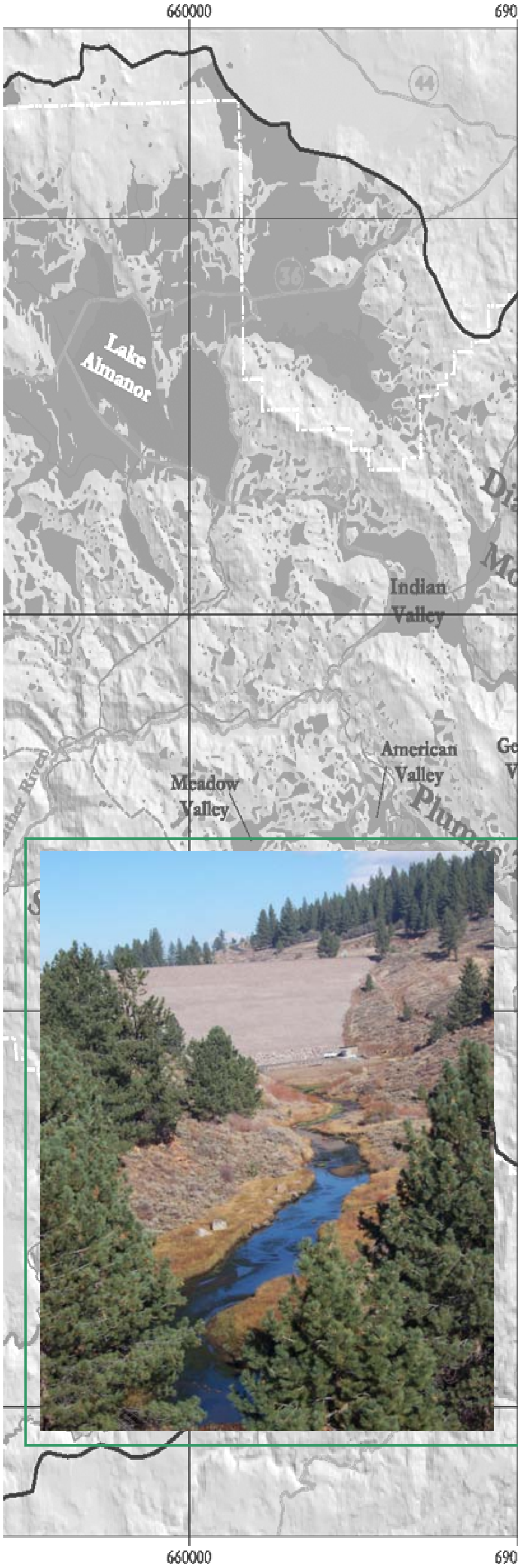

INTEGRATED REGIONAL WATER MANAGEMENT PLAN

UPPER FEATHER RIVER WATERSHED, CALIFORNIA

VOLUME 1

Issue Date: 6.30.05

Ecosystem Sciences Foundation Statement

This Integrated Regional Water Management plan was prepared by Ecosystem Sciences Foundation with matching grants from the foundation and Plumas County, California. Ecosystem Sciences Foundation supports finding balanced and lasting solutions to economic, logistical, and ecological challenges of water management. Ecosystem Sciences Foundation encourages and promotes integrated regional strategies to improve water management. It is the hope of the Board of Directors at the Ecosystem Sciences Foundation that resource managers in the Upper Feather River Watershed utilize the integrated strategies presented in this document to enhance their communities and landscape by protecting their ecologic resources including water quantity and quality.

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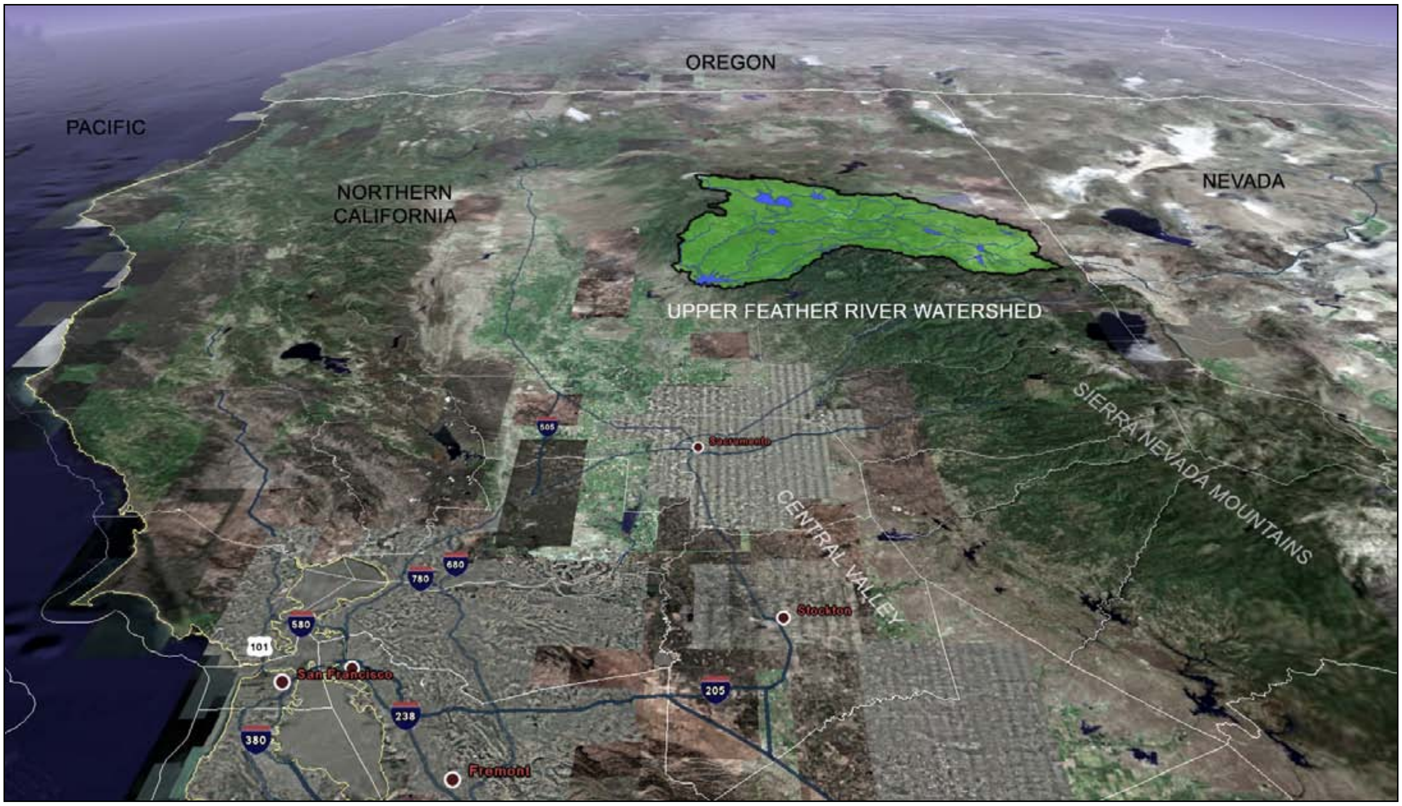
Abbreviations Used:

AF- acre foot (of water)
AUM- Animal Unit Month
AW- American Whitewater
BMP- Best Management Practices
CCWA- Central Coast Water Authority
CD- Critically Dry (water year)
CDFG- California Department of Fish and Game
CFS- cubic feet (per second)
CEQA- California Environmental Quality Act
CO- California Outdoors
CP- Chico Paddleheads
CPA- Citizens Planning Association of Santa Barbara County
CSPA- California Sportfishing Protection Alliance
CT- California Trout
CVRWQCB- Central Valley Regional Water Quality Control Board
CWA- Clean Water Act
DWR- State of California Department of Water Resources
EIR- Environmental Impact Report
EIS- Environmental Impact Statement
ERC- Ecological Resources Committee
ESA- Endangered Species Act
FERC- Federal Energy Regulatory Commission
FOR- Friends of the River
FPA- Federal Power Act
FRCRM- Feather River Coordinated Resources Management
FS- Forest Service (United States Department of Agriculture)
FWS- Fish and Wildlife Service (United States Department of Interior)
HCP- Habitat Conservation Plan/Natural Community Conservation Plan
IRWM- Integrated Regional Water Management
KWBA- Kern Water Bank Authority
MCDG- Maidu Culture and Development Group
MMC- Mountain Meadows Conservancy
MOU- Memorandum of Understanding
NEPA- National Environmental Policy Act
NFFR- North Fork Feather River
NHI- Natural Heritage Institute
NPS- National Park Service
PC- Plumas County
PCL- Planning and Conservation League
PCFC- Plumas County Flood Control and Water Conservation District
PGE- Pacific Gas and Electric Company
PME- Protection, Mitigation & Enhancement
PNF- Plumas National Forest
PWF- Plumas Watershed Forum
QLG- Quincy Library Group
SP- Shasta Paddlers
SWP- State Water Resources Development System (State Water Project)
SWRCB- State Water Resources Control Board
SVGMD- Sierra Valley Groundwater Management District
TRG- Technical Review Group
UNFFR- Upper North Fork Feather River



Upper Feather River Watershed Regional Setting

The Upper Feather River Watershed straddles the Northern Sierra Nevada Range between the Great Basin Desert and the Central Valley of California. The collective streams, rivers, lakes and reservoirs of the watershed drain into Oroville Reservoir and are a major source of freshwater for the State Water Project of California.

EXECUTIVE SUMMARY

The Upper Feather River Watershed is part of the northern Sierra Nevada mountain range. The tributaries of the Upper Feather River flow southwest to eventually fill Lake Oroville, a major reservoir of the California State Water Project. Water flows from Lake Oroville through canals to irrigate farms of the Central Valley and provide domestic water to Southern Californians, and also to the Lower Feather River and beyond to enrich the aquatic ecosystem of the Sacramento-San Joaquin Delta. The Oroville Reservoir is the principal water storage facility of the State Water Project (SWP), which conserves and delivers water to over two-thirds of California's population.

This Integrated Regional Water Management (IRWM) Plan is an implementation plan for the management of water resources throughout the Upper Feather River Watershed. The foundation for the IRWM Plan is the integration of seven existing plans by the statutory planning entities in the watershed. These plans all have statutory authority and are, therefore, mandatory. However, the mandatory plans do not address all water issues in the watershed, nor do they geographically encompass the entire watershed. Thus, there is a compelling need to integrate the mandatory plans into an IRWM Plan that does have the geographic scope and capacity to manage water resources throughout the watershed.

The IRWM Plan is divided into two Volumes. Volume One, this document, is the watershed plan. Volume Two is a compilation of the seven mandatory plans with statutory authority that support the IRWM Plan. Volume Two is considered a reference volume. Each of the seven mandatory plans is described in detail in Chapter 1 of this document.

The Feather River Watershed Authority is responsible for the creation of the IRWM Plan. The Feather River Watershed Authority incorporates several organizations of which Plumas County is the lead agency; Plumas National Forest, Sierra Valley Groundwater Management District, and Plumas County Flood Control and Water Conservation District are partner agencies. These four entities have statutory authority in the Upper Feather River Watershed.

The foundation for the IRWM Plan is based on a long history of collaboration in the Upper Feather River Watershed. Partnerships among numerous watershed resource management entities have included federal and state agencies, conservation groups, and county and municipal departments. The effectiveness of these partnerships provides a strong foundation for the IRWM Plan to achieve success.

The IRWM Plan goals and objectives are a logical extension of the interplay, public involvement, agency coordination and negotiation inherent in each of the mandatory plans. Because of the dialogue and ultimate agreement on actions and objectives for these separate water plans, the IRWM is able to build a more comprehensive plan with some certainty of consensus by stakeholders and government organizations.

The mandatory plans set many of the goals and objectives for the IRWM Plan. Linking the mandatory plans with the IRWM Plan and extrapolating shared goals and objectives throughout the watershed is accomplished by integrating all of the goals, objectives, and actions into cohesive strategies that can be implemented independently or collectively.

The IRWM Plan consists of 7 goals, 12 objectives to achieve the goals, and 24 actions to meet the objectives. For every goal there is a mix of objectives and for every objective there is a mix of actions. These are organized into distinct strategies that structure specific actions to specific objectives and to specific goals. Each strategy is designed to be independent of other strategies, yet be linked through overlapping objectives and actions. This independence and linkage within and between strategies gives decision-makers the flexibility to implement the Plan piecemeal, if necessary (because of limited funding for example), without losing continuity or sacrificing goals or objectives. The seven independent strategies are:

Water Quantity Strategy
Water Quality Strategy
Flood Control Strategy
Temperature/Sediment Strategy
Groundwater Strategy
Land Management Strategy
Habitat Strategy

Implementation of the IRWM Plan can be prioritized by strategy, however. There is a hierarchy to the strategies such that water quality and water quantity strategies, if implemented first, create a foundation and direction for the other strategies. Implementing these two strategies accounts for 83% of the objectives (10 of 12) in the Plan and 83% of the actions (20 of 24). Thus, other goals can be achieved with little additional cost or effort if the strategies for water quality and quantity goals are implemented first and concurrently.

The IRWM Plan, while meeting the criteria described in Proposition 50 guidelines, is intended to surpass the minimum Proposition 50 requirements. Over time, the statutory authorities in the Upper Feather River Watershed expect to grapple with numerous water issues that may not be identifiable today or in the near future. Throughout this process, an organic and dynamic watershed plan is needed to provide guidance to decision makers.

Implementation of this IRWM Plan will meet or contribute to California State resource agency priorities including reduction of water conflicts, coordination with and support Regional Water Quality Control Board (RWQCB) plans, support for Delta water quality objectives, support for State Water Quality Control Board (SWQCB) Non-point Source (NPS) Pollution Plans through agriculture waiver components, implementation of floodplain management strategies, assist for state species recovery plans with improved habitats, and in addressing environmental justice concerns.

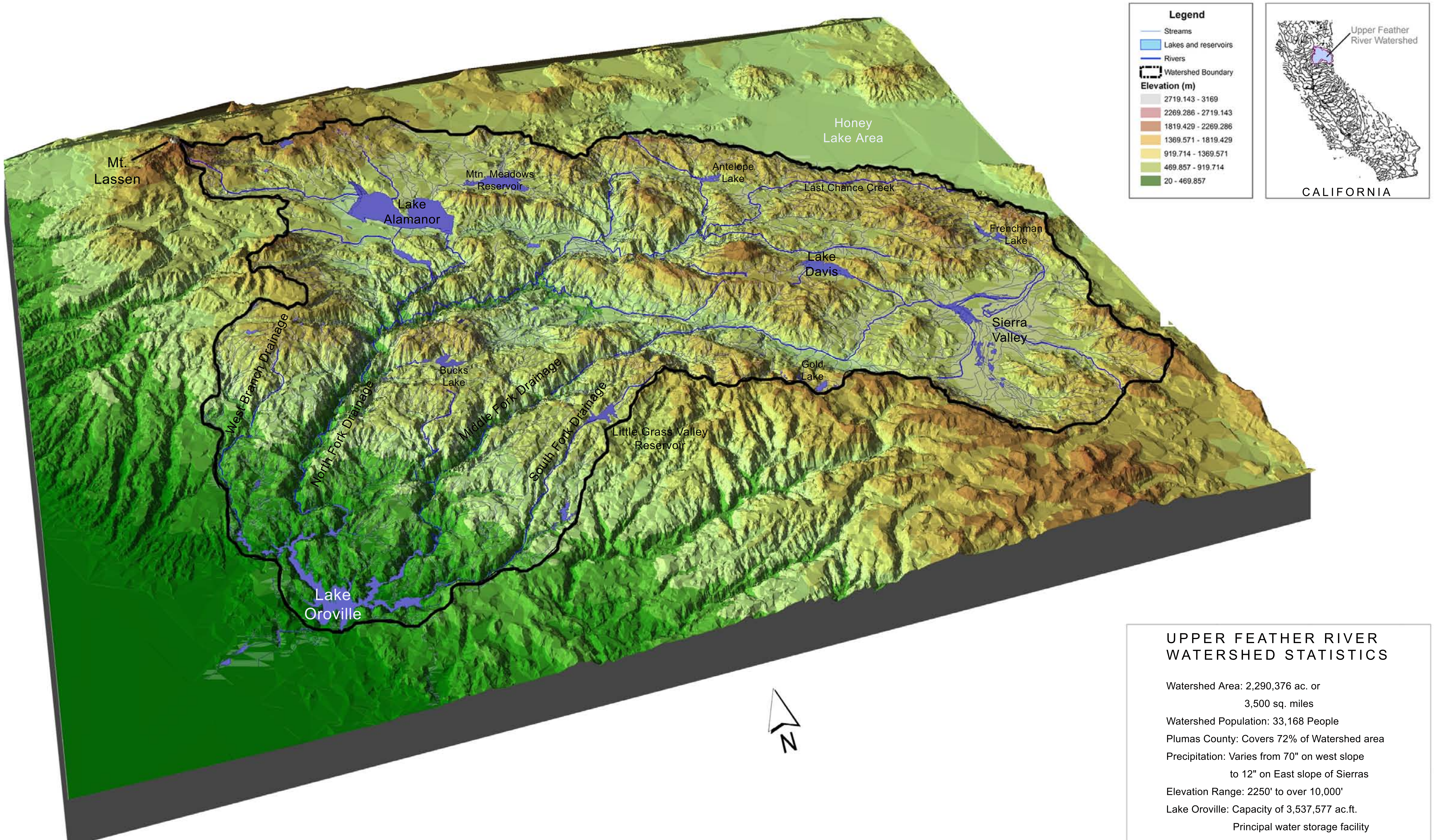
This Plan meets IRWM objectives by protecting local communities from drought, protecting and improving water quality, and improving local water security. The following water management elements (California Water Code § 79561) that serve to meet IRWM objectives are included in the actions recommended by this IRWM Plan:

- watershed management planning and implementation
- storm water
- creation and enhancement of wetlands;
- restoration of open space and watershed lands;
- programs for water supply reliability, water conservation, and water use efficiency;
- NPS pollution reduction, management, and monitoring;
- groundwater recharge and management projects;
- planning of multipurpose flood control programs that protect property, improve water quality, and protect and improve wildlife habitat;
- water banking, water exchange, water reclamation, and improvement of water quality.

The following water management strategies are included as actions described in this IRWM Plan:

- ecosystem restoration;
- conjunctive use management;
- environmental and habitat protection and improvement;
- water supply reliability;
- flood management;
- land use planning;
- groundwater management;
- NPS pollution control;
- recreation and public access;
- surface storage;
- storm water capture and management;
- watershed planning
- water conservation;
- water quality protection and improvement;
- wetlands creation and enhancement.

Proposition 50 funds will be sought for some projects described in the IRWM Plan, but the Plan is predicated on the assumption that other funding sources will be available to underwrite projects over time. Water resource planning and management in the Upper Feather River Watershed have been and will continue to be financed and supported from a number of sources. Proposition 50 funds will be one potential source among others. Because of the availability of funds for the watershed, the IRWM Plan has been designed to guide decision-makers through time, not through just a single funding cycle or opportunity.



UPPER FEATHER RIVER WATERSHED

UPPER FEATHER RIVER WATERSHED STATISTICS

Watershed Area: 2,290,376 ac. or 3,500 sq. miles

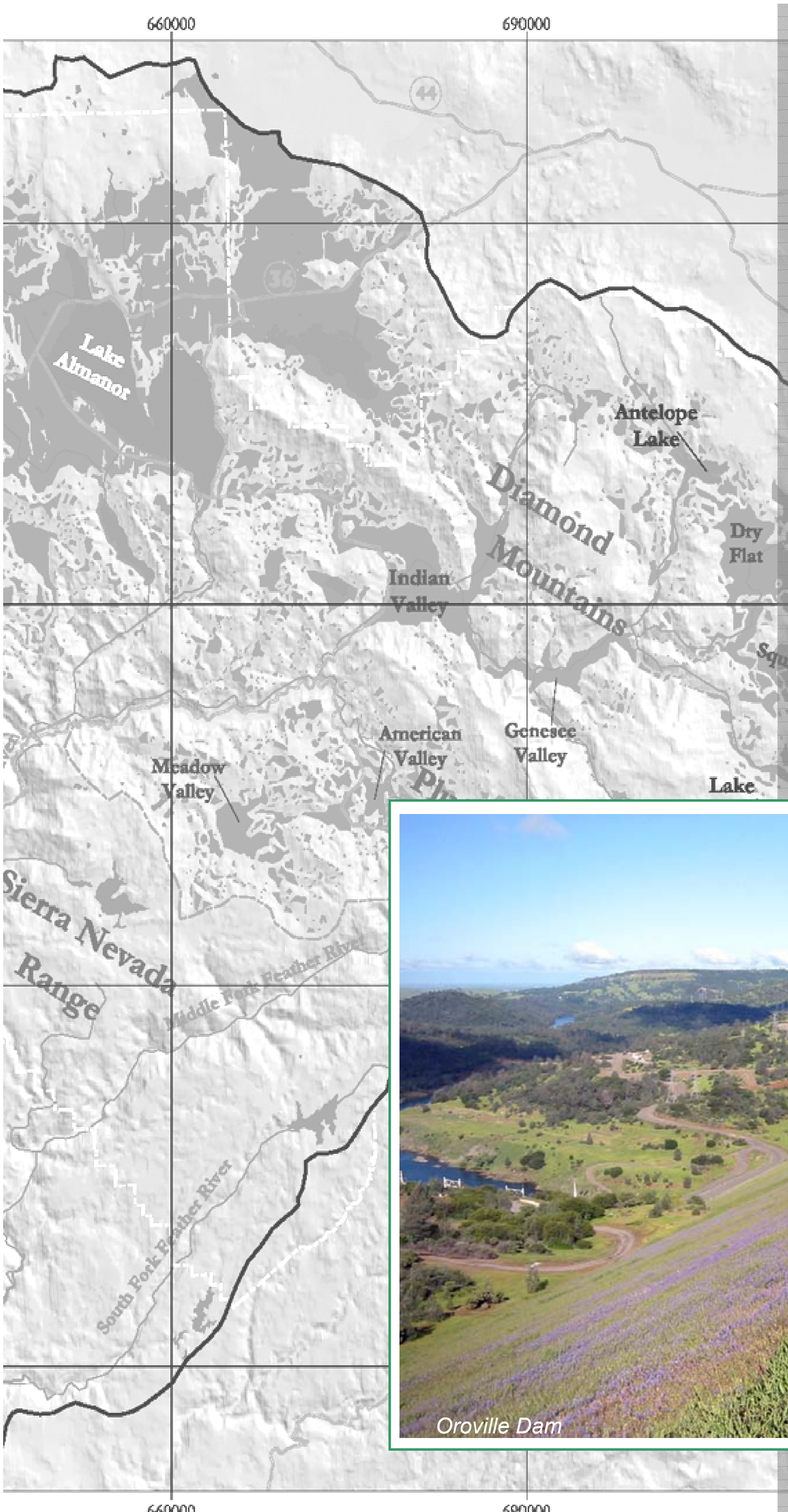
Watershed Population: 33,168 People

Plumas County: Covers 72% of Watershed area

Precipitation: Varies from 70" on west slope to 12" on East slope of Sierras

Elevation Range: 2250' to over 10,000'

Lake Oroville: Capacity of 3,537,577 ac.ft. Principal water storage facility for the State Water Project. Supplies water to over two-thirds of Californias population.



