake*, DWR would notify and consult with FWS prior to initiating activities in areas of the OWA that would affect giant garter snake habitat and the minimize activities that would modify habitat in uplands within 200 feet of giant garter snake wetland habitat. These actions would limit many of the activities discussed above from occurring in giant garter snake habitat, thereby eliminating potential effects. Avoiding rodent control activities in giant garter snake wetland habitat would protect their escape cover habitat. Restricting invasive species control methods to hand removal, hand tools, or through individual treatment of appropriate herbicides within snake habitat would keep toxins from decreasing habitat and potentially killing snakes if they were present. A public education program with signage and restricting dog-training activities would minimize the harming or killing of giant garter snakes associated with recreational use. Finally, if unanticipated adverse effects on giant garter snake habitat occur, the compensation requirements contained within FWS's biological opinion would maintain baseline habitat conditions.

Overall, the project, with the proposed protection and enhancement measures, would be beneficial to giant garter snakes by prohibiting or restricting habitat disturbing activities, however, the project may be likely to adversely affect the giant garter snake.

California Red-legged Frog

There are no known California red-legged frogs, a federally threatened species, within the project boundary; however, potential suitable habitat exists. Project operations, maintenance, and recreational use could potentially affect California red-legged frog habitat.

Under Proposed Article A121, *Protection of Red-legged Frogs*, DWR would implement conservation measures required by FWS's biological opinion and evaluate the effectiveness of those conservation measures in accordance with the biological opinion. DWR would, in consultation with FWS, annually evaluate and report the effectiveness to the Commission. The conservation measures would be revaluated in the spring every other year for the term of any new license, in accordance with the biological opinion. If the conservation measures are deemed to be unsuccessful in protecting California red-legged frog habitat, DWR would coordinate with FWS to develop and implement additional or alternative conservation measures to protect California red-legged frog habitat. Modifications outside the scope of the biological opinion would be filed with the Commission for approval prior to implementation. These conservation measures are consistent with those proposed for the giant garter snake (Proposed Article A119), discussed above. Interior's (on behalf of FWS)'s 10(j) recommendation no. 15 and DFG's 10(j) recommendation no. 9 are consistent with Proposed Article A121, *Protection of Red-Legged Frogs*.

Staff Analysis

No California red-legged frogs are known to exist in the project boundary; however, the closest known population is approximately 1 mile from the project, in the French Creek drainage pond. Potentially suitable habitat for the California red-legged frog occurs in the project boundary around the Thermalito forebay, Thermalito afterbay, and within the OWA; however, predators, such as crayfish, bass, and bullfrogs, limit the habitat suitability within all these locations. According to FWS (letter dated March 31, 2006), several small, isolated patches of backwater habitat along the Feather River provide suitable habitat for the California red-legged frog. The potential effects of the project on California red-legged frog habitat and the proposed measures are the same as those discussed for the giant garter snake above. As with the giant garter snake, the potential project effects on California red-legged frog habitat would be minimized. Because there are no known California red-legged frogs in the project area and California red-legged frog habitat would benefit from the implementation of these habitat protection measures; the proposed project is not likely to adversely affect the California red-legged frog.

Vernal Pool Invertebrates

DWR originally mapped 253 vernal pools totaling 18.3 acres in the project boundary, of which 173 are located around the Thermalito afterbay and 80 are located around the Thermalito forebay. These pools range in size from <0.002 to 3.9 acres and 67 percent are human made as the result of roads, berms, weirs, or levees. FWS reported (2007) that based on further studies, 645 individual vernal pools or vernal swales, totaling 72.3 acres occur within the project boundary. Although the three vernal pool branchiopods—Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp—are not known to occur within the project boundary, protocol level surveys were not conducted. Occurrences of vernal pool fairy shrimp and vernal pool tadpole shrimp are known to occur within 3 miles of the project boundary, and it is assumed that all three species could occur in the vernal pools on project lands. Conservancy fairy shrimp are unlikely to occur in the project area because suitable habitat does not exist.

Under Proposed Article A117, *Protection of Vernal Pools*, DWR would implement conservation measures required by FWS's biological opinion and evaluate the effectiveness of those conservation measures in accordance with the biological opinion. DWR would, in consultation with FWS, annually evaluate and report the effectiveness to the Commission. The conservation measures would be revaluated in the spring every other year for the term of any new license, in accordance with the biological opinion. If the conservation measures are deemed to be unsuccessful in protecting vernal pool habitat, DWR would coordinate with FWS to develop and implement additional or alternative conservation measures to protect the vernal pool habitat. Modifications outside the scope of the biological opinion would be filed with the Commission for approval prior to implementation. These conservation measures (FWS, 2007) include: (1) installing and maintaining signage in coordination with DPR and DFG to prevent illegal OHV use in areas containing vernal pools; (2) inspecting and prompting maintenance of vehicular barriers (primarily existing fences) in coordination with DPR and DFG; and, (3) continuing existing patrol and enforcing vehicular closures in coordination with DFG and DPR. In addition, if vernal pool habitat is affected, DWR would compensate for the effects by a combination of habitat creation/restoration and habitat preservation. Interior's (on behalf of FWS) 10(j) recommendation no. 11 and DFG's 10(j) recommendation no. 9 are consistent with Proposed Article A117, *Protection of Vernal Pools*.

Staff Analysis

Potential habitat for two species of vernal pool invertebrates, one federally listed endangered species, and one federally listed threatened species occurs in the project boundary in the vernal pools within the Thermalito Complex. Project operations, maintenance, and project-related recreational use could potentially affect these species of vernal pool invertebrates and their habitat. Construction of new facilities and regular maintenance of recreation sites can disturb soil and vegetation. Earth moving activities can alter hydrology and affect how a vernal pool holds water and drains. Current and proposed upland habitat enhancements, such as those discussed in section 3.3.4, *Terrestrial Resources*, for waterfowl, can disrupt the impermeable hardpan soil layer or affect surface water flows, which could alter vernal pool hydrology. As a result, vernal pool habitat and vernal pool invertebrates can be lost. Herbicides and pesticides used for project maintenance, and the proposed invasive species management, can be toxic to vernal pool plants and invertebrates. Sedimentation and siltation from road run off and unauthorized OHV use can cause increased water turbidity or fill vernal pools which would alter habitat and could suffocate invertebrates. OHV traffic and other recreational use can compact soils, potentially altering overland flow patterns; degrade habitat suitability for vernal pool plant species; and/or encourage algae growth. DWR proposes additional recreational developments, such as the Thermalito forebay trail development and additional day-use facilities at the Larkin Road car-top boat ramp, discussed in more detail in section 3.3.6, *Recreational Resources*, which could increase recreation-related effects on vernal pools. Compacted soils are unsuitable for sustainability of vernal pool ecology. Unauthorized OHV use could also crush or damage adult and cyst vernal pool invertebrates.

As previously mentioned, DWR has implemented conservation measures as a result of the draft programmatic biological assessment under the current license and DWR proposes to implement FWS's conservation measures contained in the final biological opinion. These conservation measures include installing additional signage, continuing to provide maintenance to vehicular barriers such as fences, and continuing to patrol and enforce vehicle closures to keep OHV use away from vernal pools. These measures address many of the potential project-related effects on vernal pools and vernal pool invertebrates. Closing the areas of vernal pools to OHV use would prevent invertebrate crushing, soil disturbance and sedimentation. Sedimentation would be further minimized by the current sediment-trapping measures being assessed by DWR. Monitoring conservation measure effectiveness would identify continuing effects and provide a mechanism for consultation with FWS and development of additional or alternative conservation measures. As a result, it is likely the proposed conservation measures would be successful in minimizing the effects of OHV use and sedimentation on vernal pool invertebrates.

Some potential project-related effects on vernal pool invertebrates and their habitat are not addressed by the proposed measures. The conservation measures that DWR discusses in the Settlement Agreement do not include prohibiting earth moving activities and herbicide and pesticide use near vernal pools. As discussed in the draft biological assessment prepared by DWR and contained in the biological opinion, the following measures would protect vernal pool invertebrates and their habitat from altered hydrology and toxins: (1) conduct earth moving activities in a manner that does not alter the hydrology to the vernal pools and swales in the project boundary; (2) do not conduct disking closer than 100 feet from vernal pool edges and inform other land management agencies of this requirement; and (3) avoid the use of any herbicide for weed control and/or fuel control within 200 feet of vernal pools to the extent practical. Implementing these measures, as recommended in FWS's biological opinion would protect vernal pool invertebrates from habitat degradation and loss. In addition, the habitat compensation requirements contained within FWS's biological opinion would maintain baseline habitat conditions in the event of unanticipated habitat effects.

Overall, DWR's existing and proposed vernal pool conservation measures would be beneficial to vernal pool invertebrates by protecting their habitat from soil disturbing activities; however, the project may be likely to adversely affect vernal pool fairy shrimp and vernal pool tadpole shrimp. Because potential habitat does not occur within the project boundary, the project is not likely to adversely affect Conservancy fairly shrimp.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle, a federally listed threatened species, is found in elderberry shrubs and is one of the most common shrub species in high terrace habitats in portions of the OWA bordering the Feather River. Approximately 95 acres of elderberry shrubs (the host plant for the valley elderberry longhorn beetle) were delineated within the project boundary, with 0.402 acre around Lake Oroville, 2.255 acres in the area downstream from the Oroville dam and north of Highway 162, and 91.831 acres in the OWA south of Highway 162 and Larkin Road. Forty-five elderberry stems greater than 1 inch in diameter (preferred size of the valley elderberry longhorn beetle) were located along the Feather River corridor between Oroville dam and the Fish Barrier Pool and along the Thermalito power canal, elderberry shrubs with stems greater than 5 inches in diameter in high density were located along the levees within the portion of the OWA bordering the Feather River.