CHAPTER 1

Introduction

Oroville Dam

1.0 INTRODUCTION

The Upper Feather River Watershed is part of the northern Sierra Nevada, where that Range intersects with the volcanic Cascade Range to the north and the Diamond Mountains of the Basin and Range Province to the east. The tributaries of the Upper Feather River drain this terrain and flow southwest to eventually fill Lake Oroville, a major reservoir of the California State Water Project. Water flows from Lake Oroville through canals to irrigate farms of the Central Valley and provide domestic water to Southern Californians, and also to the Lower Feather River and beyond to enrich the aquatic ecosystem of the Sacramento-San Joaquin Delta. The Oroville Reservoir is the principal water storage facility of the State Water Project (SWP) which conserves and delivers water to over two-thirds of California's population.[1]

Natural and human-influenced conditions in the Upper Feather River Watershed are reflected in the quantity and quality of water flowing into Lake Oroville. Of the natural influences, climate and weather patterns are most determinant, but are outside the scope of management by agencies within the watershed. The human influences, though, are many and varied within the upper watershed, and are a result of actions by public and private entities. To integrate water management is "to blend actions and objectives favored by different entities to achieve the best total result".[2] This document works to integrate the planning and actions of water resource management entities, to increase efficiency of management actions, and identify opportunities to benefit the water resource.

This Integrated Regional Water Management (IRWM) Plan is an implementation plan for the management of water resources throughout the Upper Feather River Watershed. The foundation for the IRWM Plan is the integration of seven existing plans by the statutory planning entities in the watershed: the Plumas, Lassen, and Tahoe National Forests; Butte, Sierra and Plumas counties; the Sierra Valley Groundwater Management District; and the Plumas County Flood Control and Water Conservation District. These seven mandatory plans are included as appendices in Volume II this document. The IRWM Plan is an overarching document that includes all elements of these existing plans and also extrapolates appropriate management actions to the entire watershed.

The IRWM Plan presents and describes the current and anticipated water resource issues in the watershed. The mandatory plans are integrated so that (1) problems can be logically prioritized; (2) data and information gaps among plans are identified and addressed; (3) appropriate actions and solutions are adopted; and (4) clear, long-term management strategies are implemented.

1.1 BACKGROUND

Integrated regional water management in the Feather River Watershed is the outcome of an effort that began twenty years ago to bring the major resource planning organizations in the watershed together to address watershed concerns. Inter-agency and inter-organizational planning, public participation, and intra-regional coordination are some of the results of that process. [3] This IRWM Plan is also a product of that process, serving to document key developments and components, and chart the future direction of the IRWM process. This Plan identifies IRWM goals and objectives and describes how they were determined. It addresses the major water resource objectives and conflicts in the watershed, including water quality, ecosystem restoration, groundwater management, and water supply. This plan describes opportunities for cooperative actions among water resource management entities throughout the region. It also serves as a watershed-wide forum to identify and address water resource concerns, and provides a framework from which local water management policies, projects, and programs can be formulated, evaluated and implemented.

As the principle governing authority in the Upper Feather River Watershed, Plumas County is leading this effort to integrate the approach and actions of all watershed-pertinent water resource management entities. In the past, local, state, and federal agencies, as well as private organizations, planned and executed land and water resource management prescriptions without coordinating with one another.

[1] Oroville Facilities Relicensing website: http://orovillerelicensing.water.ca.gov/project.html
[2] Grigg 1998
[3] London and Kusel 1996

Figure 1.1. North Fork Feather River below Cresta Dam and Power House
Power production and the fixed management of water flow characterize much of the lower portion of the North Fork.

Recognizing that water resource concerns in the Upper Feather River Watershed could best be addressed through a cooperative approach, Plumas County promoted the establishment of the Feather River Coordinated Resource Management Committee (FRCRM) in 1985, to implement watershed restoration projects and promote coordinated, strategic resource planning.

The statutory watershed planning entities in the Upper Feather River Watershed agreed to cooperatively develop this IRWM Plan. Each of these statutory entities has an associated plan to implement policies and guidelines; these as well as other documents with statutory authority are included in Volume II. This IRWM Plan builds upon these previous efforts and compliments other local water management planning efforts that have been or are being completed by local and state agencies in the region. The mandatory plans include resource management policies for specific and focused areas within the context of the entire watershed and region.

WATERSHED ISSUES

Activities such as logging, mining, grazing, channel clearing, levee construction, urbanization, roads, forest fires and water diversions have resulted in decreased vegetative cover in the watershed. The lack of riparian and upland vegetation means precipitation is not retained and stored as efficiently in upper watershed water tables and aquifers, resulting in rapid runoff, flooding in high water years, and dry tributaries in the summer. The decrease in water retention underground yields surface water with higher temperatures, impairing water quality. Rapid runoff contributes to increased sediment yields. The primary sources of sediment are streambank erosion and erosion from road cut and fill slopes. Increased sediment yields have affected the water quality in the watershed impacting fish and other biotic habitat; sediments also deposit behind dams in the watershed, decreasing reservoir storage capacity, and impairing flood control capability and power generation storage. Thus, water quality and water quantity are the two central problems throughout the watershed.

Streambank and channel degradation is lowering the water table in the valleys causing changes in riparian habitat and in adjacent grazing lands. Decreased cover, channel clearing, and levee construction in streams on the valley floors causes channel bottoms to erode down which leaves channel banks high and vertical. The combination of increased runoff and lowered base flow level in the larger creeks in the valleys causes headcutting in the tributary streams. Poor grazing management that suppresses the growth of riparian and upland vegetation exacerbates headcutting in the tributary streams. Steepened banks begin failing and water tables drop as vegetation is lost. Upper watershed tributaries to the large valley streams are characteristically deeply incised and form gullies that continuously grow upslope.

Dams from Oroville to Lake Almanor caused the extirpation of salmon throughout the watershed. Cumulative degradation of streambanks and channels have degraded potential salmon habitat in segments of the Upper Feather River as well as the tributary streams. NOAA's fish passage prescriptions for restoration of salmon runs to the Upper Feather River watershed will depend upon not only successful passage at dams, but restoration of degraded spawning and rearing habitat and reduction of water temperatures.

INTEGRATED REGIONAL PLANNING

The IRWM Plan is intended to be an implementation plan for the management of water resources throughout the Upper Feather River watershed. The foundation for the IRWM Plan is the integration and extrapolation of seven existing plans that address water resources issues in specific areas of the watershed. These plans all have statutory authority and are, therefore, mandatory. However, the mandatory plans do not address all water issues in the watershed, nor do they geographically encompass the entire watershed. Thus, there is a compelling need to integrate the mandatory plans into an IRWM Plan that does have the geographic scope and capacity to manage water resources throughout the watershed. The seven mandatory plans listed below are described in Section 1.3.

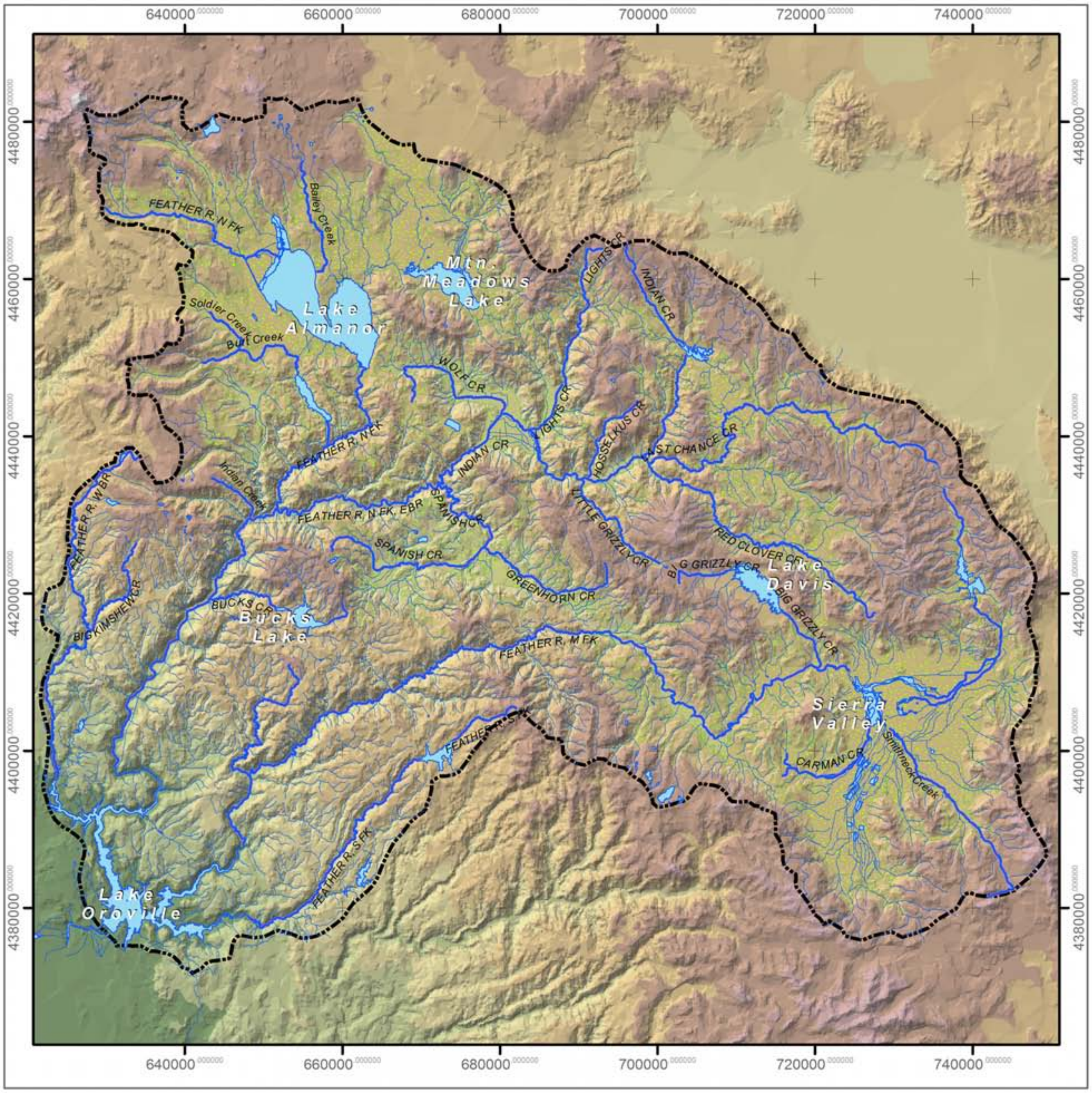
Plans	Year
FERC License #1962	2000
FERC License #2105	2004
Monterey Settlement Agreement	2003
Feather River Watershed Management Strategy	2004
Feather River Coordinated Resources Management Plan*	1987
Quincy Library Group Act and Water Related Sections of the Land and Resource Management Plans for Lassen, Plumas, and Tahoe National Forests	1998
Sierra Valley Groundwater Management District Legislation	1980

Table 1.1

Seven "mandatory" water resource management plans in the Upper Feather River Watershed included in this IRWM Plan. * FRCRM Plan is the foundation for a great many on-going partnerships, projects and work, but does not have statutory authority.

The IRWM Plan, while meeting the criteria described in Proposition 50 *Guidelines* (DWR and SWRCB 2004), is intended to surpass the minimum Proposition 50 requirements. Over time, the statutory authorities in the Upper Feather River Watershed expect to grapple with numerous water issues which may not be identifiable today or in the near future. Consequently, an organic and dynamic watershed plan is needed to provide guidance to decision makers. Proposition 50 funds will be sought for some projects described in the IRWM Plan, but the Plan is predicated on the assumption that other funding sources will be available on an on-going basis to underwrite projects over time.

The active groups and agencies in this watershed have built the prerequisite institutional capacity to manage water resources and implement projects in a holistic and coordinated manner. It is apparent to most decision-makers in the watershed that piecemeal planning constrains the range of potential solutions to the region's most pressing conflicts. By building on the wealth of hands-on watershed restoration experience, project-scale monitoring, and institutional capacity it will become possible to expand water management and planning to larger scales when water management conflicts require larger scale solutions. Completion of the IRWM Plan is the first step in realizing the ability to plan and manage water resources at a watershed and regional scale.



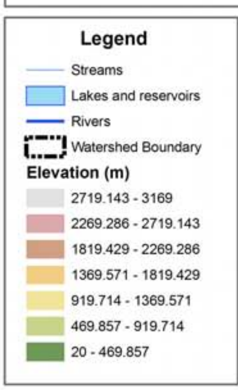


FIGURE 1.2

UPPER FEATHER RIVER WATERSHED

N

Watershed base map depicting elevation, major rivers, tributaries, streams, lakes and reservoirs.

GIS Metadata Information
Rivers, streams, lakes and reservoirs shapefiles:
California Spatial Information Library CASIL
Feather River Watershed Elevation Grid:
Ecosystem Sciences

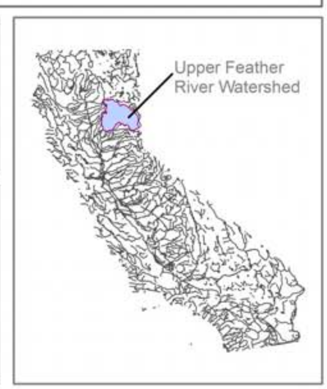


FIGURE 1.3

UPPER FEATHER RIVER WATERSHED
Political Boundaries and Urban Areas

Management solutions to conflicts over water supply, water quality, and ecosystem protection are often limited by jurisdictional and institutional boundaries. The unresolved issues of water supply, water quality and special status species' habitat needs in the watershed require workable solutions that are based on natural water catchment boundaries that extend beyond the jurisdictional and institutional limitations of the existing mandatory plans. Examples of persistent watershed-wide water conflicts include (1) temperature, sediment and nutrient water quality impairments in reservoirs and rivers; (2) fish passage and cold water refugia for salmonids; and (3) increasing water supply to ameliorate conflicts between water diverters, and riparian and in-stream environmental water needs.

Current water management planning and actions leave little margin for error in water supply allocations. Water supply and demand assessment errors, cumulative environmental and economic effects, or extreme climatic conditions are watershed scale issues that are rarely addressed in localized plans.

WATER MANAGEMENT CONFLICTS AND DISADVANTAGED COMMUNITIES

Current water management plans, including the seven mandatory plans, effectively address water resource objectives within their jurisdictional purview. However, because of the limited jurisdictional boundaries, current planning and implementation processes are not responsible for the overall flexibility and vitality of watershed-scale management of water resources. The cumulative result of incremental planning can be tightened water supplies and increased competition between users for those increasingly unreliable water resources. This inequity is paramount to Plumas County and the Upper Feather River Watershed. All of Plumas County qualifies as a disadvantaged community according to IRWM *Guidelines*.[4] Water management decision-making often ignores historic, economic, environmental, and social burdens of disadvantaged communities. These communities reside amidst the economically viable water infrastructure, but rarely directly benefit from the economics of water resource supply and demand.

[4] DWR and SWRCB 2004

Management solutions to watershed scale problems that fail to enhance overall water reliability and flexibility disproportionately shift risks from managers to those that benefit the least - the residents of the watershed. The Area of Origin statutes legally ensure that Plumas County residents have first rights to domestic supplies and may, in the future, legally obtain water supplies by minimally reducing the reliability of water supplies to Lake Oroville.

The IRWM Plan is built on the premise that it is in the best interest of both local and downstream water users to enable the statutory watershed planning entities in the Upper Feather River Watershed to achieve the integration of sustainable water management programs at a regional, watershed scale.

PURPOSE OF THE WATERSHED PLAN

- Implement projects prioritized by the IRWM Plan and the supporting mandatory plans that address priority water management conflicts and problems in the larger Feather River Watershed.
- Implement priority projects concurrently throughout the watershed to achieve maximum benefits.
- Expand beyond the boundaries of the mandatory plans, using an integrated implementation and assessment strategy.
- Integrate mandatory plans, priority projects, and regional planning using the implementation and assessment strategy described in this IRWM Plan.
- Use the integrated implementation and assessment process to inform the public and stakeholders.
- Use the IRWM implementation and assessment process to inform the development of localized water management options to reduce water conflicts and to improve water supply reliability, flood flow management, water quality and ecosystem benefits.
- Use the integrated implementation and assessment process to develop future water management priorities and projects, at scales larger than the boundaries of current mandatory plans and projects.

- Involve disadvantaged communities in the assessment and implementation of priority projects.

1.2 IDENTIFICATION OF ENTITIES CREATING IRWM PLAN

Coordination between state and federal agencies and other local entities (e.g. schools, non-profits, cities, service districts, RCDs etc.) in the Upper Feather River Watershed has a long history of success. Two well known successes are the Quincy Library Group and the Feather River CRM. The success of these two multi-member organizations within the Upper Feather River Watershed community has established the principle that coordination between federal, state, and local entities is possible, especially with open communication.[5] Utilizing this coordination process as strategy, several entities within the Upper Feather River Watershed conferred to form the Feather River Watershed Authority and a plan that will conserve, manage and protect the resources of the Upper Feather River Watershed. The Feather River Watershed Authority coordinates federal, state, and local organizations to enact strategies aimed at conserving and enhancing the resources of the Upper Feather River Watershed.

The Feather River Watershed Authority is responsible for the creation of the IRWM Plan, with Plumas County as the lead agency. The Feather River Watershed Authority incorporates several organizations as partner agencies; Plumas National Forest, Sierra Valley Groundwater Management District, and Plumas County Flood Control and Water Conservation District (PCFC). The four entities, mentioned above, have statutory authority in the Upper Feather River Watershed. The fact that the partner organizations have statutory authority signifies that a majority of land in the watershed is managed by decision makers with the ability to enact effective change for the resources of the Feather River. The remaining area of the Upper Feather River Watershed is contained, or in some way managed, by entities affiliated with the Feather River Watershed Authority. The affiliated entities of the Feather River Watershed Authority are Butte County, City of Portola, Indian Valley Community Services District, Quincy Community Services District, Maidu Cultural & Development Group, Feather River CRM, Feather River Land Trust, Sierra Institute, and University of California Cooperative Extension. These affiliated entities endorsed and agreed to support the IRWM effort, even though their participation may be minimal.

Several affiliated entities are also members of two other watershed management organizations: Plumas Watershed Forum (PWF) and FRCRM (each is described further in Chapter 3). Members of PWF and FRCRM include numerous organizations ranging from academic institutions to federal agencies and non-profit environmental groups. Overlap between partners and affiliates of the Feather River Watershed Authority with the two other watershed management organizations ensures that all concerned groups within the area are involved in decisions regarding water and resource management. Coordination and integration between and amongst concerned organizations in the Upper Feather River Watershed is paramount to successful resource management decisions.

1.3 SUPPORTING MANDATORY DOCUMENTS WITH STATUTORY AUTHORITY

The IRWM Plan is derived from and supported by seven existing regional water resource management plans, all of which were created or adopted by at least two agencies with statutory authority. These seven, mandatory plans address water supply reliability, water quality protection and enhancement, wetland, ecosystem, environmental and habitat restoration and improvement, and recreation and public access. Summaries of each plan and how they relate to this document are included in this section. Volume II contains each plan in full.

The existing mandatory water resource management plans and the IRWM Plan differ more in scale than scope. The existing plans are broad and inclusive in their application of water management elements and in their level of inter-agency coordination involved in

[5] London and Kusel 1996

plan development, evaluation, and, implementation. Each plan listed in Table 1 was developed with intensive public and stakeholder involvement. Each is signed and adopted by all or most of the agencies responsible for water regulation and management in the regions covered by the plans. It should be noted, however, that these existing management plans cover only portions of the Feather River watershed. There are geographic as well as topical gaps and overlaps among the plans. Most importantly the existing water management plans pertain to institutional boundaries rather than watershed boundaries. The mandatory plans, therefore, have limited capacity for integrated problem solving at the watershed scale, and need exists to assimilate them in order to best achieve integrated water management benefits.

DESCRIPTION OF MANDATORY DOCUMENTS

1. FERC LICENSE #1962[6]

Execution Date:	18 September 2000
Term:	30 Years
Parties involved:	

Pacific Gas and Electric Company (Licensee)
United States Department of Agriculture Forest Service (FS)
United States Department of the Interior Fish and Wildlife Service (FWS)
California Department of Fish and Game (CDFG)
California State Water Resources Control Board (SWRCB)
Natural Heritage Institute (NHI)
American Whitewater (AW)
Friends of the River (FOR)
Plumas County (PC)
California Outdoors (CO)
California Trout (CT)
Chico Paddleheads (CP)
Shasta Paddlers (SP)

[6] FERC #1962 can be found in the Volume II Appendix of the IRWMP.

Background
On September 28, 1979, Licensee filed with the Federal Energy Regulatory Commission (FERC) an application for a new license for the Rock Creek - Cresta Project, FERC Project No. 1962 located on the North Fork Feather River in Plumas and Butte Counties, California. On October 9, 1991 Licensee and CDFG entered into a Fish and Wildlife Agreement (“1991 Fish and Wildlife Agreement”) to establish minimum streamflows and other resource management measures for the protection, mitigation, and enhancement of fish and wildlife resources affected by the Project. This Agreement updates and supersedes the 1991 Fish and Wildlife Agreement. On March 15, 1996 FS issued revised preliminary conditions for the Project pursuant to 18 CFR §4.34 b(1) and in furtherance of its mandatory conditioning authority under Section 4(e) (“Preliminary 4(e) Conditions”) of the Federal Power Act (“FPA”). Various Parties and others subsequently submitted comments and appeals to FERC and FS regarding the Preliminary 4(e) Conditions. On November 1, 1996 FERC issued a Draft Environmental Assessment for the Project (“DEA”) pursuant to the National Environmental Policy Act (“NEPA”). Various Parties and others subsequently submitted comments to FERC regarding the DEA. In July 1998, Licensee, FS, FWS, CDFG, SWRCB, AW, FOR, PC, NHI, CT, California Sportfishing Protection Alliance, SP, and CP met and agreed to engage in discussions to resolve issues related to flow in the Rock Creek and Cresta reaches of the NFFR. Since those initial discussions, Licensee has provided several progress updates to the FERC and requested that additional time be allowed to continue the process. Over time the group became known as the Rock Creek - Cresta Relicensing Collaborative (“Collaborative”) and subcommittees were formed to discuss technical issues on fisheries and whitewater recreation. Meetings of the Collaborative were publicly noticed by FERC. This Settlement is an end product of the Collaborative’s work.

Purpose
The purpose of this Settlement is to resolve among the Parties all streamflow issues for ecological purposes and river-based recreational use and other related subjects in support of the Forest Service issuing its final 4(e) conditions and FERC issuing a New Project License. The Parties agreed that this Settlement constitutes an entire agreement that provides an appropriate balancing of hydroelectric power generation with the issues related to water management.

Figure 1.3 North Fork Feather River
Portion of the Cresta Powerhouse facilities along the North Fork Feather River.

Results
Subjects resolved by this settlement:

(a) Streamflows for the protection, mitigation, and enhancement of fish, wildlife, and other aquatic biota in project-affected stream reaches
(b) Streamflows for the protection, mitigation, and enhancement of riparian habitat in Project-affected stream reaches
(c) Streamflows for stream channel maintenance in project-affected stream reaches
(d) Streamflows for whitewater boating and other river-based recreation on the Rock Creek and Cresta reaches
(e) Water quality associated with project operations and facilities, including water temperatures
(f) Streamflow fluctuations from project operations, including ramping rates
(g) Streamflow gaging for compliance monitoring
(h) Stream ecology monitoring
(i) Whitewater boating use monitoring
(j) Streamflow information for use by the public
(k) Access facilities for whitewater boating on the Rock Creek and Cresta reaches
(m) Adjustment of the protection, mitigation, and enhancement measures through adaptive management over the term of the license
(n) Facility modifications to implement the protection, mitigation, and enhancement measures
(o) Administration of Settlement Agreement
(p) Term of New Project License
(q) River sediment management

Specific terms of each resolved subject (a-q) are detailed in Appendix A of the *FERC #1962* document. Many of the resolved items pertain to mandatory water elements as required by IRWM *Guidelines*.[7] Each of these water elements is discussed in further detail in Chapter 7 Implementation Strategies. As well, this settlement produced a number of Project Mitigation and Enhancement (PME) recommendations that were not to be included as a part of the New Project License. These recommendations pertain to water temperature, fishery, macroinvertebrates, natural hydrograph, flow fluctuations, geomorphology, riparian habitat, special status species, hydropower, recreation streamflows, and recreational access. Specific terms of each of these recommendations are detailed in Appendix B of the *FERC #1962* document. The Settlement establishes an Ecological Resources Committee to assist Licensee in design of the monitoring plans, review and evaluation of data, and to make specific decisions regarding ecological resources and flow related issues to be addressed by Licensee as provided in the settlement.

2. FERC LICENSE #2105[8]

Execution Date: 22 April 2004
Term: Unresolved
Parties involved:

Pacific Gas and Electric Company (Licensee)
United States Department of Agriculture Forest Service (FS)
California Department of Fish and Game (CDFG)
American Whitewater (AW)
Plumas County (PC)
Chico Paddleheads (CP)
Shasta Paddlers (SP)
Mountain Meadows Conservancy (MMC)
California Sportfishing Protection Alliance (CSPA)

Background
On October 23, 2002, Licensee filed with the Federal Energy Regulatory Commission (FERC) an application for a New Project License for the Upper North Fork Feather River Project, FERC Project No. 2105 located on the North Fork Feather River (NFFR) in Plumas County, California. Prior to filing its application for a New Project License the Licensee consulted with the Parties and other

[7] DWR and SWRCB 2004
[8] FERC #2105 can be found in the Volume II Appendix of the IRWMP.

individuals and organizations in development of the studies, data, and other material presented in the application. In 2002, Licensee and the Parties met and agreed to engage in discussions to resolve issues and agree on PME measures appropriate for the relicensing of the Project. This group, sometimes referred to as the 2105 Licensing Group, engaged in collaborative discussions and is referred to in this Settlement as the "Collaborative." This Settlement is an end product of the Collaborative's work. State Water Resources Control Board (SWRCB) staff has participated in the Collaborative in order to provide the Parties with guidance concerning the SWRCB's regulatory requirements and in furtherance of the SWRCB's policy to promote voluntary settlement agreements. However, the SWRCB cannot prejudge the Licensee's request for water quality certification pursuant to Section 401 of the Clean Water Act (33 USC §1341[a][1]) ("401 Certification") in connection with this relicensing proceeding and therefore can not execute this Settlement.

Figure 1.4 Upper Butt Creek
Portion of the water and hydroloelectric facilities in the Upper North Fork Feather River drainage.

Purpose
The purpose of this Settlement is to resolve among the Parties all lake level and streamflow issues for ecological purposes, river-based recreational uses, and other Resolved Subjects in support of FS issuing its recommended mitigation and FERC issuing a New Project License. For this purpose, the Parties agree that this Settlement constitutes an entire agreement that provides an appropriate balancing of the Resolved Subjects and the Parties will request that the FERC use the provisions of this Settlement as an alternative to be considered in the FERC's NEPA analysis process.

Results
Subjects resolved by this settlement:
a) Streamflows for PME of fish, wildlife, and other aquatic biota in Project-affected stream reaches
b) Streamflows for stream channel maintenance in Project-affected stream reaches
c) Streamflows for whitewater boating and other river-based recreation on the Belden and Seneca Reaches
d) Water quality associated with Project operations and facilities excluding erosion and water temperature
e) Streamflow fluctuations from Project operations, including Ramping Rates
f) Streamflow gaging for compliance monitoring
g) Stream ecology monitoring
h) Streamflow information for use by the public
i) Facility modifications to implement the PME measures stated in Appendix A
j) Administration of Settlement
k) River sediment management
l) Project reservoir operation and lands management principles
m) Recreation facilities development during the term of the New Project License

Specific terms of each resolved subject (a-m) are detailed in Appendix A of the *FERC #2105* document. Many of the resolved items pertain to mandatory water elements as required by *IRWM Guidelines*.[9] Each of these water elements is discussed in further detail in Chapter 7 Implementation Strategies. As well, this settlement produced a number PME recommendations that were not to be included as a part of the New Project License. These recommendations are grouped into the two categories of Recreation and Plumas County Lake Almanor Water Quality Monitoring and Protection. Specific terms of each of these recommendations are detailed in Appendix B of the *FERC #2105* document.

[9] DWR and SWRCB 2004

3. MONTEREY SETTLEMENT AGREEMENT[10]

Execution Date: 05 May 2003
Term: in effect for 8 years
Parties involved:

- Planning and Conservation League
- Citizens Planning Association of Santa Barbara County
- Plumas County Flood Control and Water Conservation District
- State of California Department of Water Resources
- Central Coast Water Authority
- Kern Water Bank Authority
- State Water Resources Development System (State Water Project) Contractors

Background
SWP operates three reservoirs in the Upper Feather River watershed. Water from these reservoirs flows to Oroville Reservoir, where some of it enters canals that are distributed throughout southern California. Lawsuit was filed by PCL (with CPA and PCFC as plaintiffs) against DWR and CCWA seeking to overturn a 1994 agreement that implemented major changes in the operation of the SWP. Accusation was made that the 1994 deal was unfairly reached due to a lack of consideration of environmental impacts and without the participation of environmental groups, therefore not in compliance with CEQA.

Figure 1.5 Reservoir in the High Sierra
Water from many reservoirs flows into Oroville reservoir operated by SWP.

Purpose
The Monterey Settlement Agreement resolves among all groups the abovementioned lawsuit (out of court); specifically, the validity of the EIR associated with the 1994 agreement is in question. The Agreement was presided over by a mediator, retired Judge Daniel Weinstein.

Results
The Monterey Settlement Agreement directs DWR to re-write the contested EIR, with special consideration to required public participation. It authorizes the establishment of a Watershed Forum to implement watershed management and restoration activities in the Feather River watershed, with particular focus on the drainages of the three SWP Upper Feather River reservoirs, for the mutual benefit of Plumas County and the SWP. The Water Forum's specific goals include:

a. Improve retention (storage) of water for augmented base flow in streams;
b. Improve water quality (reduced sedimentation), and streambank protection;
c. Improve upland vegetation management; and
d. Improve groundwater retention/storage in major aquifers.

The Settlement Agreement directs DWR to pay $8-million to Plumas County, the majority of which is to be used for watershed improvement programs. Lastly, approximately $5-million was awarded to plaintiffs in the case.

[10] The Monterey Settlement Agreement can be found in the Volume II Appendix of the IRWMP.

4. FEATHER RIVER WATERSHED MANAGEMENT STRATEGY[11]

Execution Date: 2004
Term: 10 years
Parties involved:

Plumas County Flood Control and Water Conservation District
Plumas Corp
Plumas Watershed Forum
Technical Advisory Committee

Background
The Monterey Settlement Agreement (2003) mandated the distribution of some $8,000,000 toward watershed management and restoration activities in the Upper Feather River Watershed. The same Agreement authorized the creation of the Watershed Forum to receive and manage these monies. Plumas County Flood Control and Water Conservation District, acting as the Plumas Watershed Forum, hired the consultant, Ecosystem Sciences, to research and write the Feather River Watershed Management Strategy document.

Purpose
The Feather River Watershed Management Strategy was prepared to help decision making by the Plumas Watershed Forum. The document provides an overview of watershed conditions, identifies and prioritizes key problems, and prioritizes watershed management strategies and restoration actions. It directs the Technical Advisory Committee to guide the Plumas Watershed Forum through the process of allotting funds for specific actions. The goals of the Forum, and of the prioritization, are to improve temporal retention of water to increase base flows, reduce sedimentation, protect streambanks, improve upland vegetation, and improve groundwater recharge for the mutual benefit of Plumas County and the SWP.

Results
The PWF has received numerous project proposals from a variety of individuals and organizations and evaluated them based upon criteria established by the Feather River Watershed Management Strategy document. Based on the prioritization of potential resource actions, PWF has accepted and funded high priority projects. Preliminary research has documented that improved temporal retention of water in upper watershed basins as well as reduced sedimentation have been achieved in some instances. Project implementation and monitoring continues.

5. FEATHER RIVER COORDINATED RESOURCES MANAGEMENT PLAN[12]

Execution Date: 02 June 1987
Term: Perpetual
Parties involved:

Plumas National Forest, USFS/USDA
Natural Resource Conservation Service, USDA
North Cal-Neva Resource Conservation and Development Area
U.S. Army Corps of Engineers
Farm Services Agency, USDA
U.S. Fish and Wildlife Service
Department of Fish and Game
Department of Forestry & Fire Protection
Department of Parks and Recreation
Department of Transportation
Department of Water Resources
Regional Water Quality Control Board, Central Valley
University of California Cooperative Extension
Plumas County
Plumas County Community Development Commission
Plumas Unified School District
Feather River Resource Conservation District
Feather River College
Pacific Gas & Electric
Salmonid Restoration Federation
Plumas Corporation
Trout Unlimited

Background
There are currently more than 30 active CRM groups operating at the local (i.e., watershed or sub-watershed) level in California. The FRCRM was developed to encourage local initiative and participation in resource management and to coordinate requests for Federal and State technical and financial assistance. The FRCRM is the 3rd oldest watershed group in California. The FRCRM group is a partnership of 22 public and private sector groups who formed in 1985 to collectively improve watershed health in the Upper Feather River Watershed. The original FRCRM pertained

[11] The Feather River Watershed Strategy can be found in the Volume II Appendix of the IRWMP.

[12] The Feather River Coordinated Resource Management Plan can be found in the Volume II Appendix of the IRWMP.

only to the East Branch of the North Fork Feather River, but the geographic scope has since expanded to include the rest of the North Fork, Middle Fork, and South Fork Feather Rivers. In addition to the agencies that have signed the MOU, numerous other county agencies, private consultants, community groups, and students have worked together on FRCRM projects.

Purpose

The Feather River Coordinated Resources Management Plan is a compilation of agreements that establish the legal and institutional framework of the FRCRM group. Included in the compilation are one section describing the goals and objectives and organizational framework of FRCRM as well as one Memorandum of Agreement and two Memorandums of Understanding that reflect the legal foundations of the FRCRM.

Figure 1.6 Last Chance Creek

FRCRM is very active in restoration projects throughout the Upper Feather River Watershed, particularly on smaller creek systems in high meadows.

The FRCRM is composed of three main committees; Executive Committee, Management Committee, and Steering Committee. In addition, four sub-committees with open membership exist as arms of the Management Committee. They are the Projects, Finance, Design, and Monitoring sub-committees.

The Executive Committee is responsible for policy guidance and dispute resolution, and support in the political arena. The Management Committee is responsible for administration of projects. The Steering Committee is composed of representatives from each contributing organization who review program status, approve new projects, and interact with landowners. Ideally, all affected parties necessary to implement long-term, comprehensive solutions are involved at the beginning of the project planning process. Since participation in the CRM is voluntary, participants must recognize that the value of benefits they will receive outweigh the value of their contributions. All decision-making on project prioritization is based on consensus, with ultimate control resting in the hands of the land owners.

Once a project is endorsed, a Technical Advisory Committee of resource specialists, landowners, interest groups and anyone with a specific interest in the site is formed to evaluate the site and design the project. Implementation and funding requests are coordinated by Plumas Corporation, the local non-profit economic development corporation.

Results

More than 50 watershed projects have been completed including studies and assessments, stream restoration, monitoring, resource management plans, strategic planning, community outreach and educational activities. Over 15 miles of stream and 4,000 riparian acres have been treated over the last decade, at a cost of five million dollars contributed largely by FRCRM partners. Overall, restoration activities play an important role in accelerating improvement in watershed function, the local economy, and downstream uses. Public education is also an essential element to the success of FRCRM programs. Plumas County's watershed management initiatives such as the FRCRM provide the foundation for larger scale water management and planning. The FRCRM has, over the past 20 years, piloted and honed strategies for engaging multiple landowners in multiple-objective watershed restoration projects.

6. QUINCY LIBRARY GROUP ACT AND WATER RELATED SECTIONS OF THE LAND AND RESOURCE MANAGEMENT PLANS FOR LASSEN, PLUMAS[13], AND TAHOE NATIONAL FORESTS

Execution Date: QLG: 1998; Plumas NF: 1988; Tahoe NF: 1990; Lassen NF: 1992

Term: 5 years
Parties involved:

United States Department of Agriculture, Forest Service
Plumas National Forest
Lassen National Forest
Tahoe National Forest

Background
Land and Resource Management Plans for National Forests are required by Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act of 1976, and by the implementing Code of Federal Regulations (36 CFR 219). The Plans include associated EISs which are required by the National Environmental Policy Act and the Federal Regulations (36 CFR 219.10 (b)). The Herger-Feinstein Quincy Library Group Forest Recovery Act began as a pilot project for the three National Forests to implement the Quincy Library Group Community Stability Proposal, which is an agreement by a coalition of representatives of fisheries, timber, environmental, county government, citizen groups, and local communities that formed in northern California to develop a resource management program that promotes ecologic and economic health for certain Federal lands and communities in the Sierra Nevada area.

Figure 1.7 Plumas National Forest
Current forest plans are working to demonstrate effective resource management activities

Purpose
The National Forest Plans summarize demand and supply potential, amplify the selected alternative (from EIS process), and apply management direction to each management area of the respective Forest. The plans are intended to address and be guided by management concerns as well as public issues. Some of the topics addressed are directly related to IRWM concerns, such as Range, Wildlife, Fish, and Sensitive Plants, Riparian Areas, Water, Soil, Lands, Fire and Fuel.

The purpose of the QLG Act is to conduct a pilot project on Plumas and Lassen National Forests, and the Sierraville Ranger District of Tahoe National Forest, to implement and demonstrate the effectiveness of recommended resource management activities that relate to fuelbreak construction, forestry activities, and riparian management.

Results
Chapter Four of the PNF Land and Resource Management Plan describes specific management plans for the entire forest area, and subsequent sections go into further detail concerning specific sections of the Forest. Many of the standards and guidelines presented in these chapters and in QLG management prescriptions pertain to mandatory water elements as required by IRWM *Guidelines* (DWR and SWRCB 2004).

[13] Relevant sections of these plans can be found in the Volume II Appendix of the IRWMP.

7. SIERRA VALLEY GROUNDWATER MANAGEMENT DISTRICT LEGISLATION[14]

Execution Date: 1980
Term: Perpetual
Parties involved:

Plumas County Board of Supervisors
Sierra County Board of Supervisors
Lassen County Board of Supervisors

Background
The act, known as Senate Bill No.1391, was introduced by Senators Nejedly, Ayala, and Johnson in January 1980. Under the then existing laws, there were no provisions providing for the management of the Sierra Valley Groundwater Basin. Associated bills #1401 and #215 amend this Act. Two other documents, the Sierra Valley Groundwater Management District Ordinances Pertaining to Development Projects and Sierra Valley Groundwater Management District Groundwater Supply Evaluation Requirements outline the guidelines for application for groundwater extraction for development projects.

Purpose
This Senate Bill enacted the Sierra Valley Groundwater Basin Law which authorized the Board of Supervisors of Plumas and Sierra Counties to create a district for the purposes of groundwater management. The bill specified the powers, duties and financing of the district, including the authority to levy groundwater extraction charges and management charges. To establish a groundwater management district and entities with the powers to manage those districts.

Senate Bill #1401 amends the Sierra Valley Groundwater basin Act. The bill deletes provisions in the act requiring the district to limit or suspend groundwater extractions by district off-basin users before extractions by overlying users, and declares legislative intent regarding the regulation of district of basin groundwater users. It also revised the provisions of the act relating to approval of proposed development projects within the district that propose to extract groundwater for service of water.

[14] The SVGM District Legislation can be found in the Volume II Appendix of the IRWMP.

Figure 1.8 Sierra Valley
Sierra Valley landscape.

Senate Bill #215 amends the Sierra Valley Groundwater basin Act. It amends the rules regarding voting in district elections and collections of groundwater extraction charges and taxation.

Sierra Valley Groundwater Management District, Ordinances Pertaining to Development Projects: this document outlines the ordinances governing the appropriation of groundwater resources for proposed development projects. It outlines the methods by which the board determines whether sufficient groundwater is available for the proposed project. It requires the person seeking approval (the "project developer") of the district to provide a "groundwater supply evaluation" at the time of application and empowers the district to impose a reasonable fee for applications.

Sierra Valley Groundwater Management District, Groundwater Supply Evaluation Requirements (February 1984, revised April 2000). This document presents the guidelines for project developers to follow when conducting groundwater supply evaluations. Project developers must conduct a comprehensive hydrologic study and a groundwater supply evaluation for both bedrock and alluvial areas if groundwater is proposed to be used for development projects.

Results
a. Creation of "Sierra Valley Groundwater Management District" by the Board of Supervisors of Plumas and Sierra Counties.
b. Legislature declared that the preservation of the groundwater within Sierra Valley for the protection of agricultural and other resources is in the public interest.
c. Established the Board of Directors of the Sierra Valley Management District as the governing body of the district.

d. The Board of Directors of the Sierra Valley Management District is granted the power to conduct necessary technical investigations in order to properly manage the district.
e. Granted the board authority to require accurate flow measuring devices on extraction wells.
f. Granted the board authority to move, purchase, retain, export, exchange, or otherwise manage the groundwater resources within the district. These rights include purchasing and managing water rights, and well as the right to regulate extractions and exports within the district.
g. Granted the board authority to charge extraction and management charges within the district.
h. Declared the Board of Supervisors of the District to be the "responsible agency" for appropriating groundwater extraction constraints for development projects.
i. Empowered the board with enforcement powers to prohibit a person from operating an extraction facility or other action appropriate because of the failure to follow the provisions of the board.
j. Creation of a "Long Valley Groundwater Basin Management District" with the same rules and powers outlined above for the Sierra Valley Groundwater Management District.

SUMMARY OF HOW MANDATORY DOCUMENTS CONTRIBUTE TO THE IRWM PLAN

Mandatory plans and other watershed issues are linked in the IRWM Plan with shared goals and objectives. The goals of the IRWM are over-arching and sufficiently robust to incorporate specific goals of the mandatory plans. The objectives to achieve the goals of the IRWM Plan are in common with the mandatory plans. Chapter 2 describes in detail the goals and objectives for the IRWM Plan and they are listed here.

Specific IRWM Plan Goals include:

- Improve Local Water Retention and Ensure Local Water Supply
- Reduce Flood Potential
- Improve Water Quality (temperature and sediment)
- Improve Water Quality to Meet CVRWQCB Basin Plan Limits
- Improve Upland Vegetation Management
- Improve Groundwater Retention and Storage in Major Aquifers
- Accommodate Restoration of a Salmon Fishery in Segments of the Feather River Mainstems and Tributaries

Specific IRWM Plan Objectives include:

- Continuous Flow in Perennial Streams
- Streambank Protection
- Sediment Transport Reduction
- Stream Temperature Improvement
- Agriculture NPS Waiver Program
- Wetland Wastewater Treatment
- Road Closure or Improvement
- Grazing Management
- Groundwater Recharge:Extraction Balance
- Instream and Riparian/Wetland Habitat
- Education and Outreach
- Monitoring and Adaptive Management

It is essential that the mandatory and IRWM Plans be linked in practice as well as in theory. The IRWM Plan derives from and is grounded in existing, adopted water resource management plans. IRWM also pilots a broader science-based, assessment and management framework for programs throughout the watershed and region. This is done by prioritizing implementation projects that analytically link the management plans from which they are derived, and facilitate extrapolation to and between sub-basins in the region, by focusing on water management problems that are both local and regional such as temperature, sediment and nutrient water quality impairments in reservoirs and rivers, fish passage and cold water refugia for trout and, potentially, for endangered salmon, and, decreasing/increasing water supply conflicts between water diverters, and riparian and in-stream environmental water needs. A matrix of the goals and objectives of the IRWM Plan and the mandatory plans are described below and in Table 1.2.

Table 1.2. Matrix detailing presence and location of IRWM Goals and Objectives included in the Mandatory Plans

IRWM Goals and Objectives	FERC #1962 (page, Appendix: Section numbers)	FERC #2105 (page, Appendix: Section numbers)	Monterey Settlement Agreement (page number)	Feather River Watershed Management Strategy (page numbers)	FRCRM Plan (Appendix: page number)	Plumas NF-LRMP (page numbers)	SV Groundwater Management (Bill: Article numbers)
Improve Local Water Retention	■	■	19 ●	19 ●	1 ●	4-7 ●	1391:6,7 ●
Reduce Flood Potential	A:2 ●	A:3 ●	■	△	△	■	■
Improve Water Quality (temperature and sediment)	5 A:1,4 ●	6 A:5 △	19 ●	21 ●	A:3 ●	4-7 ●	■
Improve Water Quality to Meet TMDL Limits	■	■	19 △	21 ●	1 △	■	■
Improve Upland Vegetation Management	■	■	19 ●	9, 17 ●	2 △	4-5 ●	■
Improve Groundwater Retention and Storage in Major Aquifers	■	■	19 ●	19 ●	1 ●	■	1391:8 ●
Restore Salmon Fishery in North Fork and Middle Fork Feather River Mainstems and Tributaries	5 A:3 △	5 A:5 △	■	■	■	■	■
Maintain Continuous Flow in Perennial Streams	5 A:2 △	5 A:1 ●	19 △	19 ●	1 ●	4-7 ●	■
Streambank Protection	5 A:2 ●	5 ●	19 △	16, 19 ●	2 ●	4-7 ●	■
Sediment Transport Reduction	5 A:4 ●	5 ●	19 ●	15, 21 ●	2 ●	4-7 ●	■
Stream Temperature Improvement	5 A:1 ●	8 △	■	■	2 △	4-7 △	■
Agriculture NPS Waiver Program	■	■	■	■	■	■	■
Wetland Wastewater Treatment	■	■	■	21 △	2 △	■	■
Road Closure or Improvement	■	■	■	15 ●	A:3, 6 △	4-10 ●	■
Grazing Management	■	■	■	9 ●	2 ●	4-5 ●	■
Groundwater Recharge-Extraction Balance	■	■	19 ●	16 ●	■	■	1401:1 ●
Instream and Riparian/Wetland Habitat	5 A3 ●	5 A:1 ●	19 △	16 ●	2 ●	4-7 ●	■
Education and Outreach	■	A:6 ●	■	21, 25 ●	2 ●	■	■
Monitoring and Adaptive Management	A:2,4,7 ●	A:1,5,7 ●	■	24 ●	4 △	■	■

Key:

■ = Does not address the subject.