Under Proposed Article A120, *Protection of Valley Elderberry Beetle*, DWR would implement conservation measures required by FWS's biological opinion and evaluate the effectiveness of those conservation measures in accordance with the biological opinion. DWR would, in consultation with FWS, annually evaluate and report the effectiveness to the Commission. The conservation measures would be revaluated in the spring every other year for the term of any new license, in accordance with the biological opinion. If the conservation measures are deemed to be unsuccessful in protecting valley

elderberry longhorn beetle habitat, DWR would coordinate with FWS to develop and implement additional or alternative conservation measures to protect valley elderberry longhorn beetle habitat. Modifications outside the scope of the biological opinion would be filed with the Commission for approval prior to implementation. These conservation measures include maintenance of the same amount and quality of valley elderberry longhorn beetle habitat that now exists within the project boundary and implementation of best management practices and other protective measures to ensure that elderberry plants are not inadvertently damaged during project maintenance activities. In addition, if adverse effects to habitat occur, DWR would compensate for these effects by either purchasing credits from a conservation bank or conducting onsite habitat preservation. Interior's (on behalf of FWS) 10(j) recommendation no. 14 and DFG's 10(j) recommendation no. 9 are consistent with Proposed Article A120, *Protection of Valley Elderberry Beetle*.

Staff Analysis

Several project-related activities have the potential to affect elderberry bushes, and subsequently, valley elderberry longhorn beetles. Project maintenance, such as road grading and vegetation removal, pesticide use, vegetation trimming and control of transmission-line rights-of-ways, and levee repair could all damage or remove elderberry shrubs. OHV use and other recreational use could also damage elderberry shrub habitat. Gravel harvesting on OWA levees could also destroy shrubs or alter habitat. Construction of the fish habitat and channel improvement measures, fish barrier weirs, and placing spawning gravel, as discussed in section 3.3.3, *Aquatic Resources*, could cause disturbance within the Feather River floodplain where elderberry shrubs are present. The proposed invasive species control measures could benefit elderberry shrubs if competing invasive species such as giant reed and Chinese tree of heaven were controlled.

Existing valley elderberry longhorn beetle protection measures and habitat locations limit the potential for these effects. In the Lake Oroville area, pesticide use is restricted within 100 feet of mapped elderberry stems and DWR maintains a 25-foot buffer around elderberry shrubs during ground-disturbing activities. Elderberry shrubs in the vicinity of Lake Oroville occur in areas where OHV use is controlled such as the Thermalito power canal or in steep or rocky areas where OHV use does not occur. In the Thermalito Complex and the OWA, OHV use is also limited in areas of elderberry shrubs because of steep levee slopes. DWR currently requires dust abatement during road maintenance activity and does not use pesticides or herbicides around elderberry shrubs.

DWR's proposal to maintain the 95 acres of elderberry shrubs and implement best management practices during project maintenance, recreational facility development, and the implementation of the proposed measures would be likely to limit or eliminate the potential effects of these activities on elderberry shrubs and the valley elderberry longhorn beetle. As described in the DWR's draft biological assessment and FWS's biological opinion, DWR would conduct maintenance and compensate for any elderberry shrub losses following FWS's *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (1999) or subsequent FWS guidelines.

Overall, DWR's existing and proposed vernal pool conservation measures would be beneficial to vernal pool invertebrates by protecting their habitat from soil disturbing activities; however, the project may be likely to adversely affect the valley elderberry longhorn beetle.

3.3.5.3 Cumulative Effects

The cumulative effects on geomorphic, floodplain, riparian, and aquatic resources listed in sections 3.3.3 *Soils, Geology, and Paleontological Resources*, and 3.3.3, *Aquatic Resources*, have adversely affected and led to ESA-listing of Chinook salmon and steelhead in the Feather River. DWR's Proposed Action includes nine conservation measures to improve coldwater fisheries habitat and increase the populations of ESA-listed Chinook salmon and steelhead within the project area. These measures

include the formation of an Ecological Committee, a Gravel Supplementation and Improvement Program, Channel Improvement Program, Structural Habitat Supplementation and Improvement Program, Fish Weir Program, Riparian and Floodplain Improvement Program, Feather River Fish Hatchery Improvement Program, Flow/Temperature to Support Anadromous Fish, and a Comprehensive Water Quality Monitoring Program that have been previously discussed.

DWR developed the coldwater fisheries conservation measures in the Proposed Action in cooperation with NMFS and other entities to reduce the cumulative effects associated with the Oroville Facilities and its operation and to improve the quality of coldwater habitat in the Feather River and operations of the Feather River Fish Hatchery. These measures are expected to increase the listed Central Valley Chinook salmon and steelhead populations in the Feather River, and conserve the spring-run of Chinook salmon, which is consistent with the Anglers Committee et al. recommendations. However, genetic introgression of hatchery and wild stocks and of spring-run and fall-run Chinook, potential disease transfer between hatchery and wild salmonids, redd superimposition, and pre-spawning mortality would still occur (albeit to a lesser degree than current conditions) due to the intense competition for limited spawning and rearing habitat, hatchery supplementation and other fisheries management practices (e.g., stocking fish from another basin) that are intended to compensate for the loss of high quality, anadromous habitat.

Perhaps, the most significant adverse cumulative effect is the loss of anadromous access to higher quality, coldwater habitat in the upper watershed due to Oroville facilities and other unrelated, upstream facilities. The Reservation of Section 18 Authority (Proposed Article A109) would maintain the option of restoring steelhead passage via fishways at Oroville dam (as per the Anglers Committee recommendations) if a Habitat Expansion Agreement between DWR and PG&E to restore anadromous fish populations above Lake Oroville is finalized. However, a possible Habitat Expansion Agreement is not a license requirement and is outside the scope of this analysis.

3.3.5.4 Unavoidable Adverse Effects

The dam blocks anadromous fish passage to higher quality spawning and rearing habitat in the upper watershed, and blocks the downstream transport of sediment and LWD from the upper watershed. Project operations alter natural flow regimes, which adversely affects the quality and quantity of coldwater fish habitat in the Feather River.

The proposed conservation measures, particularly gravel supplementation (Proposed Article A102), Channel Improvement (Proposed Article A103), LWD supplementation (Proposed Article A104), and increased flows and decreased water temperatures (A108) including our staff recommendations (see section 5.2, *Comprehensive Development and Recommended Alternative*) would reduce some of these effects by improving and/or increasing Chinook salmon and steelhead spawning and rearing habitat in the Feather River to varying degrees.

Overall, the Oroville facilities and operations would continue to adversely impact Chinook salmon and steelhead populations in the Feather River. However, the proposed conservation measures in the Settlement Agreement and our staff recommendations (see section 5.2, *Comprehensive Development and Recommended Alternative*) would ameliorate many of these unavoidable adverse effects as compared to current conditions.

With the proposed protection and enhancement measures, no unavoidable adverse effects on plant and wildlife threatened and endangered species would be expected to occur.

3.3.6 Recreational Resources

3.3.6.1 Affected Environment

The Oroville Facilities are located at the edge of the foothills of the Sierra Nevada and on the eastern margin of the Sacramento Valley. Lake Oroville sits above the city of Oroville and is surrounded by steep slopes with oak woodlands and mixed conifers. Several hills and ridges rise from 1,000 to 2,000 feet or more above the reservoir. Aside from Oroville dam and developed recreation areas, most of the surrounding lands are undeveloped and natural-appearing. The reservoir has narrow and winding forks and has a surface area of over 15,810 acres at the full pool elevation of 900 feet msl, making it the fourth largest reservoir in California in surface acres after Shasta Lake, Lake Almanor, and Lake Berryessa.

Other impounded waterbodies of the Oroville Facilities that have recreational importance, listed in order from upstream to downstream, include Thermalito diversion pool, Thermalito forebay, and Thermalito afterbay. The Thermalito diversion pool winds 4.5 miles through steep wooded hillsides below Oroville dam. The next reservoir in the series of project impoundments is the Thermalito forebay, which is a 630-acre hourglass-shaped reservoir sitting at the base of low-lying grass covered hills. Thermalito afterbay, the lowest elevation impoundment in the project, is a 4,300-acre broad and shallow reservoir surrounded by a low earthfill dam on two sides and flat to gently rolling grasslands surrounding the remaining landscape.

Water not routed through Thermalito forebay and Thermalito afterbay from the Thermalito diversion pool passes to the low flow channel of the Feather River, which is the 9-mile-long section of the Feather River upstream of the Thermalito afterbay outlet. The first 0.5 mile of the low flow channel is occupied by the fish barrier pool, a small reservoir formed by the fish barrier dam at the Feather River Fish Hatchery. The low flow channel flows between levees and passes near downtown Oroville and residential areas before entering the OWA. The main management unit of the OWA consists of more than 5,000 acres of land on both sides of the Feather River and is dominated by gravel and cobble tailing piles interspersed with cottonwood and willow-lined ponds. The Thermalito afterbay and surrounding lands are managed as a part of the OWA. The project boundary terminates about 5 miles downstream of the Thermalito afterbay outlet, at the southern end of the OWA.

Regional Setting

Reservoirs of various sizes are numerous in northern California, offering recreationists many choices in destinations, settings, and activities. The two largest reservoirs (in terms of surface area) in the state are within a 2-hour drive of Oroville: Shasta Lake, with 29,500 surface acres, and Lake Almanor, with 27,064 surface acres. Both of these reservoirs are in attractive mountainous settings. Three reservoirs in the region are similar in size to Lake Oroville, including Folsom Reservoir (12,000 acres), Lake Berryessa (21,000 acres), and Trinity Lake (16,535 acres). Smaller reservoirs (less than 5,000 acres) are more numerous and include Black Butte Lake, Bucks Lake, Bullards Bar reservoir, Butt Valley reservoir, East Park reservoir, Englebright Lake, Indian Valley reservoir, Lake Pillsbury, Lake Spaulding, Little Grass Valley reservoir, Stony Gorge reservoir, State Water Project Upper Feather River reservoirs (Antelope, Frenchman, and Davis), and Whiskeytown Lake. These waterbodies range in surface acreage from 698 acres (Lake Spaulding) to 4,700 acres (Bullards Bar). The region also offers two large and well known natural lakes: Lake Tahoe (122,200 acres) and Clear Lake (40,000 acres).