● = Fully addresses the subject.

△ = Partially addresses the subject.

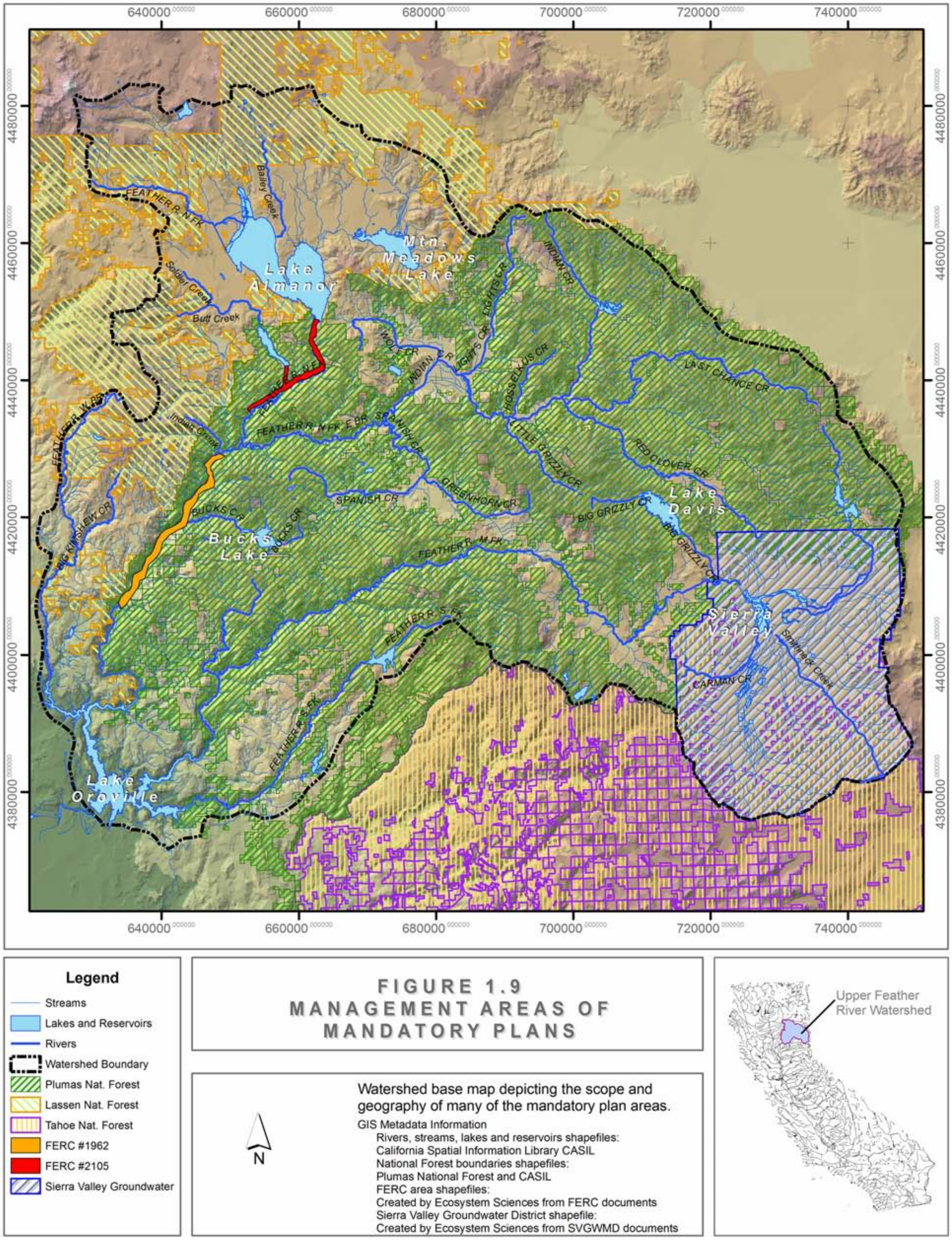


FIGURE 1.9
MANAGEMENT AREAS OF MANDATORY PLANS

SUCCESS AND GAPS

The mandatory plans collectively address almost all IRWM goals and objectives[15] as seen in Table 1.2, but there are geographical and topical gaps that exist between the plans. As noted above, this IRWM Plan seeks to unify the goals and actions of all the mandatory plans, and extrapolate them to areas of the Upper Feather River Watershed outside the domain of the mandatory plans. This section describes the pertinence of the plans to IRWM goals and objectives and addresses some of the gaps that are filled by this IRWM Plan.

The PNF and associated Land and Resource Management Plans address a wide geographic area and most of the IRWM goals and objectives. The plans fail to address some important issues though, such as flood potential, CVRWQCB Basin plan for water quality, groundwater, and salmonids. The PNF document does specifically address road closure and improvement, and the PNF has performed numerous habitat and stream restoration projects.

The FERC #1962 and #2105 documents address concerns related to the hydropower operations on the North Fork Feather River. Since they principally involve the impoundment of water behind in-channel dams, and the release of that water downstream, the documents address flooding and the reduction of flood potential. Water quality, including issues related to sediment and temperature, is a major focus of both FERC documents, although some water quality issues were left unresolved in the #2105 document. Major land use issues such as roads, grazing, and agriculture are not addressed by the FERC documents. Monitoring and adaptive management plans are included. These FERC documents are geographically very specific, leaving the majority of the Upper Feather River Watershed to be addressed by other plans.

The major goals of the Monterey Settlement Agreement include improving water retention and storage, water quality, upland vegetation management, and balancing groundwater extraction with recharge. Indirectly, these goals necessitate addressing sediment transport, streambank protection, flood attenuation and improving stream flow. The Feather River Watershed Management Strategy is the implementation strategy for the Monterey Settlement Agreement. It provides a framework for implementation, monitoring, and adaptive management, and goes further to address more specific issues such as solutions to water quality issues, road closure and improvement, grazing, and instream and riparian habitat including wetlands. This mandatory plan does address flood potential, stream temperature, and the Agriculture NPS Waiver Program. The Feather River Watershed Management Strategy document is geographically all-inclusive.

The Sierra Valley Groundwater Management District Legislation documents address issues specific to groundwater pumping in Sierra Valley only, and are therefore geographically and topically limited. There is need for IRWM goals and objectives to be applied to the Sierra Valley, including issues related to grazing, water quality including sediment and temperature, instream and riparian/wetland habitat, upland vegetation management, and monitoring and adaptive management.

The FRCRM also addresses the entire Upper Feather River Watershed and a majority of the IRWM goals and objectives. The document does not attend to some major issues, though, including a salmonid fishery, the Agriculture NPS Waiver Program, nor balancing groundwater extraction with recharge. FRCRM directly or indirectly addresses all other IRWM goals and objectives and includes implementation prescriptions with monitoring and adaptive management programs.

Many of the IRWM goals and objectives are addressed by more than one mandatory plan, but gaps do exist. The Agriculture NPS Waiver Program is not addressed by any mandatory plan, therefore need exists for the IRWM Plan to concentrate on this subject. The restoration of the salmonid fishery and the use of wetlands for wastewater treatment are issues only indirectly addressed by a few mandatory plans, therefore the IRWM Plan should address them. As well, geographic gaps exist between mandatory plans and the IRWM Plan should work to extrapolate important issues and plans for implementation to the entire Upper Feather River Watershed.

[15] DWR and SWRCB 2004

1.4 RELATION TO LOCAL PLANNING

The purpose of the IRWM Plan effort is to link the localized mandatory plans into a watershed-wide plan. The IRWM Plan encourages improved inter-agency cooperation and integrated water management at the watershed scale. The IRWM Plan will be signed and adopted by the four agencies with land management authority for the majority of the Feather River watershed. Plumas NF, Plumas County, Butte County and Sierra Valley Groundwater Management District all will have a stake in the coordinated management of the IRWM Plan. Future planning includes linking Tahoe National Forest, Lassen National Forest and Sierra Valley groups in the watershed through forthcoming General Plan and Forest Plan Amendments. As those processes are initiated Plumas County proposes a water resource element in the Conservation section of its next General Plan update which is scheduled to occur in the next 5 years. Butte County has identified a goal of developing a water resources element in its next General Plan update. The Quincy Library Group Pilot Project which encompasses portions of the Plumas, Lassen, and Tahoe National Forests will be updated in a similar timeframe.

The above outlined local planning efforts will incorporate strategies outlined in the IRWM Plan. Thus, the IRWM Plan will serve as the guidebook for how to manage water resources in future General Plan updates and Forest Plan Amendments. The IRWM Plan will serve as the link between past planning efforts, since it is based on the existing mandatory plans, and future planning efforts (Figure 1.10).

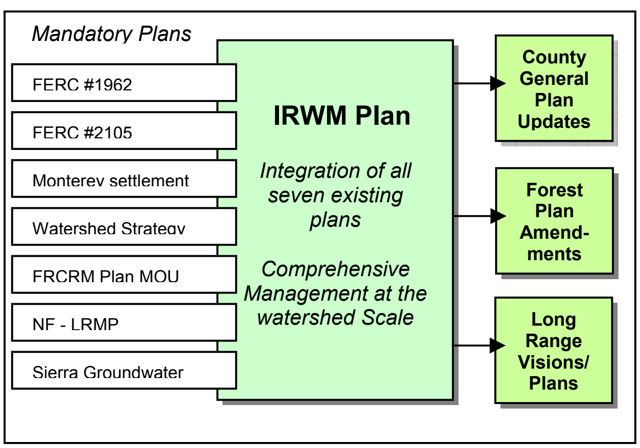


Figure 1.10. IRWM Plan integration schematic

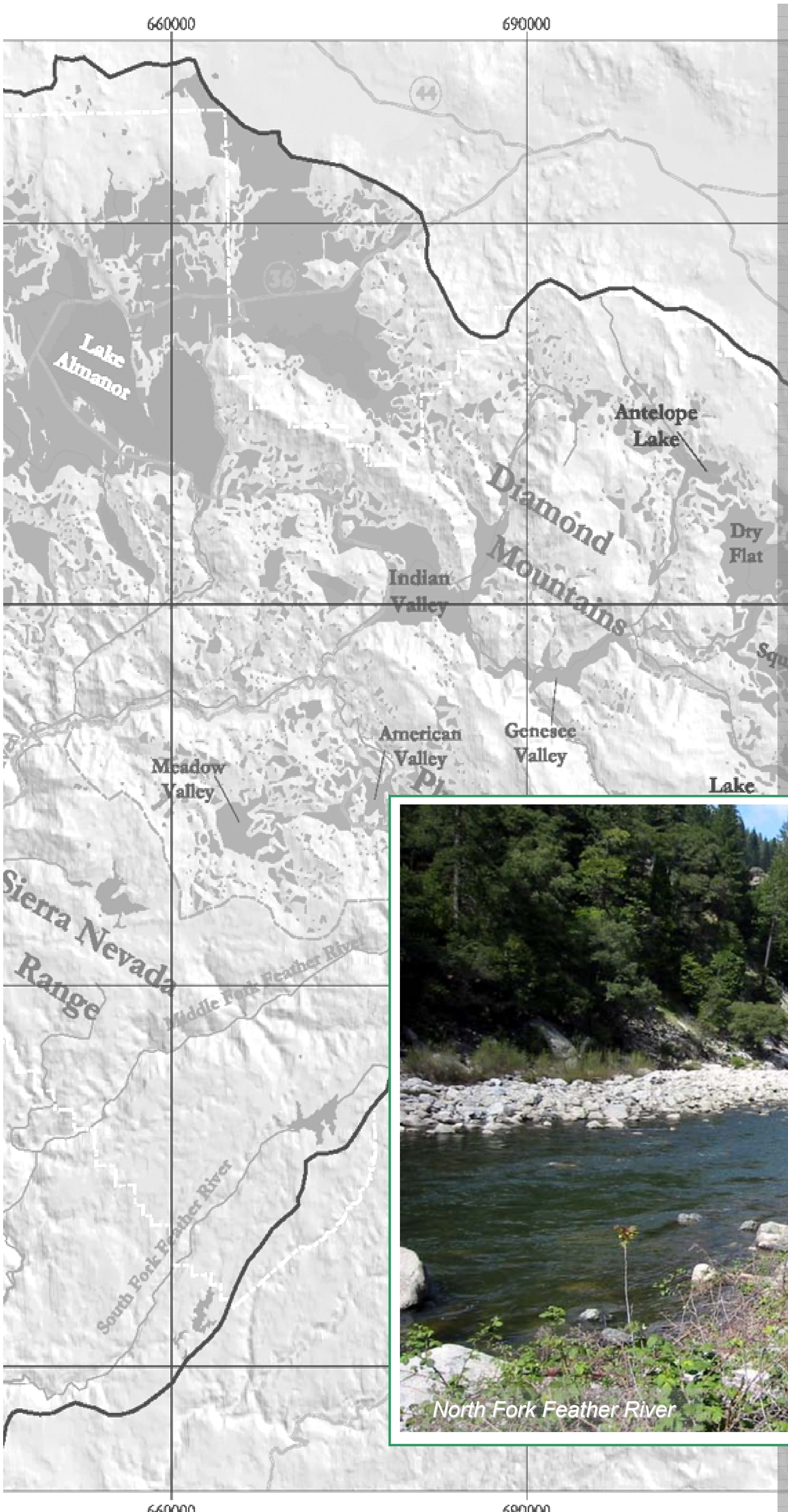
The IRWM Plan links with past and future planning efforts.

1.5 PURPOSE AND USES OF THIS DOCUMENT

The purpose of this plan is to identify potentially feasible opportunities, initiatives, programs or projects to improve water supply, water quality, and ecosystem protection in the Upper Feather River Watershed. The result of this coordinated effort is the completion of a watershed-wide IRWM Plan.

Plumas County's IRWM goals, objectives, and strategies are shaped by the geographic and geopolitical characteristics of the Upper Feather River Watershed. The regional water management priority is to build linkages: analytical, institutional, and experiential. These linkages are derived from existing planning frameworks to establish watershed scale management of water resources. The assimilation of local plans into the IRWM Plan is required for the optimal resolution of water management conflicts in the Upper Feather River Watershed.

The Upper Feather River IRWM Plan addresses both the physical and technical underpinnings of water management in the region. The IRWM Plan describes the physiography of the watershed, the hydrology, geology and hydrogeology, the water storage and delivery infrastructure, land use, water demands, water quality, and pertinent legal issues related to water resources. The IRWM Plan also considers present and possible future policies, programs, and projects that allow for the efficient distribution, use, protection, and possible enhancement of water resources in the watershed.



CHAPTER 2

Goals and Objectives


North Fork Feather River

Introduction

This chapter describes the watershed conditions or issues that affect the resources, and the goals and objectives needed to address those water issues. Implementation of the stated goals and objectives is the core of the IRWM Plan and is achieved through a series of specific actions. Chapter 6 describes the watershed actions. Actions combined with goals and objectives form the IRWM Plan strategies that will be used to implement and manage water resources. Management strategies and priorities are discussed in Chapter 7.

2.1 Watershed Condition and Influences

Westside versus Eastside

As described previously, the Feather River watershed is divided by the Sierra Crest, such that there is geologically distinct east and west sides. The west side is characterized by steep, forested v-notched valleys. The west side is less susceptible to erosion and headcutting; thus, the west side is less degraded than the east side and exports considerably less sediment. The east side exhibits less steep terrain with broad valley floors and is more degraded by the loss of riparian and upland vegetation. Headcutting is common throughout the upper east side of the watershed and the source of a majority of sediments exported from the watershed. The streams in the Upper East Side watershed are characteristically gullied with little riparian vegetation. Deep channel incision has lowered the water tables beneath surrounding landforms, and xeric/sagebrush vegetation has replaced meadow and wetland vegetation types. In brief, the east side is more sensitive to human activities and is more degraded as a consequence of those activities; thus, the eastside of the watershed should be given the priority for the limited resources.

Road Density

Rill and sheet erosion from roads (Plumas County, state highways, railroads and Forest Service roads) constitutes the second most important sediment source throughout the watershed. Road density is an indicator of the magnitude of the problem in terms of sediment contribution. While road density varies from subwatershed to subwatershed, Forest Service roads are the primary factor in determining density. Recognizing the problems associated with old logging roads or poorly built roads or roads in sensitive areas such as riparian zones, the Forest Service has been actively engaged in restoration of the watershed by closing roads and in some cases re-vegetating roads to eliminate sediment sources. Reducing sediment problems associated with roads remains the key Forest Service restoration activity.

Sediment Transport

The 1989 watershed erosion study quantified sediment transport from eastside subwatersheds. Although some improvements have occurred from restoration projects, it can be assumed that the highest yields of sediments are from the same subwatersheds. Since sediment transport is an indicator of overall conditions in a subwatershed, those subwatersheds contributing the greatest amount of sediments should be given the highest priority for restoration actions.

The dominant soil types in the watershed include highly erodeable granitic and sedimentary deposits in ancient lakes that once occupied most of the valleys. Human activity over time has resulted in decreased vegetative cover from logging and grazing, channel clearing, levee construction and water diversions. All of which, contribute to increasing the sediment yield from these sensitive soils and runoff from the subwatersheds. The primary sources of sediment are streambank erosion and erosion from road cut and fill slopes. Thus, water quality and water quantity are the two central problems throughout the watershed.

Sediments from all of the erosion sources results in water quality conditions that impact fish and other biotic habitat; sediments deposit behind dams throughout the watershed decreasing reservoir capacity and impairing flood control capability and power generation storage. Lack of riparian and upland vegetation means precipitation is not retained and stored in upper watershed water tables and aquifers resulting in rapid runoff, flooding in high water years, and dry tributary streams in late summer.

Streambank and bottom degradation is lowering the water table in the valleys causing changes in riparian habitat as well as in adjacent grazing lands. Decreased cover, channel clearing, and levee construction in streams on the valley floors causes channel bottoms to erode down which leaves channel banks high and vertical. The combination of increased runoff and lowered base flow level of the larger creeks in the valleys causes headcutting in the tributary streams. Poor grazing management that suppresses the growth of riparian and upland vegetation exacerbates headcutting in the tributary streams. Steepened banks begin failing and water tables drop, as vegetation is lost. Upper watershed tributaries to the large valley streams are characteristically deeply incised and form gullies that continuously grow upslope[1]. (See the photos and illustrations on p.8)

The 1989 erosion inventory for a portion of the watershed showed that the largest source of sediments is from streambanks (55%). About 73% of this erosion is on smaller streams tributary to the major streams in the valleys. The second largest single source of sediments is road and railroad cut and fill slopes (43%). Road cut slopes contribute 28% and road fill slopes contribute 15% of the total erosion.

While the decline of water tables in bank storage areas is typical of eroded streams, the depletion of deeper aquifers is also a serious problem on valley floors. Poor vegetation cover prevents the rapid infiltration of precipitation to recharge aquifers. Groundwater pumping furthers the depletion of aquifers such that in some areas of the watershed groundwater is being "mined" when recharge cannot keep pace with extraction.

Streambank	55%
Road and Railroad Cut and Fill	43%
Gullies	1.5%
Sheet and Rill	0.5%

Table 2.1 Source of stream sediment from erosion

East Branch of the North Fork Feather River Erosion Inventory Report

Priority Subwatersheds

All of the subwatersheds exhibit degradation to one degree or another. All of the subwatersheds contribute sediments to the total export from the watershed. Dry tributary channels in late summer, lowered water tables, poor water retention and streambank erosion and incision are common to most streams throughout the watershed. It would be a tremendous task to restore every stream in every subwatershed, but resources can be assigned to the worst conditions to measurably meet goals. To better prioritize restoration projects, the subwatersheds and streams listed here should be the initial focus of watershed management for sediment. There is no ranking or order of importance to the listed areas.

- **Last Chance Subwatershed**
- **Red Clover Subwatershed**
- **Spanish Creek Subwatershed**
- **Lower Indian Subwatershed**
- **Upper Indian Subwatershed**
- **Lake Davis-Long Valley Subwatershed**
- **Sierra Valley Subwatershed**

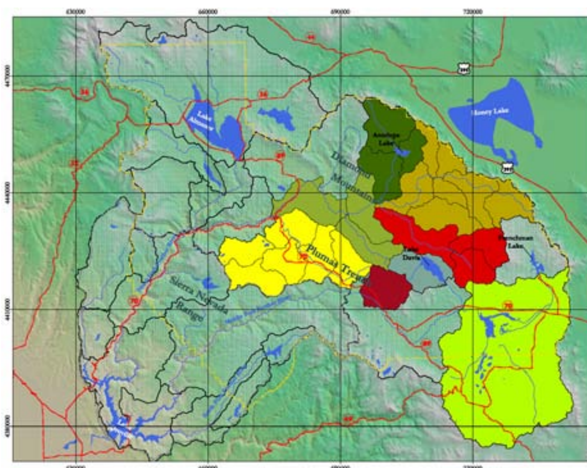


Figure 2.1 Priority Subwatersheds

See the subwatersheds map in Chapter 4.0 for a large scale view.

Groundwater

Loss of water tables and depletion of shallow aquifers is a typical consequence of headcutting throughout the watershed. Poor retention of precipitation is also a consequence when headcutting lowers water tables and vegetation changes to more desert types. Active intervention on streams where this occurs will restore water tables and shallow aquifers when headcutting is reversed and riparian and upland vegetation recovers. However, some areas of the watershed are experiencing dry year depletions of deep groundwater systems as a result of continued extraction and reduced recharge during those periods. It is these areas of the watershed which need to be managed as a separate priority. Sierra Valley is an example of a high desert groundwater basin developed for agriculture and experiences periodic drought depletions that only recover during wet periods. Prior to the end of the 1970's most groundwater use in the valley was stock water from deep, flowing artesian wells. In the early 1980's, many deep, large capacity, irrigation wells were developed to grow alfalfa and other crops. Significant groundwater declines developed in the most heavily pumped areas. Since its inception in 1980, the Sierra Valley Groundwater Management District has monitored groundwater levels and installed flow meters to monitor pumpage on all wells in the valley pumping 100 gpm or more. In response to the declining groundwater levels, the District established water budgets in the areas of significant agricultural pumping. In order to manage the drought depletions, enhancement of recharge should be investigated. Some areas of the basin, where monitoring is at a minimum, have experienced recent development of groundwater. Safe yields in these areas have not been established. These areas should be targeted for the installation of cluster monitoring wells, and water producing zones should be identified by cross section study. While other aquifers may also be in jeopardy, the highest priority should be placed on the Sierra Valley groundwater basin.

Meadows

The most sensitive landforms in the watershed are meadow areas associated with the upper subwatersheds. Meadows are remnant lake bottoms of highly erodable soil types. Meadows are also heavily used for grazing. The subwatersheds with the highest density of meadows are also those that export the greatest volume of sediments; thus, restoring stream conditions in meadow landforms to reduce erosion, increase aquifer storage, retain water to augment summer base flows, and improve riparian and upland vegetation for streambank protection will achieve IRWM Plan goals to a significant degree.

Riparian and Streambank Condition

Streams in the upper watershed (tributaries to the major valley streams) share the common characteristic of denuded streambanks. Headcutting exacerbates this condition; however, it is likely that longterm grazing and/or logging and water diversion began the decline of riparian vegetation before headcutting became the dominant force. Riparian vegetation and riparian corridors are essential to protect and maintain streambanks. Reestablishing riparian systems will be a key component of active intervention to halt and reverse headcutting. Without riparian vegetation to hold streambanks in place the benefits of geomorphic restoration cannot be sustained. Because riparian vegetation is essential for streambank protection to prevent erosion and sediment transport, priority should be given to those streams where riparian vegetation has been lost and where conditions are favorable to restore riparian systems as part of active intervention.

Upland Vegetation Condition

Reducing sediments from surface runoff and rill erosion as well as improving water retention and base flow conditions is dependent upon upland slopes, fans and meadows, being well vegetated with hydrophilic vegetation community types like grasses, forbes, emergent, wet meadow and wetland plants. In addition to the benefits of retaining water, reducing erosion, and recharging water tables, well vegetated uplands provide high quality forage for livestock. Restoration of upland vegetation (as well as riparian vegetation) is usually dependent upon sound grazing management in addition to active intervention techniques. Just as with riparian systems, upland conditions that remain degraded and unchanged will ensure that active intervention projects are not sustainable. Priority should be given to those upper watershed areas where land use management can work synergistically with the intervention technique to maximize benefits.

Instream Condition

The main stems of the Upper Feather River watershed as well as virtually all of the tributaries exhibit significant degradation as a consequence of historical and on-going land and water uses. Timber harvesting, water diversion, irrigation practices, road and railroad construction, grazing, mining – all have contributed to instream conditions that impact aquatic biota. Fish habitat for spawning and rearing, the invertebrate food base, and migration (passage) have been deleteriously affected by channelization to control flooding, sediment deposition as a consequence of bank erosion and runoff from unvegetated uplands, loss of pool habitat; lack of bank undercuts and cover as riparian systems disappeared. Instream conditions throughout the watershed can never be restored to pristine conditions, but all streams can be rehabilitated to functional, ecologically healthy conditions that support aquatic biota.

2.2 IRWM Plan Goals

The IRWM Plan goals and objectives are a logical extension of the interplay, public involvement, agency coordination and negotiation inherent in each of the mandatory plans. From this dialogue and ultimate agreement on actions and objectives for these separate water plans, the IRWM is able to build a more comprehensive plan with some certainty of consensus.

Goal #1: Improve Local Water Retention and Reduce Flood Potential

Retaining precipitation (snow and rainfall) in the watershed is critical to reduce flood events, recharge aquifers and streambank storage, and maintain hyporheic zones in uplands and riparian systems. Retaining precipitation in order to maximize infiltration is a function of vegetative conditions and land uses throughout the watershed. Land use activities that result in well vegetated slopes and landforms will reduce the erosion problems and "flashy" runoff and flooding conditions typical throughout subwatersheds in the region.

Figure 2.2 Spanish Creek

Spanish Creek reach in the American Valley near Quincy, CA.

Many of the Mandatory Plans incorporate goals to increase water retention and reduce erosion. The Plumas National Forest Plan includes goals to improve water retention and reduce flooding for riparian areas, water, and soils. The Coordinated Resource Management (CRM) Plan for the East Branch North Fork Feather River (EBNFFR) includes erosion control and site restoration as central goals. Infiltration to recharge groundwater systems is the main goal of the Sierra Valley Groundwater Management District. The Monterey Agreement and Strategy focus on stream restoration and projects that increase water retention, reduce or eliminate erosion, and contribute to reduced flooding. Management of forest and upland vegetation under the Quincy Library Group (QLG) agreement is an important element in retaining and infiltrating precipitation on steep, forested slopes.

Goal #2: Improve Dry-Season Base Flows

Figure 2.3 Feather River North Fork Canyon

Bucks Creek powerhouse operated by PG&E.

Degradation of stream channels in the watershed and continued headcutting throughout the system has caused many perennial streams to run dry in late summer. Lack of dry-season base flows (flows in late summer months) is a reflection of poor water recharge or storage capacity. The Plumas National Forest Plan has a goal to "realize feasible increases in the quantity of water yield and delays in the timing of runoff…" (p. 4-7). CRM stream restoration projects under the Monterey Strategy focus on improving the day-season base flows of streams. Maintaining minimum or base flows throughout the North Fork Feather River is a component of the FERC 1962 and 2105 Agreements. Increasing dry-season base flows will contribute to the success of stream restoration and upland vegetation management because water tables adjacent to streams are recharged and perennial streams return to perennial flow conditions. Establishing dry-season base flow goals throughout the watershed is a logical extension of the goal in the mandatory plans.

Goal #3: Improve Water Quality (Temperature and Sediment)

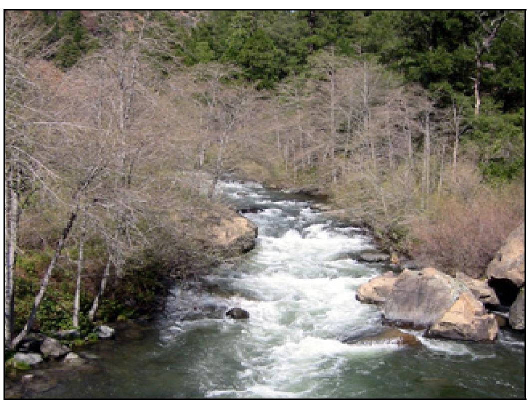


Figure 2.4 Feather River North Fork

River reach above the confluence with the East Branch of the North Fork.

Increased water temperatures and sedimentation in the North Fork and Middle Fork Feather Rivers negatively impact cold water fisheries. Warm water holds less dissolved oxygen than cold water, which impairs aquatic life. Sedimentation blankets stream bottoms interfering with salmonid spawning, photosynthesis, and respiration. These conditions are contributing to limited salmonid spawning and rearing success in many streams in the Feather River Watershed. The goal to improve water quality will be achieved by establishing a mean daily maximum water temperature of $\leq 20^0$ C. The FERC 1962 and 2105 plans have this same goal. Improving water temperatures decreases stresses to aquatic resources and is consistent with State Water Resources Control Board's (SWRCB) Water Quality Control Plan for the Central Region. The Sacramento River Basin and the San Joaquin River Basin Plans designate the beneficial uses throughout the watershed to include coldwater habitat and coldwater spawning habitat.

Goal #4: Improve Water Quality to Meet CVRWQCB Basin Plan / Agriculture Waiver

The Upper Feather River Watershed includes approximately 60,000 acres of irrigated land. Water quality concerns associated with irrigated agriculture are temperature, nutrient enrichment, bacterial contamination, and sediment discharge. Recent legislation authorized the Central Valley Regional Water Quality Control Board (CVRWQCB) to waive waste discharge requirements for agriculture if certain conditions are met.

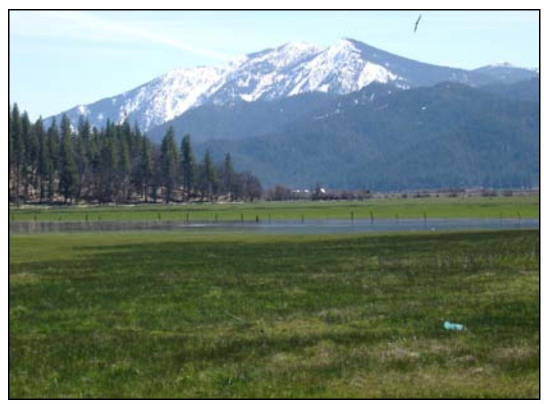


Figure 2.5 Indian Valley

Small open meadows characterize much of the small valley landscape of the watershed.

Most of the mandatory plans incorporate the goals of CVRWQCB Basin Plan programs and standards. The IRWM Plan links agriculture waivers and CVRWQCB Basin Plan attainment throughout the watershed as a common goal. The CVRWQCB Basin Plan is a watershed restoration tool used to combat pollution sources.

Goal #5: Improve Upland Vegetation Management

Figure 2.6 Feather River North Fork
Oak riparian forest in the midst of Sierra mixed conifer.

Water quality, water retention, erosion, and aquifer storage are all dependent to a large degree on the condition of vegetation on slopes, meadows, and uplands throughout the watershed. Forest standards and guidelines seek to guide management of the National Forests in the watershed to achieve an "all age, multi-story, fire-resilient forest approximating pre-settlement conditions". The Monterey Strategy and the Plumas National Forest Plan also share this goal to maintain and improve vegetation.

The IRWM goal is to extend upland vegetation improvements to all areas of the watershed through restoration actions to ensure that grazing and agricultural activities employ Best Management Practices, that forest management activities conform with QLC guidelines to protect steep slopes, and meadow vegetation moves from xeric (dry) to mesic (medium moisture) conditions.

Goal #6: Improve Groundwater Retention and Storage in Major Aquifers

Headcutting of stream channels throughout the watershed is resulting in the loss of water tables and depletion of shallow aquifers. As a consequence, precipitation retention is decreased as vegetative communities change to adapt to lower water tables, or drier conditions.. Active intervention to reverse headcutting of streams so that the riparian and upland vegetation can be restored will improve precipitation retention and restore water tables and shallow aquifers.

Figure 2.7 Sierra Valley
Mixed upland shrubs and grasses are varied with standing water, creeks, canals and wetlands.

Some groundwater systems in the watershed are being depleted due to high extraction rates and poor recharge. The most seriously degraded aquifer is in Sierra Valley where poor grazing practices are being employed and large amounts of groundwater are being pumped to meet crop irrigation needs. The Monterey Strategy and Agreement have a goal to reverse the depletion of the Sierra Valley aquifer. The IRWM will extend this goal of improving groundwater recharge, retention, and storage to all aquifers in the watershed.

Goal #7: Accommodate a Salmon Fishery in Segments of the Upper Feather River Watershed

Figure 2.8 Chinook Salmon
Many river reaches in the watershed are historic habitat of Chinook and Steelhead.

The re-licensing requirements for hydroelectric projects on the North Fork of the Feather River include the restoration of anadromous fish access throughout the drainage. In the event that passage around Oroville Dam is found to be feasible, habitat throughout segments of the Upper Feather River Watershed and its tributaries will be available to salmon and steelhead. The IRWM Plan will accommodate this goal of restoring an anadromous fishery by focusing on improving habitat for anadromous fish. The IRWM Plan recognizes NOAA's prescriptions for anadromous fishery restoration and the necessity of planning to accommodate them.

2.3 IRWM Plan Objectives

Objective #1: Continuous Flow in Perennial Streams

Riparian (streamside) vegetation is essential for storing water during the dry season and dry years. Plant roots allow water to infiltrate into the water table, which is generally connected to the aquifer. High water tables create flows in springs and seeps. During low flow periods, water is released from the water table to the channel, resulting in stream flows even in the dry season. Returning baseflows to perennial streams is a central goal of the Monterey Strategy.

The FRCRM has employed stream restoration techniques in the watershed that have shown success in retaining and releasing flows. The pond and plug techniques have been especially successful; within 3 years some stream channel flows reached near perennial conditions. The IRWM will use similar restoration techniques in specified areas throughout the watershed to restore baseflows in streams.

Objective #2: Sediment Transport Reduction

The dominant soil types in the watershed include highly erodeable granitic and sedimentary deposits in ancient lakes that once occupied most of the valleys. Human activity over time has resulted in decreased vegetative cover from logging and grazing, channel clearing, levee construction and water diversions. All of which, contribute to increasing the sediment yield from these sensitive soils and runoff from the subwatersheds. The primary sources of sediment are streambank erosion and erosion from road cut and fill slopes. Thus, a primary objective to meet water quality goals of the IRWM Plan will be the restoration of streambanks with techniques such as inset channels to build riparian systems and the re-design of county roads which have eroding cut and full slopes.

Objective #3: Streambank Protection

Riparian systems maintain channel morphology by preventing bank erosion, sloughing, and extreme channel changes that lead to increased sedimentation of the stream, flooding, and property damage. Riparian vegetation allows stream banks to build, thus increasing their capacity to handle high flows.

Streambanks can be protected with both passive and active interventions. The IRWM Plan will prioritize streams where interventions will result in the greatest benefits. For the most part, streambank protection throughout the watershed will depend upon Best Management Practices. Active interventions such as bank stabilization with rip-rap, hand planting of vegetation, and fortifying or establishing levies or dikes will be recommended only for the most degraded areas or sites. Passive interventions to restore riparian vegetation include controlled grazing such as fencing; agriculture and development setbacks; and improved seasonal stream flows through flow management. Passive restoration is less costly than active interventions.

Objective #4: Stream Temperature Improvement

Stream restoration projects proposed in the Monterey Strategy and the Plumas National Forest Plan will contribute significantly to the lowering of stream water temperatures in the late summer. These projects propose to restore the riparian vegetation along the streams to provide shading, which lowers water temperatures However, additional temperature modification over longer stream reaches can be achieved with reservoir bottom withdrawals of cooler water from State Water Projects in the Middle Fork. Some of the mandatory plans address the issue of water temperature and fisheries habitat in the North Fork, especially as they relate to FERC requirements for Pacific Gas & Electric hydrologic projects. The conditions affecting stream temperature and its effects on salmonid spawning, rearing, and passage in the Middle Fork are similar to the North Fork. However, solutions to the temperature problems will be different in the two basins.

Objective #5: Agriculture NPS Waiver Program

In 2004 a new agricultural waiver was adopted (replacing the 1983 waiver) by the State of California to address water quality problems in irrigated agricultural areas. The waiver gives the Regional Water Quality Control Board (RWQCB) authority to regulate discharges of waste resulting from agricultural lands that could impact water bodies, including groundwater. Agricultural pollutants such as excessive nutrients, animal waste, sediments, and pesticides enter waters by direct runoff or seepage to groundwater. These pollutants affect aquatic habitat by causing temperature increases, toxicity, and decreased oxygen, among others (SWRCB 2005). There are acceptable and efficient methods to treat agricultural waste discharge such as restoring riparian buffer zones, depending upon the site conditions and intervention needed. Discharge problems can also be addressed by putting wetlands back into service. Because crop yields are often marginal on former wetlands, it makes sense for farmers to offer these lands for restoration. The 2002 US Farm Bill offers landowners the opportunity to set aside and restore former wetlands, through initiatives such as the Wetland Reserve Program.

Objective #6: Wetland Wastewater Treatment

Restoration or wetlands or use of existing wetlands to meet IRWM Plan goals will be an important objective. Wetlands of various sizes and at different locations in the Upper Feather River watershed play complementary roles in moderating or preventing floods, because small wetlands high in the watershed can reduce and delay flood peaks by temporarily storing water, while large wetlands downstream can be managed to reduce peak flood levels. The ability of small, widely distributed wetlands to abate flooding depends on the amount of storage relative to the volume of floodwater, as well as the wetland's capacity for evapotranspiration loss and infiltration.

Wetlands are currently used to receive treated wastewater from urban areas in the watershed. Generally, treated wastewater is used as an irrigation source on adjacent pasturelands. As communities grow and NPDES permit standards become more restrictive, wetlands will be an essential method for treating urban wastewater throughout the watershed as an alternative to pastureland irrigation. Wetlands will be used to remove contaminants, adsorb metals, and reduce suspended sediments and turbidity in receiving waters. Not only is wetland treatment a least cost alternative to expanding wastewater needs, side benefits include reduction in sediment loading from runoff, flood control and stormwater management, increase in wildlife habitat, and potential groundwater recharge.

Objective #7: Road Rehabilitation or Closure

Degraded and poorly designed roads in the higher elevations and upper reaches of the watershed are a major contributor to the total sediment loads in watershed streams. The Plumas National Forest has been closing and revegetating roads throughout the Forest for many years. Using the Plumas National Forest methods as an example, other roads on non-federal lands can also be closed and rehabilitated. Closing and decommissioning badly eroded roads throughout the watershed will meet IRWM water quality goals and provide multiple benefits at a low cost.

Objective #8: Groundwater Recharge and Extraction Balance

Drought conditions and increased competition for surface water has led to limited groundwater development for irrigation in the watershed. Groundwater supplies are generally reliable in areas that have sufficient aquifer storage or where surface water replenishes the aquifer. However, groundwater basins where land uses have reduced the soil capacity for infiltration and where pumping exceeds recharge, experience major problems with balancing groundwater recharge and extraction. In most cases, these problems can be reversed with Best Management Practices for grazing, irrigation, and cropping. The most "at-risk" groundwater basin is Sierra Valley. A thorough understanding of the interaction between surface and groundwater is necessary, especially since the hydrology of the Sierra Valley is intimately tied to the Middle Fork hydrology. The methods of recharge and the rate at which recharge occurs in Sierra Valley will determine which BMPs will have the greatest effect.

Objective #9: Grazing Management

The FRCRM develops grazing management plans in conjunction with restoration projects.. In those restoration projects requiring improved grazing, the rancher works with the restoration team to derive an acceptable and suitable grazing plan.

Grazing can be improved with strategies that allow grazing in restored riparian systems, but on a rest-rotation basis to allow the recruitment (new growth) of riparian vegetation. These grazing management strategies almost always result in an improved forage base and weightier livestock. The effects of upland grazing can be mitigated with dispersed watering areas using water tanks, development of springs and seeps, or solar-powered windmills. The most feasible watering systems will depend upon cost and availability of water supplies. In order to manage grazing and stock movement, ranchers need fences as the primary management tool. Fencing will be required to control grazing in designated riparian pastures.

Agricultural setbacks from riparian zones are also important to not only protect riparian vegetation, but lessen sediment runoff and bank erosion. Riparian vegetation acts as a buffer to trap sediments from field runoff before sediments reach the stream channel.

Objective #10: Instream and Riparian/Wetland Habitat

The Upper Feather River Watershed includes several SWP reservoirs that control water releases, and thus, stream flow. SWP reservoirs are primarily intended to provide recreational and/or agriculture water supplies. Instream flow management involves evaluating the timing of flow releases in order to develop a coordinated release schedule that meets irrigation demands as well as the flow needs to establish and maintain riparian vegetation and minimum stream flows. The objective of the IRWM Plan is to manage instream flows to promote vegetation recruitment in riparian areas and wetlands.

The recruitment of new riparian vegetation (germination and sprouting) and maintenance of young and mature vegetation requires out of channel flows at least every two to three years. Out of channel flows are naturally high flows generally associated with high precipitation months that cause the stream flow to rise and spill over the bank within the riparian zone. These flows occur only two to three days, but provide sufficient water for the germination of new plants and allow the recharge of water tables beneath riparian zones. Out of channel flows can be released intentionally in streams below dams via a coordinated release program and synchronized with seed drop to maximize recruitment of new vegetation. Out of channel flows are of such short duration that agricultural water requirements are not affected.

This instream flow management objective will also identify reservoir release schemes that meet agriculture needs while maintaining some flow in the primary river systems during the dry season. In the initial years, before riparian systems are completely established, dry season flows may not be adequate. However, once riparian vegetation is established throughout most of the stream corridors, reservoir releases will be augmented with water table releases so that year-round flow can be maintained. Reservoir releases are also important in maintaining fish habitat, particularly in the transport of fine sediments, scouring of pools, and cleaning of spawning gravels. Instream flows are also set to meet fish passage criteria for trout as well as anadromous species.

Objective #11: Public Awareness and Stakeholder Input

As the headwaters for the California State Water Project, millions depend on water from the Feather River Watershed for irrigation, drinking water, flood control, recreation, fisheries and energy. However, in order for citizens to take care of and feel a sense of ownership for their watersheds, they must first know something about them. The more people learn and understand, the more they will recognize the value of restoration and, ultimately, make choices that reduce negative impacts on the watershed and create the need for restorative work in the first place.

Approximately three years ago, the FRCRM established an Education Committee to reach out to interested citizens, community members, and school groups. That effort resulted in 1) completing a survey of watershed education needs and recommended action steps for advancing watershed education in Plumas County, and 2) securing funding for two part-time education and citizen monitoring coordinators. With needs identified and three part-time coordinators (two contracted with FRCRM and one with Sierra Valley Resource Conservation District) working on education efforts, the foundation is now laid to accomplish additional tasks that support watershed education in the Feather River area.

The Monterey Strategy supports educational and innovative projects and this objective is shared in the IRWM Plan. The *Feather River Watershed Public Awareness Campaign* is a concerted effort to bring water quality and watershed-related information into the homes and minds of residents of the Feather River Watershed. By engaging landowners, educators, students and community members in multiple formats for learning about watershed issues, improved understanding and increased participation in stewardship activities will result over time.

Objective #12: Monitoring and Adaptive Management

The essential idea of adaptive management is to recognize explicitly that management policies can be applied as experimental treatments. A crucial implication of this thesis is that monitoring activities must be integrated with management actions. Under adaptive management, monitoring is not the last chapter of a conservation plan; rather, monitoring and conservation plans are developed concurrently to form a single adaptive-management plan.

To realistically manage the dynamics of watershed ecosystems means we must adapt objectives[1] to changes overtime that cannot be predicted or even adequately anticipated today. Adaptive management is the singular comprehensive approach for managing the ecosystem in order to reach the desired goals of a healthy and functional watershed. It also means adopting new tools and approaches from scientific advances over the course of the restoration process to constantly improve our understanding of ecology and the effects of management actions.

Passive Adaptive Management

Adaptive management comes in two varieties, passive and active. Passive adaptive management has been confused with trial-and-error approaches. As originally conceived, passive adaptive management is a scientifically rigorous process of formulating predictive models, making policy decisions based on those models, and revising the models as monitoring data become available (Figure 2.9). The model is used to estimate and predict ecosystem responses to management actions.

Monitoring and evaluation systems must be in place before management commences, but monitoring is done without controls, replication, or randomization – the three essential aspects of statistically valid experimental design. Consequently, passive adaptive management has a flaw: it cannot establish cause-and-effect relationships between management actions and changes in ecosystem conditions. Without controls, replication, and randomization, managers often cannot determine whether the observed responses are caused by the management action, by some other activity, or by some "natural" process. The advantages to passive adaptive management are that it is relatively simple and cheap.

Active Adaptive Management

Under active adaptive management, management actions are conducted as a deliberate experiment (Figure 2.10). Alternatives policies are viewed as treatments and are implemented through statistically valid experimental design.

[1] Goals define what is to be attained; objectives are how goals are attained.

Monitoring is the data-collection step of the experiment. Active adaptive management can establish cause-and-effect relationships between management actions and changes in ecological conditions. Active adaptive management leads to a better understanding of how and why natural systems respond to management. Active adaptive management has another advantage over the passive approach: responses to a range of treatments can point the way toward an optimal policy. The disadvantages of active adaptive management are that it is more complex and more expensive.

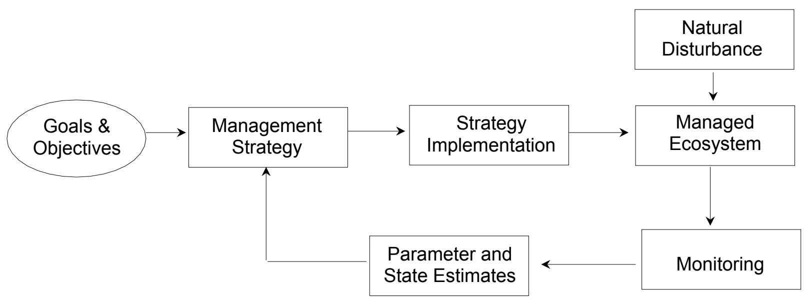


Figure 2.9 Passive Adaptive Management

Block diagram of passive adaptive management, which is natural resource management conducted as trail and error. Passive adaptive management cannot establish cause and effect relationships between management activities and changes in ecological condition.