Many of these lakes and reservoirs provide facilities similar to those at Lake Oroville and offer similar recreational experiences, activities, and opportunities. All of these regional water bodies have boat launching facilities and campgrounds. However, Lake Oroville is unique in offering floating campsites and equestrian trail riding combined with equestrian camping. The proximity of Lake Oroville to the city of Oroville is also unique because no other reservoir of similar size in California is located adjacent to a population center the size of the city of Oroville (population 12,000). The two reservoirs

closest to population centers are Shasta Lake, which is located about 12 miles from the city of Redding (population 66,000), and Folsom reservoir, which is located about 20 miles from the city of Sacramento (population 370,000). Lake Almanor is located adjacent to the town of Chester (population 2,000).

Specially Designated Areas in the Project Vicinity

The following federally designated areas are all located outside of the FERC project boundary in the vicinity of Lake Oroville:

Feather Falls Scenic Area and National Recreation Trail

The Feather Falls Scenic Area is a 15,000-acre area managed by the Plumas National Forest. The scenic area is northeast of Lake Oroville, near the town of Feather Falls. The Feather Falls National Recreation trail is a 9-mile loop trail that leads to Feather Falls and is available to hikers and mountain bicyclists. Feather Falls is located on the Fall River, which flows into the Middle Fork less than 1 mile from the northeast corner of Lake Oroville. The trailhead is a 35-mile drive from the city of Oroville and has restrooms, campsites, and parking. Feather Falls, at 640 feet, is the sixth highest waterfall in the contiguous United States and fourth highest in California. The trail provides excellent views of the falls as well as across the canyon of the Middle Fork to Bald Rock Dome, a large barren granite dome that rises above the canyon and dominates the scenery for miles around.

Feather River National Scenic Byway

The Feather River National Scenic Byway, dedicated by the Forest Service in 1998, follows State Route 70 from the north end of Lake Oroville along the canyon of the North Fork. Travelers enjoy spectacular views and many points of cultural, geologic, and historical interest along the 130-mile route which ends at the junction of State Route 70 and U.S. Highway 395.

Middle Fork Feather Wild and Scenic River

The Middle Fork was designated a National Wild and Scenic River in 1968. The Plumas National Forest administers the Middle Fork Wild and Scenic River, which extends from near Beckwourth to Lake Oroville. The designated reach totals 77.6 miles, including 32.9 miles designated as Wild River, 9.7 miles designated as Scenic River, and 35 miles designated as Recreational River. The lower part of the Middle Fork flows through a deep canyon with numerous large boulders, narrow steep canyon walls, and some impassable waterfalls. Rafting and kayaking opportunities in the lower section of the Middle Fork are considered to be for experts only (Class V), but the upper stretches are gentler with easy access.

Pacific Crest Trail

The Pacific Crest trail is one of eight National Scenic Trails in the United States, this one spanning some 2,650 miles from Mexico to Canada through three western states. The route was first explored in the late 1930s by teams of young men from the YMCA. Once proven feasible, trail pioneers Clinton Clarke and Warren Rogers lobbied the federal government to secure a border-to-border trail corridor. Largely through the efforts of hikers and equestrians, the Pacific Crest Trail was eventually designated one of the first scenic trails in the National Trails System by Congress in 1968 and was dedicated in 1993. The Pacific Crest Trail generally runs in a north-south direction, east of the Oroville Facilities. The Pacific Crest Trail crosses the Middle Fork and State Route 70 near the town of Belden, about 40 miles northeast of the Oroville Facilities.

Other Areas of Recreational Importance in the Project Vicinity

The Plumas National Forest offers access to a range of activity opportunities, such as camping, boating, hiking, bicycling, and OHV use. There are many miles of system roads and uninventoried low standard roads, including dirt roads, logging roads, and four-wheel drive tracks and trails available on the Plumas National Forest. All of the roads and trails on the Plumas National Forest are open to horses and mountain bicycles, with the exception of the Pacific Crest Trail and trails within the Bucks Lake Wilderness, which are closed to mountain bicycle use. The Forest Service provides a series of route sheets (available from ranger stations) describing recommended mountain bicycle rides (Fragnoli and Stuart, 2000). Table 42 identifies some examples of trails just beyond Lake Oroville.

Table 42. Regional riding and hiking trails within 100 miles of the Feather River Project. (Source: Fragnoli and Stuart, 2000; Brown, 2002)

Name/Location	Trail Type	Trail Mileage	Managing Entity
Feather Falls Loop/Oroville	Single track dirt	9.6	Plumas National Forest
Upper Bidwell Park/ Chico	Dirt road, single track, and pavement	17.6	City of Chico
Mt. Hough "Huff-n-Puff"/Quincy	Dirt roads	20	Plumas National Forest

One of the closest recreational opportunities to the Oroville Facilities that is located on the Plumas National Forest is the Feather Falls trail. Boaters may also hike to the base of the falls from the upper reaches of the Middle Fork arm when the reservoir water level is high. A few additional sites within the Plumas National Forest offer recreational opportunities and facilities in the immediate vicinity of the project but are outside the FERC project boundary.

Bidwell Park, located about 20 miles northwest of the Oroville Facilities in Chico, offers a 17.6-mile-long route for walking and bicycling that extends through the lower section of the park on a paved road and continues on a dirt road through the upper section of the park.

Whitewater boating opportunities are available upstream of the Oroville Facilities on the North Fork at PG&E's Poe and Rock Creek-Cresta projects and on the Middle Fork. On the North Fork, boaters occasionally boat the 8-mile Poe bypassed section, which is immediately upstream of the Oroville Facilities on the Upper North Fork arm. The upper 3.57-mile run between Poe dam and Bardee's Bar is rated class V[70] with possible portages around two class V–VI rapids. The 4.41-mile-long section extending from Bardee's Bar (an informal recreation access site located on PG&E-owned land) to the Poe powerhouse is rated class III. Flows suitable for whitewater boating in the Poe bypassed reach typically occur in the spring and early summer but they are erratic and difficult to predict.

[70] The American Whitewater Scale of River Difficulty: Class I, Easy—Fast moving water with riffles and small waves; Class II, Novice: Straightforward rapids with wide, clear channels which are evident without scouting; Class III, Intermediate—Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe; Class IV, Advanced—Intense, powerful but predictable rapids requiring precise boat handling in turbulent water; Class V, Expert—Extremely long, obstructed or very violent rapids which expose a boater to added risk; Class VI, Extreme and Exploratory—These runs have almost never been attempted and often exemplify the extremes of difficulty, unpredictability, and danger.

An additional hydroelectric development, PG&E's Rock Creek-Cresta Project, is located upstream from the Poe dam. Conditions in the Rock Creek-Cresta license require PG&E to provide recreational flows in the two bypassed reaches (Rock Creek and Cresta) of the North Fork for whitewater boating one weekend a month during the summer and early fall months.[71] The Rock Creek reach is an 8-mile-class III-IV boating run with a section of class V. The Cresta reach is a 5-mile run of mostly class III difficulty with a class V section at higher flows. Flows have been provided since 2002 and the use levels have been high with the estimated number of boaters exceeding the triggers on many occasions, especially in August and September.

On the Middle Fork, the Bald Rock Canyon run begins outside of the project boundary at Milsap Bar, 6.5 miles north of the tip of the Middle Fork arm. This 6.5 mile-long class V run ends at Lake Oroville and is suitable for expert-level whitewater boaters.

Riverbend Park and the adjacent Bedrock Park, located on the low flow channel on the west side of the city of Oroville, are owned and managed by the Feather River Recreation and Parks District. These parks are accessed from State Route 70, Oroville Dam Boulevard, Montgomery Street, and Feather River Boulevard. Riverbend Park provides riverbank access and day-use amenities, such as a frisbee golf course, a paved loop trail with exercise stations, benches, and picnic tables. Parking and restroom facilities are provided at the Feather River fish ponds, which are adjacent to Riverbend Park. At this location, visitors may fish from the pond banks and piers. The piers and restrooms meet the guidelines for accessibility under the American with Disabilities Act (ADA). Bedrock Park is a smaller facility that provides pedestrian access to the river, shaded picnic sites, an irrigated lawn area, and restrooms. Bedrock Park is separated from Riverbend Park by State Route 70, but the two parks are connected by a paved bike and walking trail.

The Clay Pit State Vehicular Recreation Area is located 3 miles southwest of the city of Oroville adjacent to the OWA and is accessed from State Route 162 and Larkin Road, south of the Oroville Municipal Airport. This location provides a riding area for OHV enthusiasts and is managed by DPR. The clay used to build Oroville dam was taken from this area, resulting in a large shallow pit ringed with low hills, providing about 220 acres of riding area for motorcycles and OHVs. A well-marked entrance road leads to a paved staging area used for loading and unloading OHVs. Parking is available for about 20 vehicles. Aside from the paved staging area and the entrance road, the entire site is one large open dirt area where OHVs are used.

The Rabe Road Shooting Range, managed by DFG, is an unstaffed public shooting area with unmarked backstops (places to place paper targets), a graded and graveled parking area, seven concrete picnic tables, and a vault toilet. It is technically a rifle range, but pistol use commonly occurs there as well. The shooting range is directly adjacent to the Clay Pit State Vehicular Recreation Area and is accessed from State Route 162, Larkin Road, and Rabe Road. A small sign on Rabe Road indicates "public shooting area."