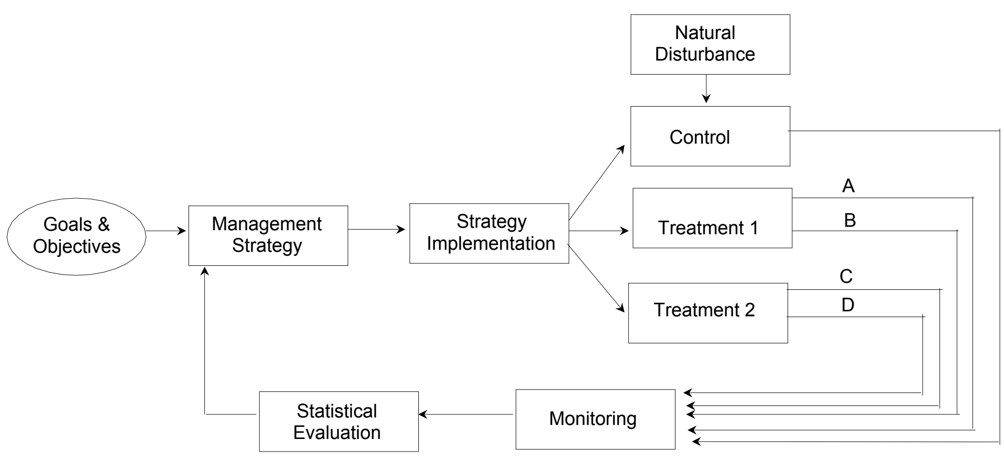
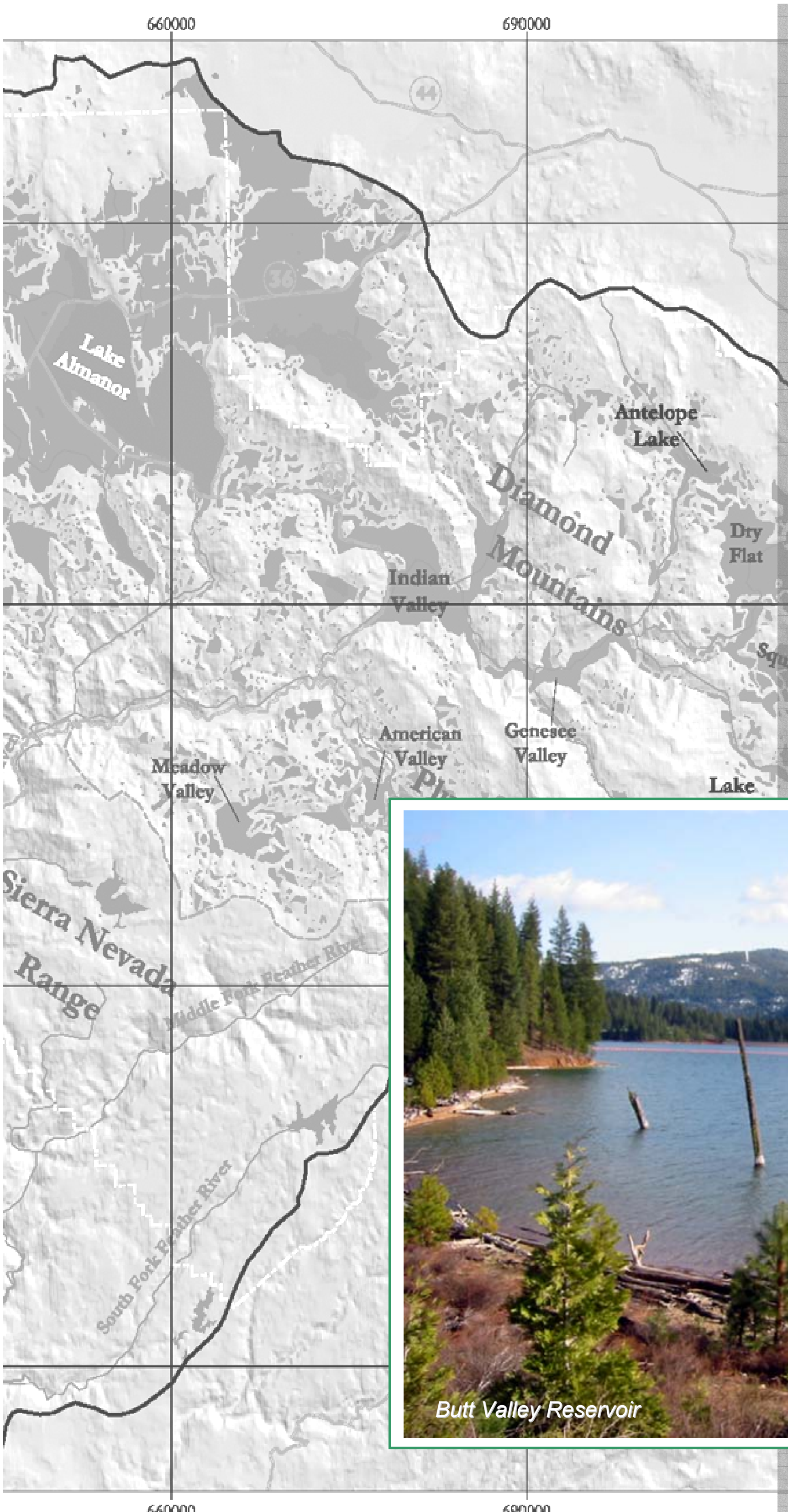


Figure 2.10 Active Adaptive Management

Block diagram of active adaptive management, which is natural resource management conducted as an experiment. Cause and effect are established through statistical measurement. Ideally, treatments and control are replicated and stratified randomly. Natural disturbances affect treatments and control.

CHAPTER 3

Planning Process



Butt Valley Reservoir

3.0 Planning Process

Watershed management initiatives in the Upper Feather River Watershed such as FRCRM provide the foundation for large scale water management and planning. The IRWM planning process in the watershed began with localized planning some twenty-five years ago, which resulted in the creation of the seven mandatory plans (Chapter 1). These seven plans provide the foundation upon which the IRWM planning process is based.

3.1 Public Involvement

The foundation for the IRWM Plan is based on a long history of collaboration in the Upper Feather River Watershed. Partnerships among numerous watershed resource management entities have included federal and state agencies, conservation groups, and county and municipal departments. The effectiveness of these partnerships provides a strong foundation for the IRWM Plan to achieve success. The IRWM Plan is built upon the seven mandatory plans, which included public and/or stakeholder involvement as an integral part of the planning process (see the plans in the Volume II for documentation of public involvement).

Plumas County has suggested that all efforts to include potential stakeholders in the IRWM process have been made. However, potential obstacles to IRWM implementation exist, especially from private landowners, municipalities, and private corporations who may not feel direct and immediate benefits from implementation actions. Many participants in the IRWM process have been forced to address such issues in the past, and success has usually been achieved. Solutions to such obstacles will continue to be pursued under the IRWM Plan. One obstacle that has been overcome in the IRWM planning process is the inclusion of the Sierra Valley Groundwater Management District (SVGMD). Sierra Valley had not been included in previous planning efforts, but has become a statutory partner and an integral part of the IRWM process. The inclusion of stakeholders representing various interests in the planning process makes the IRWM planning process more dynamic and will make the IRWM Plan a more effective planning document.

The communities in the Upper Feather River Watershed qualify as disadvantaged due to high unemployment numbers. The unemployment rate in Plumas County is the highest rate in the region and can be attributed to the recession in the timber industry (Plumas County Vision 2020 Report). The IRWM Plan regards the entire Upper Feather River Watershed as a disadvantaged community in need of environmental, economic, and social justice. The IRWM Plan seeks to restore ecological balance in the Upper Feather River Watershed and address and resolve existing environmental justice issues.

3.2 Coordination Infrastructure

Coordination between state and federal agencies and other local entities (e.g. schools, non-profit organizations, cities, service districts, RCDs) in the Upper Feather River Watershed has a long history of success. That success is due primarily to an existing infrastructure that allows for open communication between often diverse and competing groups. This established coordination infrastructure enables participants to create innovative and successful approaches to resource conservation and watershed management. Within the Upper Feather River Watershed the coordination infrastructure centers around three organizations; the Feather River Watershed Authority, which is administering the Integrated Regional Water Management Plan (IRWM Plan); the Feather River Coordinated Resource Management (FRCRM) Group; and the Plumas Watershed Forum, which was established by the Monterey Settlement (Figure 3.1 - Diagram of Existing Coordination Structure). These three entities are discussed in detail below. The representation by these watershed management organizations allows a broad and diverse assemblage of agencies to coordinate and implement management strategies that not only benefit the watershed but also benefit numerous groups.

Several state and federal agencies are represented in the Feather River Watershed Authority, the FRCRM Group, and the Plumas Watershed Forum, which makes coordination in the Upper Feather River

Watershed unique, innovative, and effective. The following local, state, and federal agencies are currently involved in one or more of the three existing coordination organizations in the Upper Feather River Watershed: California Department of Fish and Game (CDFG), California Department of Water Resources (DWR), Plumas National Forest, Plumas County, Plumas County Flood Control and Water Conservation District (PCFC) Butte County, SVGMD, U.S. Fish and Wildlife Service, and the U.S. Army Corp of Engineers. Of these entities, Plumas County, PCFC, Plumas National Forest, Butte County, and SVGMD have statutory authority. The coordination success in the Upper Feather River Watershed can be attributed to the fact that a vast majority of the land area in the watershed is managed by the decision makers with statutory authority who are involved in every step of the decision making process.

Coordination in the Upper Feather River Watershed centers around one federal agency, Plumas national Forest, one local government, Plumas County, and one resource management group, the Feather River CRM, which incorporates several agencies, governments and local groups.

The Plumas National Forest, which comprises roughly 50% of the land area in the watershed, is a member of the three coordination entities mentioned above, and a partner agency for the IRWM Plan (see Figure 3.1 - Diagram of Existing Coordination Structure). PNF main restoration efforts in the watershed include closing and restoring roads, as well as, meadow and stream restoration efforts. PNF has implemented many successful stream and meadow restoration projects such as the Freeman, Stone, Dairy, Robinson and Crocker projects. PNF has proven capacity to implement successful restoration efforts.

Plumas County is also a member of the three coordination entities, and is a logical lead in this watershed planning process as nearly 72% of the Upper Feather River Watershed is located within the county (100% of Plumas County is located within the Upper Feather River Watershed). The FRCRM group, which incorporates a broad assemblage of agencies, non-profit organizations, schools, and other groups, is also a member of the three coordination organizations. The FRCRM coordinates with these groups to make informed watershed management decisions and communicates their findings with the Plumas National Forest and Plumas County.

Several state and federal agencies are currently undertaking coordinated projects in the Upper Feather River Watershed (road closings and obliterations on NF land, meadow restoration done by the FRCRM, and upland vegetation management through the QLG). It is important that this coordinated approach continue in the future. Maintaining state and federal agency involvement in the Feather River Watershed Authority, the FRCRM, and the Plumas Watershed Forum is important to the IRWM Plan implementation process. It is also important that regulatory agencies, whose involvement is required for implementation, remain active within the three coordination organizations.

The Feather River Watershed Authority

The Feather River Watershed Authority is responsible for the creation of the IRWM Plan. The Watershed Authority contracted with the Ecosystem Sciences Foundation (ESF) to write the IRWM Plan. The Watershed Authority provided a scope of work, general data and the mandatory plans that are used to write the IRWM Plan to ESF. ESF then wrote the plan with significant input from the Feather River Watershed Authority. The Feather River Watershed Authority incorporates several groups of which Plumas County is the lead agency, with Plumas National Forest, SVGMD, and PCFC as partner agencies. Each of these entities has statutory authority in the Upper Feather River Watershed. Affiliated entities of the Feather River Watershed Authority are: Butte County, City of Portola, Indian Valley Community Services District, Quincy Community Services District, Maidu Cultural and Development Group, FRCRM, Feather River Land Trust, Sierra Institute, and University of California at Davis. Affiliated agencies provide comments on issues regarding their land holdings, provide data for informed management decisions, and bring watershed conservation projects to the Watershed Authority.

Plumas Watershed Forum

The Plumas Watershed Forum was created as a result of the Monterey Settlement to manage monies allocated to Plumas County for watershed improvement and restoration projects. The Plumas Watershed Forum has no direct effect on the IRWM Plan other than providing comments and feedback from its members. The overlap of members between the Feather River Watershed Authority and the Plumas Watershed Forum insures that the IRWM

Plan in not written in a vacuum and that many entities have a say its creation. The following entities constitute the Plumas Watershed Forum: Plumas County, DWR, and the California State Water (SWP) contractors. A Technical Advisory Committee assists the Plumas Watershed Forum by identifying actions and projects that will provide the greatest benefit for the monies available from the Monterey Settlement. The Technical Advisory Committee consists of individuals from the following groups: Plumas National Forest, SVGMD, Sierra Valley Resource Conservation District, FRCRM, University of California Cooperative Extension, CDFG, Feather River Resource Conservation District, Maidu Cultural and Development Group, the Central Valley Regional Water Quality Control Board, Natural Resources Conservation Service, and Sierra County.

Feather River Coordinated Resource Management Group

The FRCRM was involved in the planning efforts for the seven mandatory plans and is perhaps the most successful planning entity in the watershed, and thus has had a significant impact on the IRWM Plan. The Feather River Coordinated Resources Management Memorandum of Understanding (MOU) documents the legal and procedural history of that group (see Chapter 1). The FRCRM was developed to encourage local initiative and participation in resource management issues and to coordinate requests for federal and state technical and financial assistance for watershed improvement and restoration projects in the watershed. Representatives of 21 organizations including resource management and regulatory agencies, local technical experts, local government officials, and an association of private land owners serve on the steering committee, project technical assistance committees, and management committees. In addition to the agencies that have signed the MOU, numerous other county agencies, private consultants, community groups, and students have worked together on FRCRM projects. The FRCRM consists of the following entities: Plumas County, Plumas National Forest, California Department of Forestry and Fire Protection, CDFG, DWR, Central Valley Regional Water Quality Control Board, Feather River College, North Cal-Neva Resources Conservation and Development District, Plumas Unified School District, Natural Resources Conservation Service, U.S. Army Corp of Engineers, U.S. Fish and Wildlife Service, California Department of Transportation, California Department of Parks and Recreation, Plumas County Community Development Commission, U.C. Cooperative Extension, Feather River Resource Conservation District, Salmonid Restoration Federation, Plumas Corporation, USDA Farm Services Agency, and Trout Unlimited.

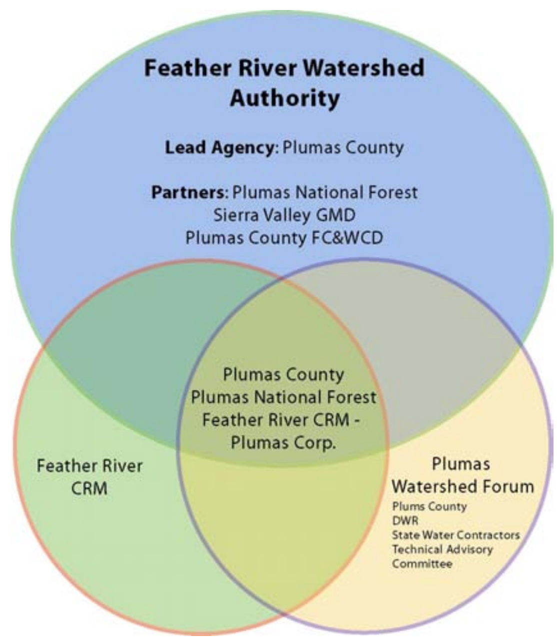
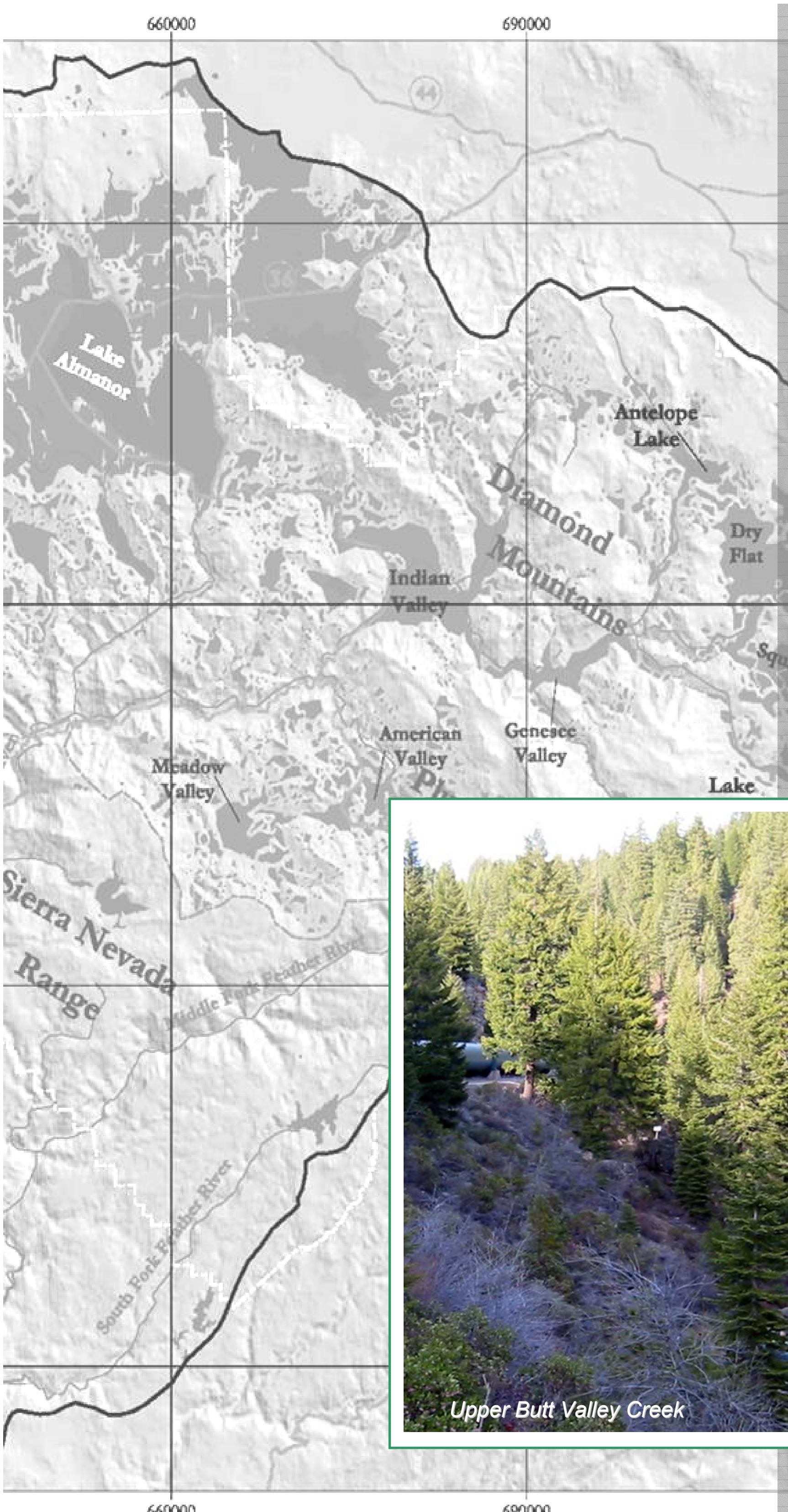


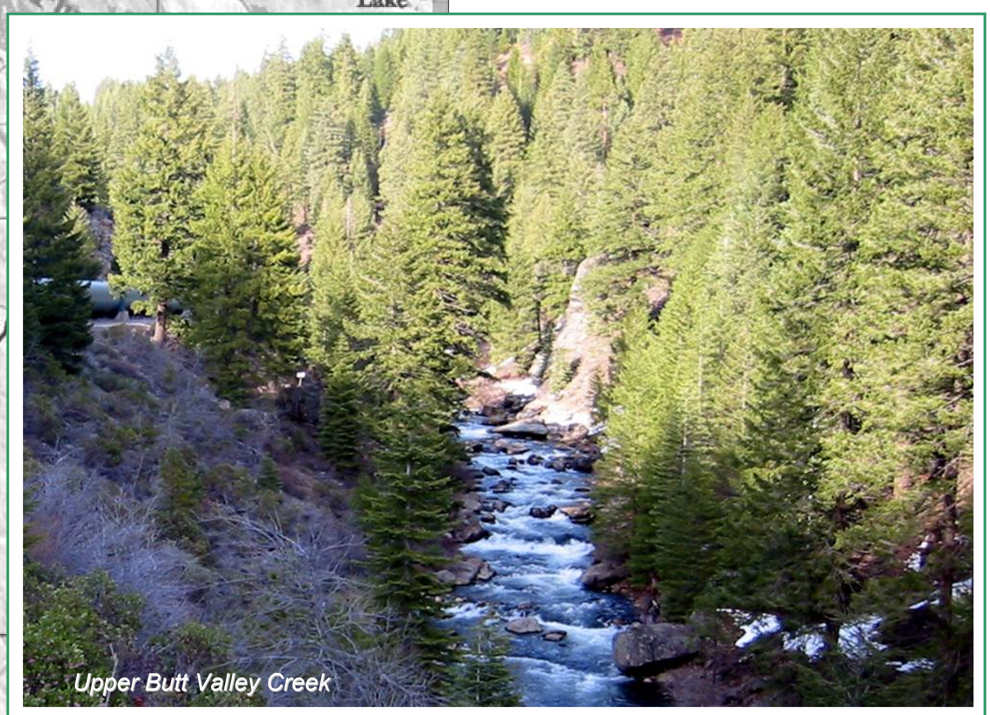
Figure3.1 Diagram of Existing Coordination Structure

The Feather River Watershed Authority is responsible for the creation of the IRWM Plan. The Feather River Watershed Authority incorporates several groups of which Plumas County is the lead agency.



CHAPTER 4

Watershed Resources



Upper Butt Valley Creek

4.0 Watershed Resources

Overview

The Feather River Watershed is located in California's northern Sierra Nevada and encompasses a broad variety of terrain, climate, historic use, and flora and fauna. It encompasses 3,500 square miles of land originating east of the Sierra Crest and draining westward into the Sacramento River. Elevations range from 2,250 to over 10,000 feet, and annual precipitation varies broadly from more than 70 inches on the wet western slopes to less that 12 inches on the arid east side. Vegetation is diverse and ranges from productive mixed conifer and deciduous forests in the west to sparse sage/yellow pine plant communities in the east. The Plumas National Forest manages roughly 50% percent of the watershed, while alluvial valleys are predominantly privately owned with the dominant land use being livestock grazing.

The Feather River Watershed has long been recognized for its recreational and aesthetic values. An abundance of montane rivers, lakes and reservoirs comprise the landscape, creating both summer and winter recreational opportunities. Water originating from these drainages also represents a significant component of the State Water Project (SWP) and provides high quality water for hydro generation, agriculture, industry, and drinking supplies for municipalities in the south. The Feather River Watershed is impacted by 140 years of intense human use. Past mining, grazing and timber harvest practices, wildfire, and railroad and road construction have contributed to the degradation of over 60 percent of the watershed, resulting in accelerated erosion, degraded water quality, decreased vegetation and soil productivity, and degraded terrestrial and aquatic habitats. Annually, 1.1 million tons of sediment is delivered to Rock Creek Dam at the downstream end of the East Branch North Fork Feather River (EBNFFR), of which 80 percent is attributable to anthropogenic activities. Long-term vegetation disturbance and consequent gully erosion has led to a dramatic change in hydrology, leading to reduced summer flow, higher summer water temperature, lower water tables, reduced meadow storage capacity, and a trend from perennial to intermittent flows. Many downcut streams no longer sustain late-season flow, causing adverse consequences to riparian and upland vegetation, aquatic communities, and downstream water users.

The Feather River drains from its headwaters in the Sierra Nevada Range into Lake Oroville, the largest water storage facility in the SWP system. Lake Oroville has a water storage capacity of four million acre feet and generates an average of 3.2 million acre feet of “firm” annual water supplies to both agricultural and urban State Water Contractors; largely through export pumping from the San Francisco Bay Delta. The North Fork of the Feather River powers PG&E’s fabled “Stairstep of Power”, a complex of four powerhouses, seven dams and four tunnels. The Middle Fork of the Feather River courses through the largest valley in the watershed, Sierra Valley, and then descends into the Middle Fork Canyon, of which 78 miles are wild and scenic, before flowing into Lake Oroville.

Within, the 2.2 million acre Upper Feather River Watershed, the land ownership is 64% Federal (primarily National Forest), 1% State and public lands, and 35% private.

Plumas County, located “in the heart of Feather River Country”, comprises 72% of the Upper Feather River Watershed. Neighboring Butte, Sierra, Lassen, Shasta, Tehama, and Yuba counties comprise 14.9%, 7%, 4.5%, 0.5%, 0.04%, and 0.06% respectively of the 3,500 square mile watershed. Land ownership in Plumas County, which constitutes the majority of the land area within the watershed, is approximately 64% National Forest, 1% State lands, 1% National Park, 5% residential, and 29% resource extraction (agriculture and private lumber).[1]

Natural resource management continues to define the Plumas County economy. New recreational housing developments and recreation and retirement based services and activities are replacing the traditional logging, grazing, hunting and fishing economies of the 1980s. Mercury pollution in the Feather River drainage is legacy pollution from the gold rush era of the 1850s. Excessive sedimentation and stream channel instability of watershed streams were mainly caused during the peak of unregulated grazing, logging, water diversions, and road building era of the 1900s. Water quality problems associated with unstable and dewatered streams persist today. As

[1] PHCG 2000

local land uses change, water use conflicts intensify between old and new uses.

Plumas County is also greatly affected by state and federal land and water policies, uses, and conflicts, given the dominant federal land tenure and its history of massive water supply and hydroelectric developments. Current hydroelectric operations are regulated by the FERC, and future operations of both PG&E's and DWR's hydroelectric dams and diversions are currently undergoing review in four discrete but inter-related relicensing proceedings before the FERC (FERC#2100, FERC#2107, FERC#2105, and FERC#1962).

The following sections on watershed resources and associated watershed maps and tables describe the region in more detail. Sections 4.1 through 4.8 contain information on the major water related infrastructure, land use divisions, lakes, rivers and reservoirs, water quantity and quality information, special status ecological and environmental resources, cultural and social characteristics, and economic conditions and trends in the region.

4.1 Geology

The geology of the Feather River Watershed is unique amongst Sierran streams. Most Sierran streams originate near the crest of the range and flow in a west or southwest direction. The Feather River flows west of the Sierra Crest as it cascades toward the Central Valley, but its headwaters do not originate near the crest. Instead, the Feather River's two main branches, the North and Middle Forks, originate east of the range and are the only Sierran streams to breach the crest. The headwaters of the North Fork flow off the south side of Mount Lassen in the north, and flow off of the western flank of the crest of the Diamond Mountains to the east. The Middle Fork's headwaters flow from the Frenchman Lake area and Sierra Valley in the southeast portion of the watershed. The North Fork flows southwest and then south into Lake Oroville, and the Middle Fork flows west and then southwest through the Sierra Crest into the same reservoir. This geologic division gives the Feather River Watershed a distinct geologic and hydrologic east and west side.

The Diamond Mountains comprise the east side of the Feather River Watershed and include the country north of Sierra Valley as far as State Highway 36, west to near Quincy, and east to near Honey Lake. The mountains, akin to the ranges of the Great Basin, are formed by a series of northwesterly to north-northwesterly tilted fault blocks. These faults create a series of parallel-lying elongated valleys separated by low elevation ridges. Mesozoic granitic rocks predominate this section. Many of the valleys once contained lakes that have become extinct only recently in geologic time. Today, these valleys contain a vast alluvial meadow system that serves as the headwaters of the Feather River.

The Diamond Mountains and Sierra Nevada Range are structurally separated by the Plumas Trench, a low strip of land extending from Sierra Valley to American Valley.[2] In geologic terms the Plumas Trench is an elongated northwesterly trending graben.[3] Strongly folded basement rocks underlie this area. West of the Plumas Trench is the northern Sierra Nevada Range and the western portion of the Feather River Watershed.

East of the Plumas Trench is Sierra Valley, a block-faulted part of the Sierra Nevada. Sierra Valley is an ancient lakebed dominated by quaternary lacustrine and alluvial deposits. Just north of Sierra Valley at the southeast side of the Diamond Mountains, is an area of mostly tertiary volcanic terrain. Miocene andesite and pyroclastic rocks dominate this section.

The crest of the Sierra Nevada divides the watershed and follows the steep scarps above Sierra Valley, Mohawk Valley, American Valley, and Meadow Valley. Beyond the North Fork of the Feather River the Sierran crest turns to the north, forming the northwestern boundary of the watershed, and terminating at a poorly defined point west of Lake Almanor. This area northwest of Lake Almanor is the end of the great spine of the Sierra Nevada, and marks the beginning of the Cascade Range.

[2] Durrell 1987
[3] Durrell 1977

Figure 4.2. Feather River West Side Valley
V-shaped valley characteristic of the West side of the Upper Feather River Watershed. Upper Butt Valley Creek.

Table 4.3. Feather River East Side Valley
U-shaped, broad alluvial-lacustrine valley characteristic of the East side of the Upper Feather River Watershed. Indian Creek.

The western portion of the Feather River Watershed is distinctly different from the east. Most streams of the east side flow through wide alluvial valleys (see Figure 4.4 Map of Alluvial Valleys), while the streams of the west flow through steep V-shaped canyons (see Figures 4.2 and 4.3). The reason for the difference is the geologic configuration of the Sierra Nevada and the weather patterns it creates. The Sierra Nevada is a block of the earth's crust about 400-miles long, consisting mostly of granitic plutons that have been uplifted and tilted westward.[4] Dividing the canyons are plateau-like areas with gentle relief in contrast to the steep walls of the V-shaped canyons. These areas are predominantly Mesozoic granitic rock and Jurassic-Triassic metavolcanic rock.

4.2 Hydrogeology and Groundwater

A groundwater basin is defined as an area underlain by permeable materials capable of furnishing a significant supply of groundwater to wells or storing a significant amount of water. A groundwater basin is three-dimensional and includes both the surface extent and all of the subsurface fresh water yielding material. It is in these groundwater basins that the majority of the Feather River Watershed's groundwater resources are contained. These sub-surface reservoirs, along with the surface waters (streams, rivers, lakes and reservoirs) comprise the water resources of the Feather River Watershed.

Groundwater basins are three dimensional underground storage areas that are expensive to measure and difficult to accurately describe. Therefore the maps and acreages used in this document refer to the surface area located above the basins (note: for further information on groundwater basins refer to California Department of Water Resources Bulletin 118).

Due to the steep V-shaped canyons of the western slopes of the Sierra Nevada, there are no large groundwater basins west of the crest. Near Lake Oroville, the Sacramento Valley Eastside Groundwater Basin marks the edge of the large underground storage reservoirs contained under the Sacramento Valley. The alluvial valleys of the east-side sub-watersheds allow water to percolate into several subsurface reservoirs. The North Fork of the Feather River drains the majority of the area east of the Sierra Crest. Consequently, this watershed contains many groundwater basins, which comprise a large proportion of the groundwater resources of the Feather River Watershed. The Middle Fork contains the largest groundwater basin, the Sierra Valley Groundwater Basin.[5]

The California Department of Water Resources recognizes 15 groundwater basins within the Feather River Watershed (see Table 4.1 of groundwater basins and Figure 4.5 map of groundwater basins).

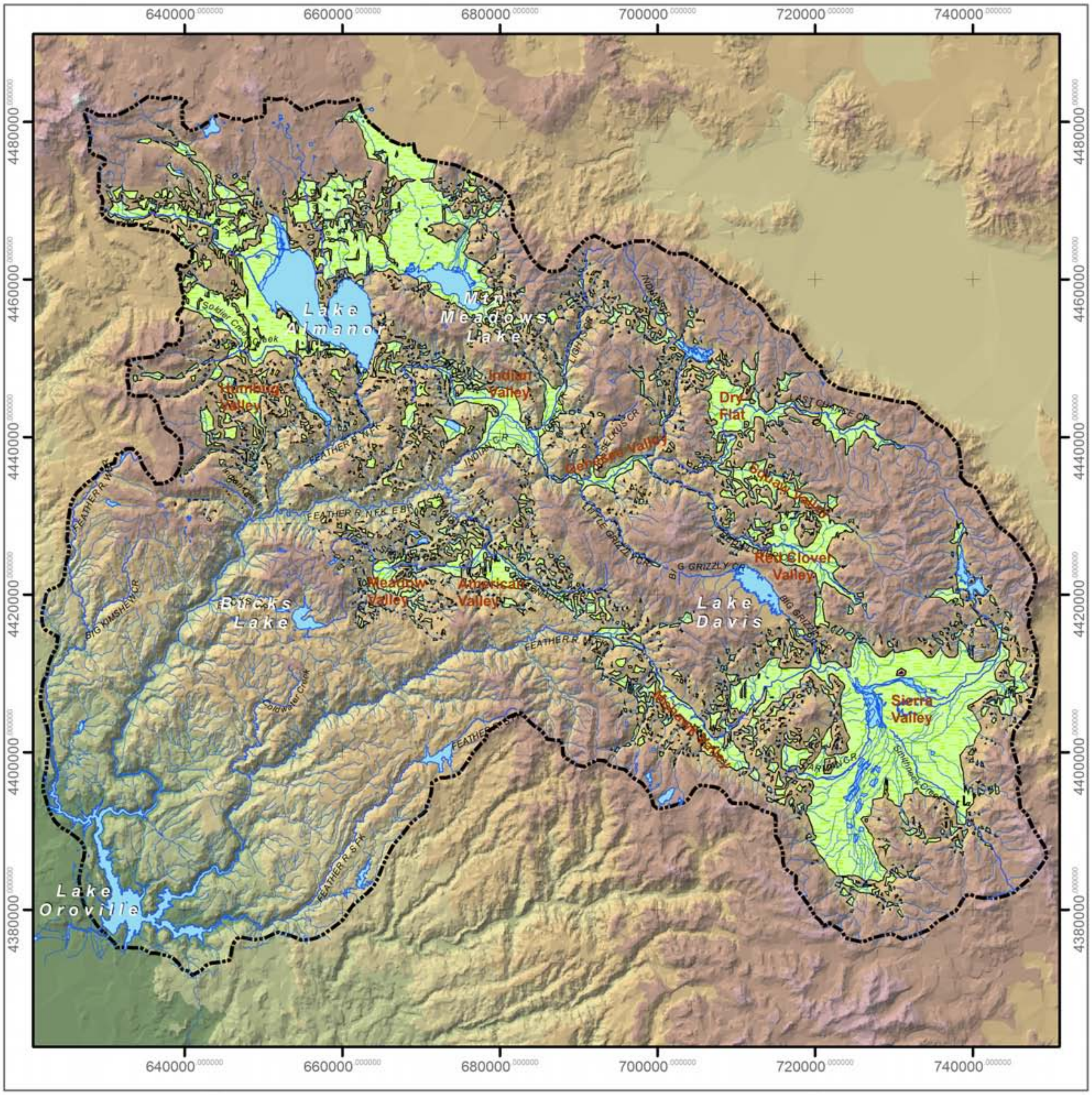
[4] Durrell 1987

[5] SVGMD 1980

The largest groundwater basin, Sierra Valley, has two sub-basins. The Modoc Plateau Pleistocene Volcanic Area Groundwater Basin appears to have two sub-basins located southeast of Mt. Lassen and north of Lake Almanor. This basin is recognized by DWR, but has not yet been described. For each of the groundwater basins (with the exception of the Modoc), the extent, size, location, basic geology, management activities, and other pertinent information are described below (the active monitoring efforts are also found in Table 4.1).

Basin	Agency	Parameter	Number of Wells and Sampling Frequency
Lake Almanor	DWR	Groundwater levels	10 wells semi-annually
	DWR	Miscellaneous water quality	4 wells biennially
	Dept. of Health Services	Miscellaneous water quality	4
Meadow Valley	Dept. of Health Services	Miscellaneous water quality	1
Indian Valley	DWR	Miscellaneous water quality	4 wells biennially
	Dept. of Health Services	Miscellaneous water quality	9
Middle Fork	None	None	None
Humbug Valley	Dept. of Health Services	Miscellaneous water quality	8
Grizzly Valley	Dept. of Health Services	Miscellaneous water quality	1
Clover Valley	None	None	None
Last Chance Creek Valley	None	None	None
Yellow Creek Valley	None	None	None
Sierra Valley	DWR	Groundwater levels	34 wells semi-annually
	DWR	Miscellaneous water quality	15 wells biennially
	Dept. of Health Services	Miscellaneous water quality	9
Long Valley	DWR	Groundwater levels	31 wells semi-annually
	DWR	Miscellaneous water quality	4 wells bi-yearly
Mohawk Valley	DWR	Groundwater levels	1 well semi-annually
	DWR	Miscellaneous water quality	2 wells biennially
	Dept. of Health Services	Miscellaneous water quality	15
American Valley	DWR	Miscellaneous water quality	4 wells bi-yearly
	Dept. of Health Services	Miscellaneous water quality	11
Modoc Plateau Pleistocene Volcanic Area	None	None	None

Table 4.1: Groundwater Basins of the Feather River Watershed and Known Monitoring Efforts.

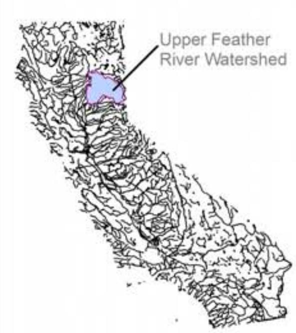


Legend

- Streams
- Lakes and reservoirs
- Rivers
- Alluvial Valleys

FIGURE 4.4

UPPER FEATHER RIVER WATERSHED ALLUVIAL VALLEYS



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Watershed base map depicting alluvial valleys in the watershed.

GIS Metadata Information
Alluvial and lacustrine valleys were derived by querying data (DEM) for areas less than or equal to 6% slope. Landforms less than or equal to 6% slope are classified as gently sloping to flat. Source : Ecosystem Sciences

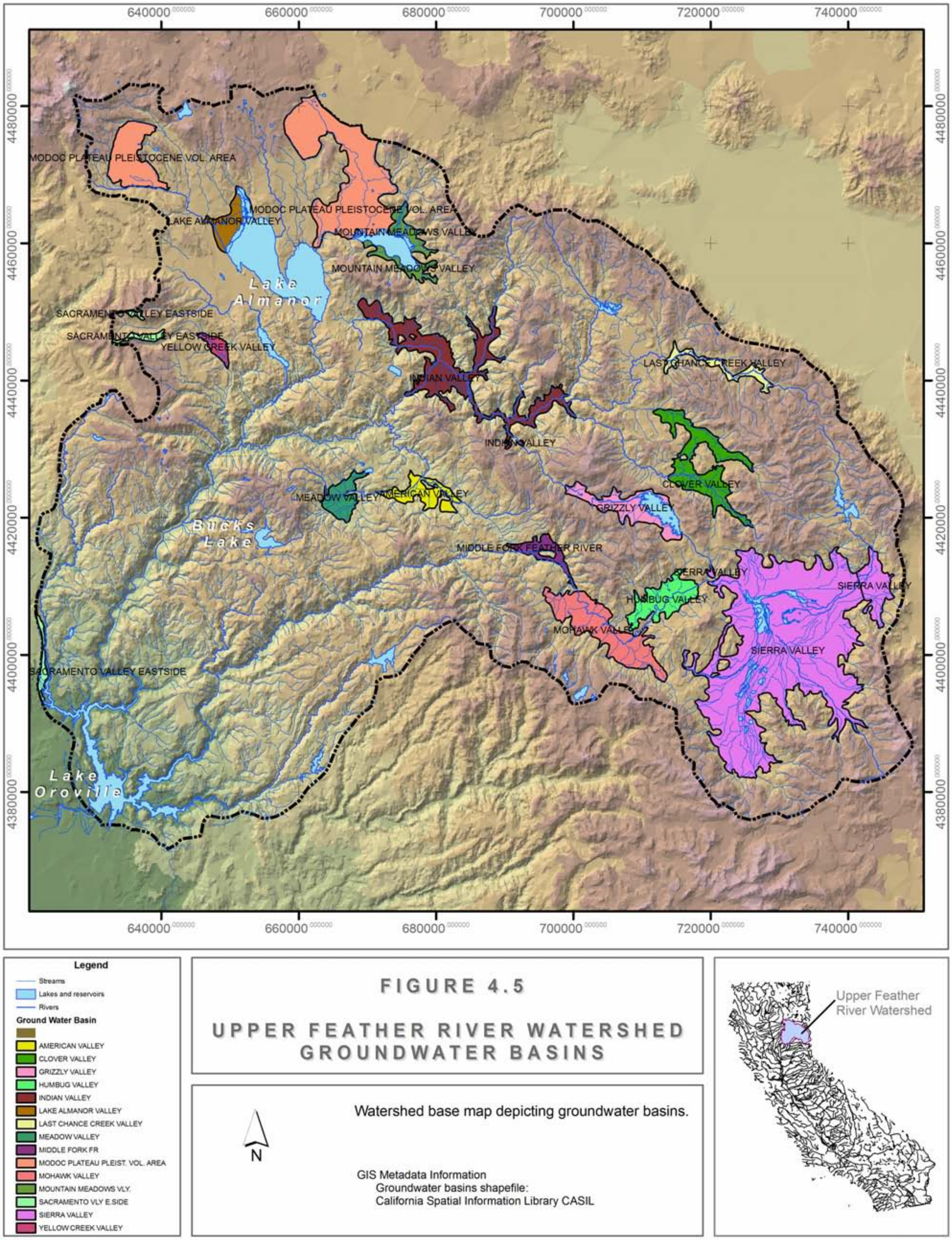


FIGURE 4.5

UPPER FEATHER RIVER WATERSHED GROUNDWATER BASINS

Watershed base map depicting groundwater basins.

GIS Metadata Information
Groundwater basins shapefile:
California Spatial Information Library CASIL

Lake Almanor Valley Groundwater Basin

The Lake Almanor Valley Groundwater Basin covers 7,150 acres along the northwest shore of Lake Almanor. The basin is bounded by Lake Almanor to the southeast and on all other sides by Pliocene basalt. The basin consists of Quaternary lake deposits and Pleistocene non-marine sediments. The California Department of Water Resources (1960) estimates the storage capacity to be 45,000 acre-feet for a saturated depth interval of 10-210 acre-feet. There are no known groundwater management plans, groundwater ordinances, or basin adjudications associated with this groundwater basin.

Mountain Meadows Valley Groundwater Basin

The 8,150 acre Mountain Meadows Valley Groundwater Basin is located to the northeast of Lake Almanor. The basin consists of Quaternary alluvium which encircles Mountain Meadow Reservoir. The basin is bounded to the northeast by Jurassic to Triassic metavolcanic rocks and Tertiary non-marine sediments. The basin is bounded to the southeast by Miocene volcanic rocks and to the northwest by Pleistocene basalt. There are no known groundwater management plans, groundwater ordinances, basin adjudications, or monitoring programs in place.

Meadow Valley Groundwater Basin

This 5,730 acre groundwater basin lies within the Melones Fault Zone of the Sierra Nevada Mountain Range. The basin is bounded on the west by Mesozoic ultrabasic rocks, to the north by Pliocene pyroclastic rocks, and to the east by ultrabasic intrusive rocks and Paleozoic marine sediments.[6] There is no information on groundwater storage or quality for this basin. In addition, there are no known groundwater management plans, groundwater ordinances, or basin adjudications.

Indian Valley Groundwater Basin

This 29,400 acre groundwater basin is an irregularly shaped basin bounded by Paleozoic to Mesozoic marine, volcanic, and metavolcanic rocks. This basin includes Genesee Valley, Indian Valley, and Bucks Valley. The DWR (1960) estimates the storage capacity to be 100,000 acre-feet for a saturated depth interval of 10-210 feet. There is no information about water quality for this basin. In addition, there are no known groundwater management plans, groundwater ordinances, or basin adjudications associated with this groundwater basin.

Middle Fork of the Feather River Groundwater Basin

The Middle Fork of the Feather River Groundwater Basin encompasses 4,340 acres and consists primarily of Quaternary lake and alluvial deposits. This region is dominated by northwest trending faults. One of these faults forms the basin boundary to the east, while the northern and southern boundaries are formed by Pliocene and Miocene volcanic rocks. The eastern boundary is formed by Paleozoic marine deposits.[7] There are no known groundwater management plans, groundwater ordinances, basin adjudications, or monitoring programs in place.

Humbug Valley Groundwater Basin

This 9,980 acre basin is a small, down-dropped area within a horst situated in the Penman Peak-Beckwourth Peak area northeast of Mohawk Valley. The Humbug Valley is approximately six miles long by three miles wide, and is bounded to the north by the volcanic rocks of Penman Peak, to the southeast by Miocene volcanic rocks of Beckworth Peak, and to the northeast by Mesozoic granitic rocks. The floor of the canyon is comprised mainly of level alluvium and gently sloping lake deposits at the western end of the valley. The DWR (1963a) estimates the storage capacity to be 76,000 acre-feet to a depth of 100 feet. There are no known groundwater management plans, groundwater ordinances, or basin adjudications associated with this basin.

Grizzly Valley Groundwater Basin

The Grizzly Valley Groundwater Basin lies within a down-dropped graben bounded to the northeast by Grizzly Valley Fault and to the southwest by a series of northwest trending faults. The basin is bounded to the north by Miocene volcanic rocks and to the south by Paleozoic marine sediments, Mesozoic granitic rocks, recent volcanics, and Tertiary intrusive rocks. Grizzly Creek drains the valley and is a tributary to the Middle Fork Feather River. There are no known groundwater management plans, groundwater

[6] Burnet 1962

[7] Burnett 1962

ordinances, or basin adjudications associated with this basin.