Access to the Oroville Facilities

The western boundary of the Oroville Facilities is located about 38 miles east of Interstate 5, which extends north from San Diego, California, through Sacramento, California, and then to Blaine, Washington. Major highways providing road access to the Oroville Facilities include State Routes 70, 99, and 162. State Route 70 is a two- and four-lane highway, which roughly parallels Interstate 5 north

[71] Flows ranging from 800 cfs to 1,600 cfs (depending on month and water year type) are provided from June to September in dry and critically dry water year types and from June to October in normal and wet water year types. Recreational flows for the Cresta and Rock Creek reaches are released on Saturdays and Sundays, respectively, on one weekend per month. License conditions include triggers to adjust the number of days per month recreational flows are provided.

from Sacramento to the city of Oroville, then turns northeast a few miles north of Oroville. State Route 70 crosses the West Branch arm before continuing north to Quincy. State Route 99 is a two- and four-lane highway, which roughly parallels State Route 70 and Interstate 5, providing an additional route between the cities of Sacramento, Chico, and Red Bluff. State Route 99 forms the western side of the Thermalito afterbay. State Route 162 is a two-lane highway extending east from Interstate 5, crossing the Thermalito afterbay and dividing it into north and south parts, continuing east through the city of Oroville, before turning north and crossing Lake Oroville at the mouth of the Middle Fork arm of the reservoir. Generally, the major recreational areas on Lake Oroville are easily accessible from these highways; however, the limited public road network makes vehicular access to the arms of Lake Oroville more difficult. To encourage increased visitation at Lake Oroville, DWR recently provided funding to the Oroville Chamber of Commerce for billboards along State Route 99 and Pentz Road to direct people to existing recreational facilities at Lake Oroville.

The Thermalito diversion pool is accessible via Cherokee Road off Table Mountain Boulevard and State Route 70. A gravel road, known locally as Burma Road, parallels the north shoreline and provides access to the pool for anglers and car-top boaters and trail access at the terminus of the road for hikers and bike riders. The Thermalito forebay is accessible via State Route 70, with the North Thermalito forebay day-use area and boat ramp immediately adjacent to the highway. Local roads provide access to the two developed sites at the north and south ends of the forebay. The Thermalito afterbay is accessible via both State Route 99 and State Route 162. State Route 162, along with Larkin Road along the east side of the Thermalito afterbay, provides immediate access to the three developed recreational facilities on the Thermalito afterbay. The OWA is accessible via gravel roads off State Route 162 to the north, State Route 70 and Pacific Heights Road to the east, and Larkin Road to the west. No paved roads enter the OWA; all roads are graveled and generally run atop elevated levees and former railroad beds.

Recreation within the Project Boundary

The existing Oroville Facilities include a wide variety of recreational facilities. About 28,000 of the 41,540 acres within the FERC project boundary are included in the Lake Oroville State Recreation Area, which includes all of the recreational facilities at Lake Oroville, the Thermalito diversion pool, the Thermalito forebay, and the associated waters and land. Recreation is also provided at the Thermalito afterbay, the OWA, and along the Feather River. Nearly 14 miles of the Feather River downstream of the Thermalito diversion pool is also within the Oroville Facilities project boundary. The upper 9 miles of this section of the Feather River is the low flow channel, which extends from the Thermalito diversion pool to the Thermalito afterbay outlet. Nearly 5 miles of the river downstream of the outlet are also within the project boundary. Table 43 lists the existing recreational facilities within the project boundary, and figure 18 shows their locations.

Lake Oroville

Lake Oroville is one of the largest reservoirs in California, with more than 15,810 surface acres and 167 miles of shoreline at a maximum pool elevation of 900 feet msl. Annually, the reservoir elevation is drawn down an average of 112 feet from the maximum surface elevation (900 feet msl). During the peak recreation season, the reservoir drawdown ranges from 50 to 75 feet. Typically, Lake Oroville is filled to its maximum level in June and the minimum reservoir level (about 700 feet msl) occurs in December or January. During and following dry years, the reservoir may not fill to desired levels the following spring. In dry water years, the minimum reservoir elevation has been as low as elevation 645 feet msl. See section 2.1.1 for additional information on reservoir operations.

Major recreational facilities are located at Lime Saddle, Loafer Creek, Bidwell Canyon, and at the Oroville dam spillway. The Lime Saddle area is located on the western shoreline of the West Branch arm of the reservoir. The Loafer Creek Recreation Area is the largest, oldest, and most diverse recreational

complex on the reservoir, located directly across Bidwell Cove from the Bidwell Canyon area. Bidwell Canyon is located at the southern end of the reservoir. The recently improved Spillway Recreation Area is adjacent to the Oroville dam spillway, at the north end of the dam and at the southwest corner of the reservoir. These developments are shown on figure 18. The recreational developments at Lake Oroville are included within the Lake Oroville State Recreation Area and are managed by the DPR. DFG management in the Lake Oroville State Recreation Area is limited to the enforcement of hunting and fishing regulations and the California Fish and Game Code, management of the fish stocking program, and participation in biological studies. A description of management responsibilities in the Lake Oroville State Recreation Area is included in section 3.3.7. Undeveloped public land around Lake Oroville is abundant and available for general public use. However, steep slopes are common above the Lake Oroville shoreline and generally limit public access to only a few areas.

DPR and DWR remove floating debris on Lake Oroville. Boats are used to collect floating debris and deliver it to coves with debris containment booms, where it is removed from the shore after the reservoir recedes, typically in the late summer or fall. DPR is also responsible for carrying out boat safety inspections and providing safety patrols at Lake Oroville.

Within the project boundary and within the Lake Oroville State Recreation Area, there are several fragmented parcels of public land managed by the Forest Service located along the North, Middle, and South Fork arms of Lake Oroville. The Forest Service allows DPR to manage recreational use on National Forest System lands that are within the Lake Oroville State Recreation Area. All of these National Forest System lands slope sharply upward from the shoreline of Lake Oroville and include relatively inaccessible steep and rugged terrain.

BLM manages about 3,852 acres of land in scattered, non-contiguous parcels along the West Branch, the North, Middle, and South Fork arms about half of which are submerged under Lake Oroville. Currently, BLM does not actively manage recreation on any lands within the project boundary.

Project Recreation Facilities at Lake Oroville

As shown in table 43 and figure 18, numerous facilities provide public recreational access to Lake Oroville. Recreational facility construction began as early as 1965. Some of the original project recreational facilities have been reconstructed or upgraded and additional facilities have been constructed throughout the term of the existing license. These efforts created additional capacity, provided additional amenities for visitors, and implemented changes to facilities to make them accessible to persons with disabilities. Recreational activities at Lake Oroville include high- and low-speed boating, non-motorized boating, fishing, swimming, bicycling, equestrian use, hiking, and camping.

Campgrounds provide a spectrum of visitor conveniences at locations that require different forms of access. At one end of the spectrum there are family and group campgrounds with paved access, potable water, tables, fire rings, grills, RV hookups, flush restrooms, and showers. These are the types of facilities that are available at Loafer Creek, Bidwell Canyon, and Lime Saddle recreational developments and constitute the majority of the developed overnight capacity available at the project. Additional developed overnight capacity exists in the form of boat-in family and group campgrounds which typically only have tables, fire rings, and vault restrooms. Ten floating campsites are provided at various locations around the reservoir, each with restroom, table, fire grill, and sleeping area; this type of facility is unique to Lake Oroville. See table 43 for detailed descriptions of the campground facilities at Lake Oroville. User fees are required to camp at these developments.

Table 43. Recreation facilities at Lake Oroville, Thermalito Complex, low flow channel, and OWA. (Source: DWR, 2005a, appendix I, as modified by staff)

Facility	Capacity	Boat Launch Availability[a]	Facility Components/Comments
Lake Oroville, West Branch, Upper and Lower North Fork Arms			
Campgrounds			
Lime Saddle campground	44 family campsites, each with a table and fire ring with a grill		Full RV hookups at 16 sites; RV dump station with 2 stalls; 2 shower buildings, each with 6 flush restrooms and 4 showers; potable water; gray water sumps; and trash dumpsters
Lime Saddle group campground	6 family campsites (8 people at one time/site)		Sites located in 2 groups; 3 sites accessible,[b] central parking area with 16 spaces (2 accessible); shower building with 3 accessible flush restrooms and 2 accessible showers; shade structures, potable water, tables
Goat Ranch campground	5 family campsites, each with a table and fire ring with a grill		Boat-in access, 2 pit restrooms, 2 vault restrooms, 5 trash receptacles
Bloomer Point campground	25 family campsites, each with a table and fire ring with a grill		Boat-in access, 2 pit restrooms, 2 vault restrooms, 14 trash receptacles
Bloomer Knoll campground	6 family campsites, each with a table and fire ring with a grill		Boat-in access, 2 pit restrooms, 4 trash receptacles
Bloomer Cove campground	5 family campsites, each with a table and fire ring with a grill		Boat-in access, 2 pit restrooms, 6 trash receptacles
Bloomer Group campground	1 group campsite (75 people at one time)		Boat-in access, 2 pit restrooms, 9 trash receptacles, several shared barbecue cooking grills
Foreman Creek campground	26 family campsites, each with a table and fire ring with a grill		Boat-in access, 2 pit restrooms, 2 vault restrooms, 16 trash receptacles, self-registration pay station

Facility	Capacity	Boat Launch Availability[a]	Facility Components/Comments
Day-use Areas			
Lime Saddle day-use area	13 picnic sites (4 accessible)	4 lanes, medium to high 2–3 lanes, low	Boat launch, marina, fish cleaning station, 4 accessible flush restrooms, 7 shade structures, potable water, telephone, 11 trash receptacles, 45 car parking spaces (3 accessible), 131 car/trailer parking spaces (7 accessible), 70 car/trailer overflow parking spaces
Nelson Bar boat launch		1 lane, high	Intended for car-top launching but trailer launching possible at high reservoir elevations, 20 car/trailer parking spaces, vault restroom, 2 trash receptacles
Dark Canyon boat launch		2 lanes, all reservoir levels	About 15–30 car parking spaces
Vinton Gulch boat launch		1 lane, high	No designated parking area but space along roadside available for about 10 vehicles, vault restroom, 2 trash receptacles
Foreman Creek boat launch		2 lanes, all reservoir levels	About 15 to 30 car/trailer parking spaces (at high pool only 7 spaces along roadside), closed at night when reservoir is below elevation 800 feet msl to protect cultural resources, 1 trash receptacle
Lake Oroville, Middle and South Fork Arms			
Campgrounds			
Craig Saddle campground	18 family campsites, each with a table and fire ring with a grill		Boat-in access, 2 pit restrooms, 2 vault restrooms, 19 trash receptacles
Day-use Areas			
Lake Oroville scenic overlook			Unknown capacity, interpretive signage; located at Highway 162/Middle Fork arm
Enterprise boat launch		2 lanes, medium to high	40 car/trailer parking spaces, 1 vault restroom, 3 trash receptacles, boat ramp closed when reservoir is below elevation 830 feet msl to protect cultural resources
Stringtown boat launch		1 lane, all reservoir levels	1 vault restroom, 1 trash receptacle, 6 car/trailer parking spaces, difficult access below elevation 866 feet msl

Facility	Capacity	Boat Launch Availability[a]	Facility Components/Comments
Lake Oroville, Main Basin			
Campgrounds			
Loafer Creek campground	137 family campsites (6 accessible), each with a table, fire ring with a grill, tent pad, and shade trees		20 flush restrooms, (12 accessible); 16 hot water showers; potable water; 12 gray water sumps; telephone; amphitheater; trail access
Loafer Creek group campground	6 group campsites (25 people at one time/site), each with several tables, a sink with running water, shade trees, five large tent pads, nearby water spigots, and parking spaces for 8 vehicles.		8 flush restrooms (4 accessible); 8 accessible showers; potable water; trail access
Loafer Creek equestrian campground	15 family campsites, each with a table, fire ring with a grill, and horse trailer parking		Stall/feeder at each site; 2 flush restrooms (1 accessible); 2 showers (1 accessible); potable water; horse washing stall; round exercise pen; trail access
Bidwell Canyon campground	75 family campsites with full RV hookups, each with a table and fire ring with a grill		4 accessible sites; 2 flush restrooms, potable water, 6 showers
Spillway RV campground	40 spaces		Overnight use allowed for self-contained RVs in parking area adjacent to the day-use area
Floating campsites	10 campsites (15 people at one time/campsite)		Gas cooking grill, vault restroom, sink (non-potable water), table, sleeping area, shelves, storage room, and cabinets

Facility	Capacity	Boat Launch Availability[a]	Facility Components/Comments
Day-use Areas			
Loafer Creek day-use area	30 picnic sites (some accessible)	8 lanes, medium to high 2 lanes, low	Boat launch, boarding dock, playground, swimming beach, 10 accessible flush restrooms, potable water, 2 showers, 17 barbecue grills, telephone, 251 car parking spaces (5 accessible), 192 car/trailer parking spaces (6 accessible), trail access
Bidwell Canyon day-use area and boat launch	21 picnic sites	7 lanes, high 5 lanes, medium 2–4 lanes, low	Boat launch, marina, boarding dock, fish cleaning station, 8 flush restrooms (2 accessible), potable water, telephone, gray water sump, undetermined no. car parking spaces, 279 car/trailer parking spaces (2 accessible), 30 car/trailer overflow parking spaces, interpretive display (historical Bidwell Bar Bridge and Tollhouse), trail access
Floating restrooms	7 restrooms		Two vault stalls/restroom, various locations on Lake Oroville
Oroville dam overlook day-use area	8 picnic sites		Parking on east side of dam with 20 spaces, 4 flush restrooms (1 accessible), potable water, interpretive display
Spillway day-use area	6 picnic sites	12 lanes, high to medium 8 lanes, medium to low 2 lanes, low	Boat launch, 3 boarding docks, fish cleaning station, 6 flush restrooms (2 accessible), potable water, shade structures, 118 car parking spaces in upper lot (8 accessible), 350 car/trailer parking spaces in upper lot (8 accessible), 264 car/trailer parking spaces in lower lot, trail access
Interpretation/Education			
Lake Oroville Visitor Center	18 picnic sites (10 accessible)		Interpretive displays and presentations of project construction, native culture and natural resources, viewing tower, telephone, gift shop, potable water, 6 flush restrooms (accessible), trail access (Chaparral interpretive trail and Dan Beebe trail), 90 car parking spaces, 17 car/trailer or bus parking spaces
Thermalito Diversion Pool, Thermalito Forebay and Low Flow Channel			
Campgrounds			
North Thermalito forebay RV campground	15 spaces		Overnight use allowed for self-contained RVs in the parking area adjacent to the day-use area

Facility	Capacity	Boat Launch Availability[a]	Facility Components/Comments
Day-use Areas			
Thermalito diversion pool day-use area			1 vault restroom, trail access, graveled area for hand launching small boats
North Thermalito forebay day-use area	117 picnic sites	2 ramps; one with 2 lanes and one with 3 lanes	2 boat launches, 2 boarding docks, 6 flush restrooms (4 accessible), potable water, 251 car parking spaces (3 accessible) 26 car/trailer parking spaces (1 accessible), sandy beach and swimming area, shared barbecue grills, telephone, trail access, aquatic center with non-motorized boat rentals and classes, interpretive displays
South Thermalito forebay day-use area	10 picnic sites (8 accessible)	2 lanes	Boat launch, boarding dock, fish cleaning station, 10 barbecue grills, 1 vault restroom, undetermined number of parking spaces, trail access, interpretive displays
Interpretation/Education			
Feather River day-use area	Undetermined number of picnic sites (1 accessible)		Sun shelters, interpretive displays, trail and river access
Feather River Fish Hatchery	1 picnic site		Viewing platform and windows, 2 flush restrooms, potable water, trash receptacles, entire facility is accessible, 100 car parking spaces
Thermalito Afterbay and OWA			
Campgrounds			
Thermalito afterbay outlet campground	Undetermined number of primitive campsites (places to park an RV or stake a tent) adjacent to the afterbay outlet		Area is not formalized and is also used for day-use, 3 vault restrooms (accessible), several trash receptacles

Facility	Capacity	Boat Launch Availability[a]	Facility Components/Comments
Day-use Areas			
Monument Hill day-use area	10 picnic sites	2 lanes	Boat launch, boarding dock, fish cleaning station, swimming area with beach, 9 barbecue grills, 4 flush restrooms (1 accessible), 8 trash receptacles, telephone, 10 car parking spaces (1 accessible), 39 car/trailer parking spaces (3 accessible), 30 to 40 car/trailer overflow parking spaces
Model Aircraft Flying facility	6 picnic sites		1 barbecue grill, 2 shade structures, 1 vault restroom, 350-by-300 foot paved runway, 20 car parking spaces, 1 informational/interpretive panel
Shoreline hunting blinds (afterbay)			Unknown
Thermalito afterbay outlet boat launch		1 lane	Unsurfaced area used for launching boats into river, no designated parking area but space for about 5–10 vehicles
Unimproved boat launches in OWA			Several unpaved areas used for launching boats into the river
Wilbur Road boat launch		2 lanes	Boarding dock, 1 vault restroom, 1 trash receptacle, 14 car/trailer spaces (1 accessible), other undeveloped nearby locations also used for launching
Larkin Road boat launch		1 ramp	1 vault restroom (accessible),trash dumpster, approximately 20 car/trailer parking spaces, 4 other undeveloped nearby locations also used for launching

Note: NA – not applicable

[a] Only for boat launches that provided access at Lake Oroville. Low pool = below elevation 800 feet msl; medium pool = elevation 800 to 850 feet msl; high pool = above elevation 850 feet msl.

[b] When used in this context, the term accessible refers to a facility that meets ADA accessibility standards.

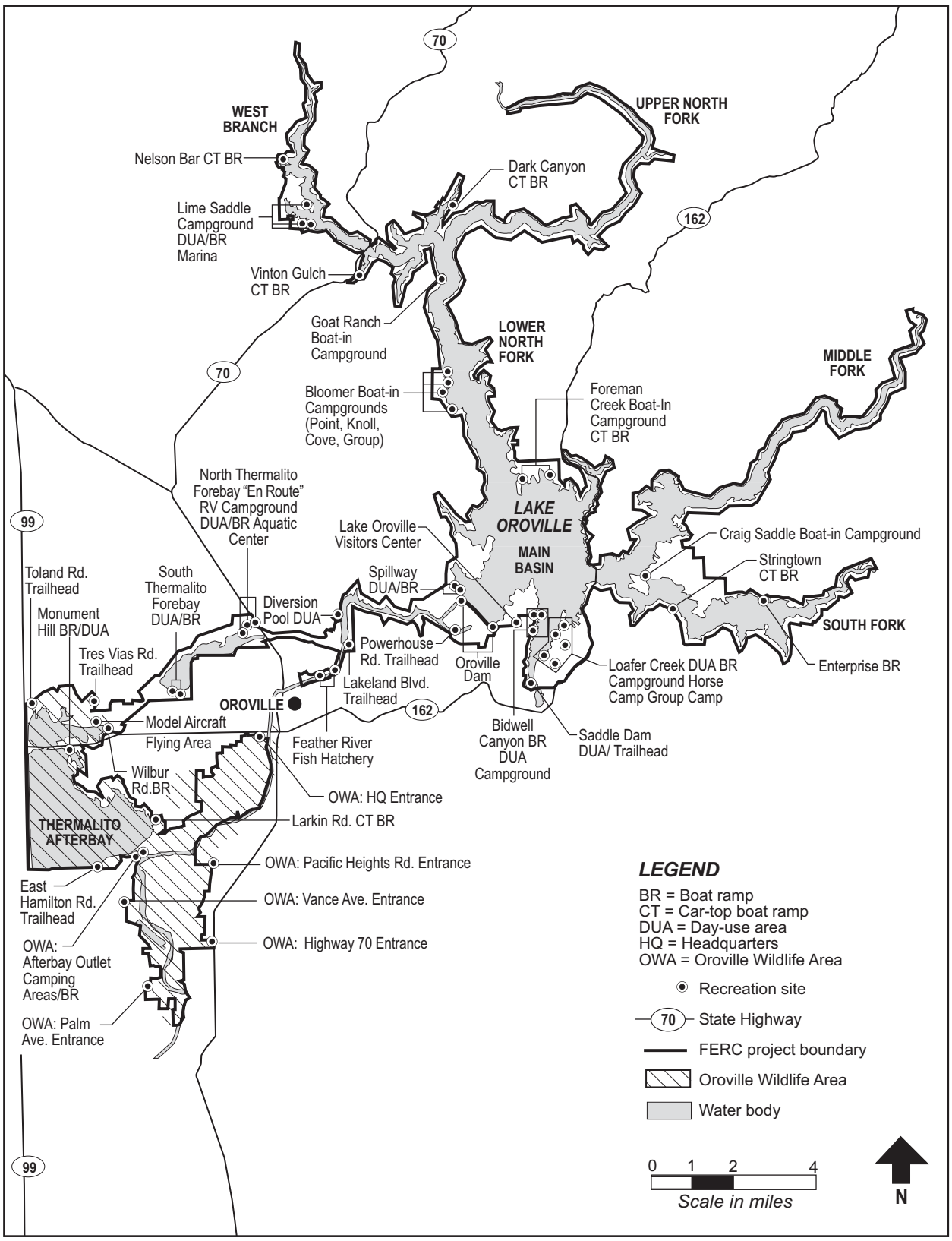

Figure 18. Lake Oroville recreational sites. (Source: DWR, 2005a)

The largest developed facilities for recreational day-use are located at the Spillway, Lime Saddle, Bidwell, and Loafer Creek recreational developments. Fees are required for visitors to use these developments. Each of these areas has a boat launch with multiple lanes, expansive parking areas, and boarding docks. Marinas providing gasoline, moorings, docks, and boat rentals are available at Bidwell and Lime Saddle recreational developments. The number of lanes and usable elevations for each boat launch at these four areas are shown in table 43. These developments also provide amenities for day-use activities, including, parking areas, flush restrooms, picnic tables, cooking grills, potable water, shade structures, and fish cleaning stations; Loafer Creek has the only designated swimming beach on Lake Oroville.

Additional boat launches that do not have developed day-use facilities are also located around Lake Oroville. One of these, the Enterprise boat launch, provides parking for 40 cars with trailers, a vault restroom, and 3 trash receptacles. DWR refers to the other five boat launches (Enterprise, Dark Canyon, Foreman Creek, Nelson Bar, Stringtown, and Vinton Gulch) as car-top boat launches; however, in most cases, visitors can use these areas to launch trailered watercraft. These five boat launches typically have a vault restroom and a graveled parking area with no designated spaces. None of these boat launches provides accessible[72] facilities.

The Lake Oroville Visitor Center has interpretive and education opportunities for visitors, picnic facilities, and an interpretive trail. Interpretive opportunities and day-use facilities are also provided at Oroville dam and Lake Oroville scenic overlook. These locations are shown on figure 18 and the amenities provided are listed in table 43. These developments do not require a user fee.

Dispersed Recreation at Lake Oroville

DWR identified seven dispersed use sites at Lake Oroville. A dispersed-use site is an area that is clearly defined by its size, and evidence of use and often has an obvious access point. These locations provide visitors with free access to the Lake Oroville shoreline.

The Old Nelson Bar Road dispersed site is located off of Old Nelson Bar Road across the West Branch arm from Nelson Bar car-top boat ramp. The site varies in size depending upon reservoir level. Shoreline use, such as sightseeing, hunting, picnicking, bank fishing, and swimming, occurs at the site, and OHV use is apparent at lower reservoir levels.

The Parish Cove dispersed site is located near the Lime Saddle recreation area. Visitors access the site by parking in a gravel lot on the east side of Pentz-Durham Road just north of the access road leading to the Lime Saddle day-use area and boat ramp and then walking under the flume on the north side of the parking lot. Shoreline use occurs at the site, including swimming. At lower reservoir levels, the site becomes less attractive for shoreline users as the swim area becomes smaller and the distance to the water increases. During scoping, DWR determined that stakes (used to hold down Christmas trees) and tires that have been dumped in Parish Cove pose a boating and wading hazard. Once the reservoir has receded, the standing water in the tires attracts mosquitoes, which are of concern.

The West Branch Bridge dispersed site is located on the west side of the State Route 70 Bridge over the West Branch arm. Access to the site is provided by parking in a small area about 200 yards west of the bridge on the north side of the highway and then walking down a barricaded road to the shoreline. An outcropping of limestone at the site is used by swimmers to jump into the water at certain reservoir levels.

The Canyon Creek Bridge dispersed site is located on the west side of the Canyon Creek Bridge on State Route 162. Visitors park in a small area on the north side of the highway about 100 yards

[72] When used in this context, the term accessible refers to a facility that meets ADA-accessibility standards.

beyond the bridge and then access the shoreline by several steep, user-defined trails. Visitors fish and swim at this site.

The Bidwell Bar Bridge dispersed site is located off of State Route 162 on the north side of the bridge. Visitors park in a relatively large area on the west side of State Route 162 and then walk down an old road from the north side of the parking area to the water. Shoreline use is possible at most times, depending on reservoir level.

The Ponderosa dam dispersed site is located near the Ponderosa dam, which is located at the eastern end of the South Fork arm. Visitors access the site via Ponderosa Way, a steep gravel road off Lumpkin Road, then cross Ponderosa dam and drive west until the road is no longer passable. From this point, the Lake Oroville shoreline is accessed by walking down the road.

The McCabe Cove dispersed site is located on the south side of the South Fork arm about 0.5 mile south of the Enterprise Bridge. McCabe Cove is one of the collection points for the Lake Oroville floating debris removal program. A dirt road off Lumpkin Road provides access to this site, which is primarily used for firewood collection.

Most other shoreline day use at Lake Oroville occurs in the vicinity of the car-top boat ramps, where non-boating visitors have access to the shoreline to picnic, swim, and fish.

Whitewater Boating Use at Lake Oroville

A limited amount of whitewater boating activity occurs on the Upper North Fork arm when Lake Oroville reservoir pool levels are sufficiently low to expose several miles of river. The Big Bend run, as it is known, begins outside of the Oroville Facilities project boundary on PG&E-owned property at the Poe powerhouse. The Big Bend run is a Class III+ to IV intermediate play run. About 0.75 mile downstream from the launch site at the Poe powerhouse is the Big Bend dam, an element of the Big Bend run that makes it unique since boaters enjoy boating over the Big Bend dam. Boaters using the Big Bend run must also paddle across flat water to reach the take out location at the Dark Canyon car-top boat ramp, making the entire run about 14 miles long. The amount of whitewater and flat water in the Big Bend run varies, depending on the level of Lake Oroville. At a reservoir elevation 730 feet msl, the whitewater portion of the run actually terminates about 0.5 mile downstream of French Creek, providing slightly less than 6 miles of whitewater and slightly more than 8 miles of flatwater. At a reservoir elevation 650 feet msl, there are 7 miles of whitewater in the Big Bend run and 7 miles of flat water. Generally, a sufficient length of the run is exposed during the fall months (when the run is normally used) only during dry or critically dry water years. DWR reported that most boaters determine when conditions are right for boating the Big Bend run only by word-of-mouth because no predictive or real-time flow information for the North Fork is currently available.

The Bald Rock Canyon run begins outside of the project boundary at Milsap Bar, 6.5 miles north of the tip of the Middle Fork arm. This 6.5 mile-long Class V run is suitable for expert-level whitewater boaters. The run ends where the flowing Middle Fork enters the flat water of Lake Oroville. There is no developed or maintained public road access to the Middle Fork arm. Currently, all roads leading to the shoreline of the Middle Fork arm of the reservoir are privately owned. Boaters are required to make a several hour-long flat water paddle to take out at the Bidwell Bar Bridge or the Loafer Creek boat ramp. Occasionally, boaters take out at one of two private roads, Eckards Lane or Island Bar Hill Road, or at Forest Service Road 20N59 near Feather Falls. However, DWR reported that access to the water from Forest Service Road 20N59 is currently unsuitable for vehicles, and the road is overgrown. These three roads are closer to the end of the whitewater run.

Thermalito Diversion Pool

The Thermalito diversion pool covers a 4.5-mile stretch of the Feather River from Oroville dam to the Thermalito diversion dam. The narrow pool covers 320 acres at maximum water surface elevation 225 feet msl, winds between steep wooded hillsides, and provides opportunities for visitors to enjoy quiet, uncrowded conditions. The Thermalito diversion pool and the lands and recreational facilities surrounding the Thermalito diversion pool are part of Lake Oroville State Recreation Area. The access road to the Thermalito diversion pool is open only during daylight hours and the area is closed to overnight use.

Project Recreation Facilities at the Thermalito Diversion Pool

The Thermalito diversion pool and its shoreline are open for day-use activities such as swimming, fishing, non-motorized boating, trail use, and picnicking. Only non-motorized boats or boats with electric motors are allowed on the Thermalito diversion pool. The Thermalito diversion pool day-use area, completed by DWR in 1996, is located along Burma Road, which runs on the north and west sides of the Thermalito diversion pool. The day-use area has an ADA accessible vault toilet and a small shoreline access point where gravel was placed at the shoreline to provide a level bench just below the waterline to facilitate car-top boat launching. Additionally, a former DWR storage yard near the Thermalito diversion dam has been cleared, graded, and graveled for use as a staging area for equestrian and other events. Burma Road is also used as a trail corridor for the Brad B. Freeman trail. Recreational facilities are listed in table 43 and shown on figure 18.

Thermalito Forebay

At a maximum water surface elevation of 225 feet msl, Thermalito forebay is a 630-acre hourglass-shaped reservoir that is divided into north and south sections at a point where the pool narrows at the Nelson Avenue Bridge crossing. The Thermalito forebay and the lands and recreational facilities surrounding the forebay are part of the Lake Oroville State Recreation Area. The north forebay area includes about 300 surface acres of the Thermalito forebay and provides non-motorized boating, which is popular for small sailboat and paddle craft uses, and other recreational opportunities, such as fishing and swimming. The south forebay includes the remaining 330 surface acres of the Thermalito forebay and provides opportunities for power boating, fishing, and swimming. DPR prohibits the operation of power boats within 50 feet of the boundaries of designated swimming areas, as marked by buoys placed 50 feet apart (and by signs on the shore). DPR also prohibits boating on the forebay from sunset to sunrise; the water surface of the Thermalito forebay is day-use only. The Thermalito forebay is stocked regularly with trout and is popular with local shore anglers. Some boat angling also occurs on both portions of the forebay. Recreational facilities are listed in table 43 and shown on figure 18.

Recreational Facilities at the Thermalito Forebay

Day use is the primary form of recreational use at the Thermalito forebay, but DWR reserves 15 parking spaces for self-contained RV camping at the North Thermalito forebay day-use area. This day-use area, located just west of State Route 70 and accessed from State Route 70 and Garden Drive, is suitable for family or large-group picnics with 117 picnic tables, barbecue grills, shade trees, and a large sandy beach and swim area designated with buoy lines on a shallow lagoon connected to the main body of the forebay. This lagoon is one of the only two formally designated swimming areas within the project boundary. An aquatic center located at the North Thermalito forebay day-use area provides boat rentals and instruction for boating clubs, educational institutions, and individual members of the public. The 1,200 square-foot facility was constructed in 1995 to provide area sailing and rowing clubs with a boathouse and an area for holding classes. Operations of the North Thermalito forebay day-use area began on October 11, 1967, when water was allowed to flow from the diversion pool into the power canal and then into the forebay. DWR constructed a new restroom and provided utilities and improvements to

this day-use area in 1997. DWR began renovating the parking area in 2000, and finished in 2001. At the southern end of the Thermalito forebay, the South Thermalito forebay day-use area, which provides 10 picnic tables, is accessed from State Route 70 and Grand Avenue. DWR recently renovated the interpretive displays at this location.

Thermalito Afterbay

The Thermalito afterbay is a shallow reservoir in the southwest corner of the Oroville Facilities project boundary with 17 miles of shoreline and 4,300 surface acres of water at maximum operating storage, which occurs at maximum water surface elevation 136.5 feet msl. Unlike Lake Oroville, the elevation of the Thermalito afterbay fluctuates on a weekly cycle during much of the year, with 4 to 6 feet of elevation change during a typical week. The typical daily elevation change is 1 to 2 feet. The pool is raised during the week and drawn down over the weekend, as dictated by hydroelectric power operations. Water temperatures can vary widely throughout the Thermalito afterbay in the summer, with water in the low 60s (°F) near the tailrace channel, in the mid-70s in the warmest, deeper water areas near the outlet, and in the mid-80s in shallow backwater areas. The diverse temperature structure of the Thermalito afterbay provides suitable habitat for both coldwater and warmwater fish, including a popular largemouth bass fishery. Fishing in the Thermalito afterbay occurs both from the shore and from boats. Boating, swimming, picnicking, and limited hunting (waterfowl and upland game) also occur at the Thermalito afterbay, but there are no opportunities for camping. The reservoir surface and shoreline are within the OWA.

DFG allows both motorized and non-motorized boats on the Thermalito afterbay. According to California regulations, boating speeds in state-managed wildlife areas are not supposed to exceed 5 miles per hour. However, Thermalito afterbay is popular with personal watercraft users and water-skiers, who normally exceed this speed when operating their watercraft. Current boating use is not consistent with the DFG 5 miles per hour speed restriction.

Project Recreational Facilities at the Thermalito Afterbay

As shown in table 43 and figure 18, recreational facilities are provided at many locations on Thermalito afterbay. Day use is the primary form of recreational use at the Thermalito afterbay. Three boat launches provide access to the afterbay: Wilbur Road, Larkin Road, and Monument Hill. In addition to these locations informal boat launching occurs at several unimproved areas between Wilbur Road and State Route 162. These informal boat launching areas are often accessed with trailers, yet some are only suited for car-top launching. There are also day-use facilities provided at the Monument Hill development. Day-use facilities provide for picnicking and include flush restrooms, tables, cooking grills, potable water, shade structures, parking areas, a swimming beach, and a fish cleaning station. Nearby, there is a 350- by 300-foot paved runway for model aircraft take-offs and landings. The site is mainly used by Oroville Model Airplane Club members, with other access occasionally arranged for special groups, activities, or events. No developed overnight facilities are provided. However, an undeveloped area delineated by signs is available for overnight camping in the vicinity of the Thermalito afterbay outlet.

Oroville Wildlife Area

DFG manages the OWA, guided by the 1978 Oroville Wildlife Area Management Plan, as well as applicable state laws and regulations. DFG, with limited assistance from DWR, works to achieve the objectives laid out in these documents through its lands, facilities, and fish and wildlife management strategies and practices. DFG is responsible for operating and maintaining recreational facilities, posting and maintaining boundary signage and fencing, enforcing codes, and patrolling for illegal uses such as refuse dumping and OHV use. Additionally, as the state agency responsible for enforcement of hunting

and fishing regulations on all public and private lands, DFG coordinates with the other management agencies at the Oroville Facilities to ensure that regulations are enforced in the OWA.

DFG's goals in managing the lands and facilities at wildlife areas are to maximize the amount and quality of habitat available for fish and wildlife, while also providing for public use and enjoyment. Ideally, DFG manages wildlife areas to protect and enhance fish and wildlife habitats and the populations that depend on them, while allowing compatible recreation in the areas used by the public only to the extent that such uses do not interfere with the primary goals of fish and wildlife management. DFG manages the OWA primarily for dispersed types of recreation, such as hunting, fishing, and bird watching, under a series of agreements with DWR, and developed facilities are minimal. No user fees are currently collected by DFG for camping or any other use of the OWA.

The OWA, not including the Thermalito afterbay described above, includes about 5,700 acres of land on both sides of the Feather River, most of which is within the FERC project boundary. A large percentage of the OWA is covered with gravel and cobble spoil piles left behind by historical gold dredging in the river. There are numerous small willow and cottonwood-lined ponds in areas where this material has been removed, adjacent to the Feather River. The Feather River runs through the center of the OWA and has several channels; the OWA is adjacent to or straddles about 10 miles of the Feather River. Fishing, hunting, nature study, and river-associated recreation are the primary activities at the OWA. The Thermalito afterbay releases water into the Feather River at the Thermalito afterbay outlet; the outlet is one of the most popular river fishing areas at the Oroville Facilities and in California, particularly during salmon runs. Bicycling is permitted in the OWA, but only on roads open to vehicles. Horses are allowed within the OWA on roads open to vehicles and within 25 feet of any exterior boundary fences. Horse drawn carriages are restricted to roads open to vehicles. OHVs are not permitted in the OWA; however, DWR reported that impacts related to illegal OHV use are a concern within the OWA, especially near shoreline and wetland areas.

Project Recreation Facilities at the Oroville Wildlife Area

Although there are a few vault restrooms, trails, and unimproved boat launches that provide access to the Feather River, there are no formalized recreational facilities located in the OWA. Recreational use at this area is dispersed in nature and relates to access to the Feather River and hunting.

Feather River

The first 1.5 miles of the low flow channel are within the Oroville Facilities project boundary. The first half mile of the low flow channel is occupied by the fish barrier pool, a small reservoir formed by the Fish Barrier dam at the Feather River Fish Hatchery. The low flow channel flows between levees, passing near downtown Oroville and residential areas before entering the OWA. The next 1.25 miles of the low flow channel, before it enters the OWA, are outside of the FERC project boundary. The FERC project boundary terminates about 5 miles downstream of the Thermalito afterbay outlet, at the southern end of the OWA.

Project Recreation Facilities at the Feather River

The Feather River Fish Hatchery is located at the upper end of the low flow channel of the Feather River, immediately below the fish barrier dam and about one-half mile below the Thermalito diversion dam and is accessed from State Route 70, Grand Avenue, and Table Mountain Boulevard. Anadromous fish migration up the Feather River is stopped at the fish barrier dam where salmon climb the fish ladder into the hatchery and DFG selects fish for breeding. The hatchery provides interpretive displays related to salmon and trout, and seasonally provides a unique opportunity for visitors to watch fish ascend the fish ladder to the hatchery through underwater windows. Windows are also provided along the spawning building to allow visitors to watch the spawning process. A visitor observation area

is provided at the gathering and holding tanks, and tours of the hatchery are offered to the public. Recreation and public use facilities on the north bank of the Feather River at the hatchery include a visitor area with a landscaped parking lot for 100 vehicles, two restrooms with flush toilets (ADA accessible), riverbank benches, drinking water, trash receptacles, a telephone, and an observation platform overlooking the fish barrier dam and its flow over the dam. ADA-accessible ramps provide access to the viewing platform, viewing window, and the gathering tank at the top of the fish ladder. For more information on the Feather River Fish Hatchery, see section 3.3.3, *Aquatic Resources*.

Day use of the east side of the fish barrier pool has recently been improved to include a pedestrian trail (Sewim Bo trail) and a day-use area adjacent to the Feather River Nature Center with picnic tables, sun shelters, and interpretive signs. One picnic site is ADA accessible with parking and an access route.

A few motorized and non-motorized boaters use the low flow channel. Few developed boat access facilities are provided, particularly at the upstream end where non-motorized boaters would most desire to launch. Non-motorized boats, however, are occasionally hand launched from the riverbank near the Feather River Fish Hatchery.

The Sewim Bo trail is a half-mile-long trail primarily used for hiking, but also used by equestrians and bicyclists, located in the vicinity of the Feather River Nature Center on the opposite side (eastern bank) of the Feather River from the Feather River Fish Hatchery and extending upstream to the Diversion dam. Much of this trail (and the Feather River Nature Center) is located outside the current project boundary. The trail was created in conjunction with the Feather River Nature Center in 2003 and 2004. The trail leads to the day-use area adjacent to the Feather River Nature Center; the day-use area is a project feature, the nature center is not.

Informal walking paths exist where visitors may access the Feather River from roadside parking areas. Paved (street) segments of the Brad B. Freeman trail are located near the east riverbank of the low flow channel from the OWA to the Thermalito Diversion dam, linking Riverbend Park and the Feather River Nature Center. Recreation facilities are listed in table 43 and shown on figure 18.

Trail and Trailheads

There are about 90 miles of non-motorized trails and 5 trailheads are distributed throughout the project boundary. Each trail is designated for one or more types of use (e.g., hiking, bicycling, equestrian use). The trail locations are shown on figure 19, and table 44 lists trail lengths, designated uses, and other pertinent information. About 52 miles of these trails are located in the Lake Oroville State Recreation Area, of which, 36 miles are located at Lake Oroville and 12 miles of the trails at Lake Oroville are accessible to persons with disabilities. Trails also provide access to project lands and waters at the Thermalito diversion pool, Thermalito Complex, and OWA.

Bicyclists using the Brad B. Freeman trail cross Oroville dam, travel along the north side of the Thermalito diversion pool and the north side of the North Thermalito forebay before crossing the Nelson Avenue Bridge and traveling along the east and south sides of the South Thermalito forebay, then wind around the Thermalito afterbay to and through the OWA and along the Feather River to the south side of the Thermalito diversion pool, and travel in an easterly direction back to the Oroville dam. On the south side of the Thermalito diversion pool near the spillway, there is a 1,700-foot section where the Dan Beebe trail and the Brad B. Freeman trail follow the same alignment. This section of trail is considered multiple use and is clearly marked as such at both ends of that trail section. Approximately 15 miles of the trail is paved. The Bidwell Canyon trail begins at the east end of the Saddle dam, which is located on the south arm of Lake Oroville, travels north through Bidwell Canyon to the Lake Oroville Visitor Center, and down to the southern end of the Oroville dam connecting to the Brad B. Freeman trail. Bicyclists may also use fire roads and designated trails at the Loafer Creek area. A fire road starts at the Saddle dam parking area, crosses the dam, and continues to the horse camp. Bicycles must stay on the gravel road to the main campground.

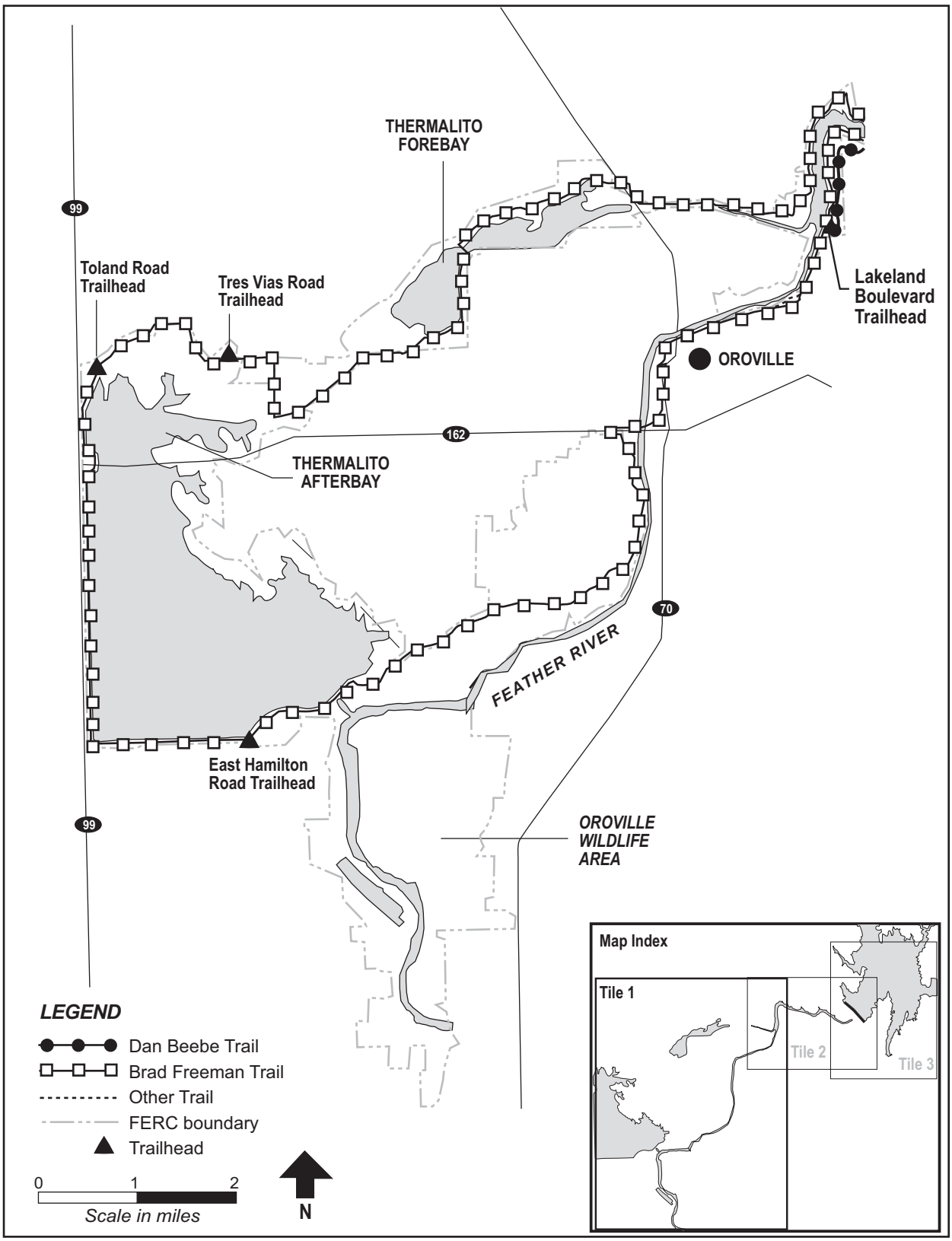

Figure 19. Lake Oroville trails. (Source: DWR, 2005a). Page 1 of 3

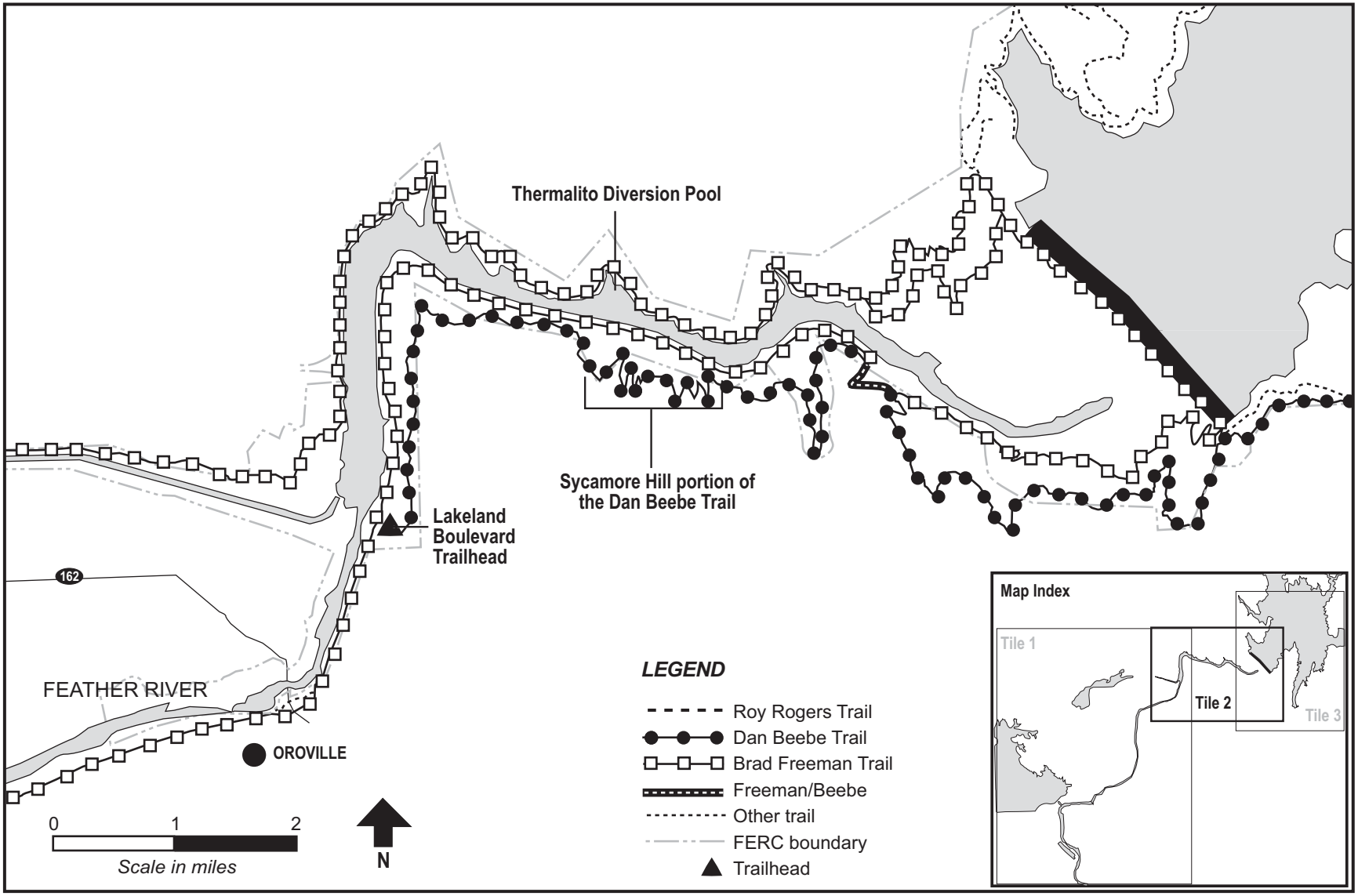

Figure 19. Lake Oroville trails. (Source: DWR, 2005a) Page 2 of 3