Clover Valley Groundwater Basin

The Clover Valley Groundwater Basin is an irregular shaped basin of 16,780 acres that includes McReynolds Valley, Squaw Valley, Clover Valley, and Wakeynolds Valley. These valleys consist of alluvium deposits and lake sediments. The basin is bounded by Miocene volcanic rocks on the north, east, and south and by recent volcanic and Mesozoic granitic rocks to the west.[8] Dixie Creek and Red Clover Creek drain the southern two-thirds of the basin to the west, and Squaw Queen Creek drains the northern third of the basin to the northeast. There are no known groundwater management plans, groundwater ordinances, basin adjudications, or monitoring programs in place.

Last Chance Creek Valley Groundwater Basin

The Last Chance Valley Groundwater Basin is a narrow east/west trending basin located south of Honey Lake covering 4,660 acres. The basin is bounded to the south by Tertiary pyroclastic rocks and to the north by Miocene volcanics, Mesozoic granitic rocks, and Tertiary pyroclastic rocks. Eocene basalt borders the basin in the west. There are no known groundwater management plans, groundwater ordinances, basin adjudications, or monitoring programs in place.

Yellow Creek Valley Groundwater Basin

The Yellow Creek Groundwater Basin is a 2,310 acre basin located to the southwest of Lake Almanor and consists of Quaternary alluvium. The valley is drained to the south by Yellow Creek. The valley is bounded to the east by Mesozoic and Paleozoic marine sediments, bounded to the north and west by Tertiary volcanic rocks, and to the south by recent volcanic and Paleozoic marine sediments. There are no known groundwater management plans, groundwater ordinances, basin adjudications, or monitoring programs in place.

Sierra Valley Groundwater Basin

The Sierra Valley Groundwater Basin is the largest groundwater basin in the Feather River Watershed ,covering 125,250 acres, or nearly 200 square miles. The Sierra Valley Groundwater Basin is composed of two sub-basins, Chilcoot and Sierra Valley. For further information on Sierra Valley please see Vestra 2005.

Sierra Valley Sub-Basin

The Sierra Valley Sub-basin covers 117,700 acres, the majority of the Sierra Valley Groundwater Basin. Sierra Valley is an irregularly shaped, complexly faulted valley in eastern Plumas and Sierra counties. The basin is bounded to the north by Miocene pyroclastic rocks of Reconnaissance Peak, to the west by Miocene andesite of Beckwourth Peak, to the south and east by Tertiary andesite, and to the east by Mesozoic granitic rocks.[9] The primary water-bearing formations in Sierra Valley are Holocene sedimentary deposits, Pleistocene lake deposits, and Pleistocene lava flows.

The aquifers of the valley are mainly alluvial fan and lake deposits. The alluvial fans grade laterally from the basin boundaries into course lake and stream deposits. The deposits of silt and clay act as aquitards or aquicludes in the formation. Aquiclude materials are predominantly fine-grained lake deposits. In the central part of the basin, alluvial, lake, and basin deposits comprise the upper 30 to 200-feet of aquitard material that overlies a thick sequence of interstratified aquifers and aquicludes.

Most of the upland recharge areas are composed of permeable materials occurring along the upper portions of the alluvial fans that border the valley. Recharge to groundwater is primarily by way of infiltration of surface water from the streams that drain the mountains and flow across the fans. Increases in groundwater development in the mid to late 1970s resulted in the cessation of flow in many artesian wells. Large pumping depressions formed over the areas where heavy pumping occurred. Water levels in a flowing artesian well in the northeast portion of the basin declined to more than 50 feet below ground surface by the early 1990s. Subsequent reductions in groundwater pumping through the 1990s helped to recover groundwater levels to mid 1970's levels.

The estimated groundwater storage in the basin is 7,500,000 acre-feet to a depth of 1000 feet.[10] The DWR (1963b) notes that the quantity of water that is

[8] Lydon 1960

[9] Saucedo 1992

[10] DWR 1963a

useable is unknown. The DWR (1973) estimates storage capacity to be between 1,000,000 to 1,800,000 acre-feet for the top 200 feet of sediments based on an estimated specific yield ranging from five to eight percent. These estimates include the Chilcoot Subbasin. A wide range of mineral type waters exist throughout the basin. Sodium chloride and sodium bicarbonate type waters occur south of Highway 49 and north and west of Loyalton along fault lines. Two well waters are sodium sulfate in character. In other parts of the valley the water is bicarbonate with mixed cationic character. Calcium bicarbonate type water is found around the rim of the basin and originates from surface water runoff.[11]

The poorest quality groundwater is found in the central west side of the valley where fault-associated thermal waters and hot springs yield water with high concentrations of boron, fluoride, iron, and sodium. Several wells in this area also have high arsenic and manganese concentrations. Boron concentrations in thermal waters have been measured in excess of 8 mg/L. At the basin fringes, boron concentrations are usually less than 0.3 mg/L. There is also a sodium hazard associated with thermal waters in the central portion of the basin.[12]

This basin is managed by the Sierra Valley Groundwater Management District, an entity created by the Sierra Valley Groundwater Management District Legislation.[13] This legislation clearly defined the boundaries over which the District has authority to manage the groundwater resources. The Chilcoot Sub-basin, described below, falls within the boundaries of the Sierra Valley Groundwater District.

Chilcoot Sub-Basin

The Chilcoot Subbasin is an irregularly shaped, 7,550 acre complexly faulted valley on the eastern side of the Sierra Valley Groundwater Basin in Plumas County. The basin is bounded to the north and east by Mesozoic granitic rocks, and to the south by Tertiary Sierran basalt and pyroclastic rocks and Paleozoic metamorphic rocks. The basin is hydrologically connected to the Sierra Valley Sub-basin to the west in the near surface but may be discontinuous at depth due to a bedrock sill. The primary water-bearing formations in the Chilcoot Sub-basin are the Holocene sedimentary deposits and silt and sand deposits, fractured and faulted Paleozoic to Mesozoic metamorphic and granitic rocks, and Tertiary volcanic rocks.

Long Valley Groundwater Basin

The 46, 840 acre Long Valley Groundwater Basin is an elongated north-south trending basin located at the western edge of the Basin and Range Geomorphic Province. This basin is bounded by Peavine Peak to the south, Mesozoic granitic rocks of the Diamond Mountains to the west, Peterson Mountains to the east, and Honey Lake Valley Basin to the north. Peterson Mountain consists mainly of Cretaceous to Jurassic granitic rocks with exposures of metavolcanic rocks near Cold Springs Valley.

Two east-dipping normal faults are inferred to lie along the western and central parts of the valley. The two major faults include the Diamond Mountain Fault and a central unnamed fault that extends from Peavine Peak through Reno Junction. The valley is generally an asymmetric half-graben development. Valley sequences are tilted westward. The half-graben structure is likely to be characterized by numerous buried normal faults and large bedrock slivers at depth. Sedimentation patterns are expected to be complex.

South of Highway 70, the bedrock is shallow (150 to 300-feet in depth) between the Diamond Mountains and the Long Valley Fault. Pleistocene non-marine sedimentary rocks constitute valley fill in this region. This older valley fill underlies terraces along the west side of the valley. East of the central fault, the valley is underlain by a thick, west-dipping Pliocene nonmarine sequence referred to as the Hallelujah Formation. Long Valley is also hydrologically connected to Cold Spring Valley in the south. The USGS has reported that Cold Spring Valley receives an estimated 200 to 500 acre-feet annually as underflow from Long Valley.[14]

The DWR (1989) estimates storage for the Upper Long Valley (the southern portion of the basin south of Hallelujah Junction), to range between 180,000 and 300,000 acre-feet based on 12,300 acres, a depth interval of 100-feet, and a specific yield ranging from 0.15 to 0.25.

The Basin is managed by the Long Valley Water Management District, another entity created by the Sierra Valley Groundwater Management District

[11] DWR 1973
[12] DWR 1983
[13] SVGMD 1980

[14] DWR 1989

Legislation.[15] This legislation clearly defines the Long Valley District's boundaries.

Mohawk Valley Groundwater Basin

The Mohawk Valley Groundwater Basin lies within an elongated valley occupying a portion of a long, narrow graben. The graben is bounded on the southwest side by the Mohawk Valley Fault. The east side of the valley is bounded by a group of northwest trending faults that branch from the Mohawk Valley fault near Gattley. The floor of the valley consists of a narrow strip of nearly flat alluvial material overlying lake sediments. Lake sediments also underlie the upland areas of the valley. Depth to bedrock is estimated to range between 1,500 to 3,000-feet. The basin is bounded to the northeast by Pliocene volcanic rocks of Penman Peak, to the east by Miocene volcanic rocks of Beckwourth Peak, and to the west and southwest by Paleozoic metavolcanic rocks and Mesozoic granitic rocks of the Sierra Nevada Mountains. Sulphur Creek drains the southern half of the valley and enters the Middle Fork Feather River near the midpoint of the valley and flows northwesterly. Storage capacity for the basin is estimated to be 90,000 acre-feet based on a specific yield of five percent for a depth interval of zero to 200 feet.[16] Calcium-magnesium bicarbonate and sodium bicarbonate are the predominant groundwater types in the basin. There are no known groundwater management plans, groundwater ordinances, or basin adjudications associated with this basin.

American Valley Groundwater Basin

The American Valley Groundwater Basin is a 6,800 acre basin bounded to the southwest and northeast by a northwest trending fault system. The basin is bounded to the northeast by Paleozoic metavolcanic rocks and is bounded on all other sides by Paleozoic marine sedimentary and meta-sedimentary rocks of the Sierra Nevada Mountains. Spanish Creek drains the valley and is a tributary to the North Fork Feather River to the northwest. The DWR (1960) estimates storage capacity to be 50,000 acre-feet for a saturated depth interval of ten to 210-feet. There are no known groundwater management plans, groundwater ordinances, or basin adjudications associated with this basin.

[15] SVGMD 1980
[16] DWR 1963b

4.3 Soils

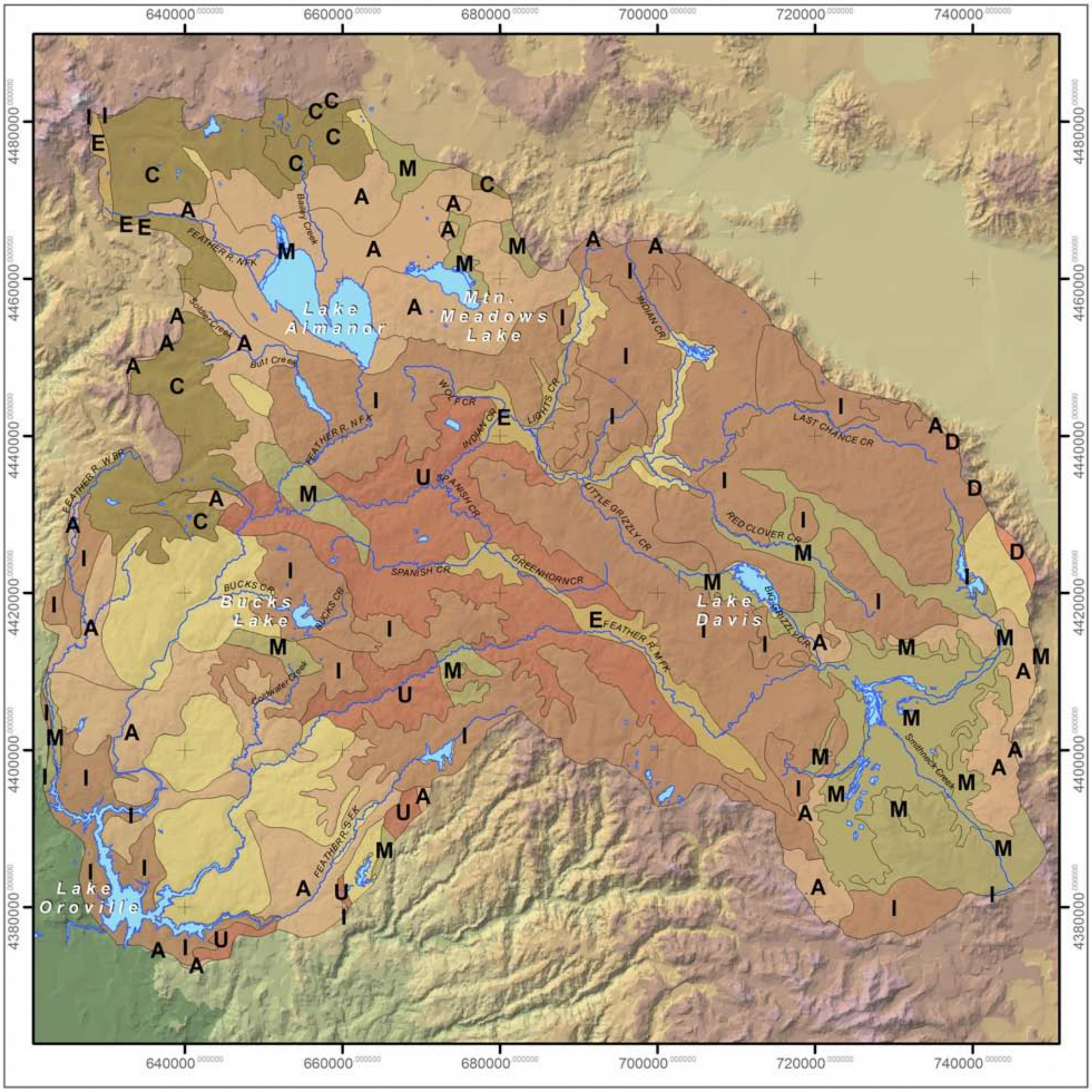
Due to its geologic and climatic complexity, the watershed has diverse soils (see Figure 4.6 soils map). As a general rule, the west side of the Sierra Crest has deeper more productive soils than the east side. This is a result of warmer temperatures and higher precipitation on the west side (for further information on precipitation patterns, see the Precipitation discussion below and Figure 4.10 Precipitation map). Aspect also plays an important role, as north facing slopes have deeper, more productive soils than south facing slopes due to increased evaporation from more direct sun.

It is important to note that many of these granitic soils are highly erosive.[17] The erosion hazard to exposed soil is "high" on 29% of Plumas National Forest System lands; the majority of this high erosion hazard classification occurs in granitic soils. The volcanic rock and soils of the east side are susceptible to landslides; 14% of the Plumas National Forest is classified as "high" risk to landslides.[18]

In general, the soils of the Sierra Nevada Range include Alfisols, Andisols, Aridisols, Entisols, Inceptisols, Mollisols and Ultisols in combination with mesic, frigid, or cryic soil temperature regimes and xeric, udic, aridic, or aquic soil moisture regimes. The soils of more specific regions are discussed below.[19]

The soils adjacent to Lake Almanor, along the Plumas Trough to Mohawk Valley are mostly Ultic Haploxeralfs, Dystric Lithic Xerochrepts, Ultic Palexeralfs, and Typic Haploxerults. They are mostly Lithic Haploxerolls, Typic Xerochrepts, and Ultic Haploxeralfs on ultramafic rocks; and Cumulic Endoaquolls and Typic and Cumulic Haplaquolls on basin floors. The soils are mostly well drained, but on basin floors soils are poorly drained. Soil temperature regimes are mostly mesic. Soil moisture regimes are mostly xeric, but aquic on basin floors.

[17] Plumas County 1989
[18] Plumas National Forest 1988
[19] USDA 1997 was major source for the descriptions in this chapter.



Legend

- Lakes and reservoirs
- Rivers

ORDER

- Rock Outcrop
- A - Alfisols
- C - Andisols
- D - Aridisols
- E - Entisols
- I - Inceptisols
- M - Mollisols
- U - Ultisols

FIGURE 4.6

UPPER FEATHER RIVER WATERSHED SOILS

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Watershed base map depicting soil conditions.

GIS Metadata Information
Soils shapefile:
California Spatial Information Library CASIL

The upper part of the subwatershed is composed of a granitic pluton. The soils on granitic rocks are mostly Dystric, Lithic, and shallow Typic Xeropsamments and Typic and Dystric Xerochrepts. On other kinds of rocks they are mostly Dystric Xerochrepts, Andic Xerumbrepts, Lithic Ultic and Ultic Haploxerolls, and Ultic Haploxeralfs. The soils are well drained. Soil temperature regimes are frigid on the plateau and mostly mesic in the canyon of the Feather River. Soil moisture regimes are mostly xeric.

The lower Middle Fork and the South Fork of the Feather River have a slightly different distribution of soils. The soils are mostly Typic, Dystric, and shallow Dystric Xerochrepts, Mollic and Ultic Haploxeralfs, Lithic Xeropsamments, and shallow Entic Haploxerolls on granitic rocks; and Typic Haploxerults, Xeric Haplohumults, Lithic and Dystric Lithic Xerochrepts, and Ultic Palexeralfs on other kinds of rocks. The soils are well drained. Soil temperature regimes are mostly mesic and soil moisture regimes are xeric.

In the steeper parts of the Diamond Mountains and in the high plateau adjacent to the Diamond Mountains, the soils are mostly shallow Typic and Dystric Xeropsamments, Typic and Entic Xerumbrepts, and at lower elevations Ultic Haploxeralfs. Soils on volcanic rocks are mostly Lithic and Andic Xerumbrepts, Typic Argixerolls, and Andic Haploxeralfs. These soils are mostly well drained. Soil temperature regimes are mostly frigid, with some mesic, while soil moisture regimes are xeric.

Southeast of the Diamond Mountains is the Frenchman area, which is composed of Tertiary volcanic terrain north of Sierra Valley. The soils are mostly Ultic Argixerolls, Ultic Haploxeralfs, Andic Xerumbrepts, and a diverse group of shallow soils. Dystric Xeropsamments, Entic Haploxerolls, and Entic and Dystric Xerochrepts are common on granitic rocks. There are Cumulic Endoaquolls, Aridic Haploxerolls, and Aridic and Pachic Argixerolls on alluvial and lacustrine deposits. The soils are mostly well drained. Soil temperature regimes are mostly frigid, with some mesic in the valleys. Soil moisture regimes are mostly xeric, but some are aridic and some in the valleys are aquic.

Sierra Valley, which is in the block-faulted part of the Sierra Nevada at the head of the Middle Fork of the Feather River, lies just south of the Frenchman area. The soils are mostly Pachic and Aquic Argixerolls, Aridic Haploxerolls, Typic Haplaquolls, and Aquic Natrargids, plus Abruptic Xerollic Durargids on alluvial fans on the east side of the valley. The soils are well to poorly drained. Soil temperature regimes are mesic. Soil moisture regimes are xeric on the west side, commonly aquic on the basin floor, and aridic on the east side of the valley.

4.4 Hydrology, Water Resources, Infrastructure

Hydrologic overview

The Upper Feather River Watershed is divided into four main branches: the West Branch, the North Fork, the Middle Fork and the South Fork of the Feather River. The West and South branches are relatively small, comprising (106,985 acres and 81,071 acres respectively). The North Fork of the Feather River is the largest branch (1,380,108 acres, 60%) and its upper reaches are divided into two main branches: the Upper North Fork and the East Branch of the North Fork. The Middle Fork drains the remaining 738,887 acres (32%).

These main branches are divided into 24 subwatersheds. The west and south branches are not divided, as their watersheds are small and comparatively simple. The Middle Fork is divided into six subwatersheds, with the remaining 17 subwatersheds comprising the North Fork. Figure 4.7 is a schematic diagram that reveals how the subwatersheds fit together and how water moves between them. Figure 4.8 shows the subwatershed locations within the entire watershed, and Figure 4.9 illustrates the major river drainages.

Major River Drainage	Acres	% of Watershed Area
West Branch Feather River	106985.60	4.64
South Fork Feather River	81071.44	3.51
North Fork Feather River	1380108.00	59.82
Middle Fork Feather River	738877.10	32.03
Total	2307042.14	100.00

Table 4.2 Major River Drainages area

Drainage areas for the four major rivers in the Upper Feather River Watershed

The table below (4.3) represents a rough estimate of yearly inflow to Lake Oroville from the four major river drainages of the Upper Feather River Watershed. This data is an approximation of average conditions, as data is not available for similar years for all watersheds.

Major River Drainage	Mean Daily CFS	Mean Gallons Per Day (1000's)	Average Yearly Inflow to Lake Oroville (Acre-Feet)	% of Inflow
West Branch Feather	345.51	223308.6	250137.74	6.47
South Fork Feather	261.60	169074.6	189387.92	4.90
North Fork Feather	3227.6	20860.53	2336679.2	60.48
Middle Fork Feather	1502.3	970987.7	1087645.2	28.15
Total	5337.0	1384231	3863850.1	100.00

Table 4.3 Approximate Annual inflow to Lake Oroville per major river drainage

*West Branch data obtained from USGS gauging station #11406500 WB FEATHER R NR YANKEE HILL CA and calculated using yearly averages from 1931 – 1967

**South Fork data obtained USGS gauging station #11396350 SF FEATHER R A PONDEROSA DAM CA and calculated using yearly averages from 1967 – 1983

***North Fork data obtained from USGS gauging station # 11404901 COMBINED FLOW N F FEATHER R PULGA + POE PP CA and calculated using yearly averages from 1968 – 1982

****Middle Fork data obtained by combining flow data from USGS gauging stations #11394500 MF FEATHER R NR MERRIMAC CA and #11394620 FALL R NR FEATHER FALLS CA and calculated using yearly averages from 1964 – 1983

Approximately 8% or 10,000 acres of the Plumas National Forest is directly affected by deteriorated conditions.[20] Most of the westside watersheds are in good condition, with a few major exceptions. Slate and Canyon Creeks along with South Fork Feather River are examples of degraded sections on the westside. The granitic watersheds frequently found on the westside are sensitive to erosion. For example, sheet and gully erosion caused by roads and skid trails is widespread in the French Creek Watershed, and impacts on the fishery and water quality are high. Human activity over time (logging, grazing, channel clearing, levee construction, and water diversions, etc.) has resulted in decreased vegetative cover, which has contributed to increased sediment yield and runoff. The primary sources of sediment are streambank erosion and erosion from road cut and fill slopes. Thus, water quality and water quantity are the two central problems throughout the watershed.

Sediments from all of the erosion sources result in water quality conditions that impact fish and other biotic habitat; sediments deposited behind dams throughout the watershed decrease reservoir capacity and impair flood control capability and power generation storage. Lack of riparian and upland vegetation means precipitation is not retained and stored in upper watershed water tables and aquifers, resulting in rapid runoff, flooding in high water years, and dry tributary streams in late summer.[21]

Many of the eastside watersheds are sensitive to land-use activities, and therefore exhibit degraded conditions. The alluvial valleys and meadows have been dewatered by creek channel downcutting, and sediment production in these watersheds is frequently high. Streambank and bottom degradation is lowering the water table in the valleys causing changes in riparian habitat as well as in adjacent grazing lands. Decreased cover, channel clearing, and levee construction in streams on the valley floors causes channel bottoms to erode down, which leaves channel banks high and vertical. The combination of increased runoff and lowered base flow level of the larger creeks in the valleys causes headcutting in the tributary streams. Poor grazing management that suppresses the growth of riparian and upland vegetation exacerbates headcutting in the tributary streams. Steepened banks begin failing and water tables drop as vegetation is lost. Upper watershed tributaries to the large valley streams are characteristically deeply incised and form gullies that continuously grow upslope.

[20] PNF 1988

[21] Ecosystem Sciences 2004

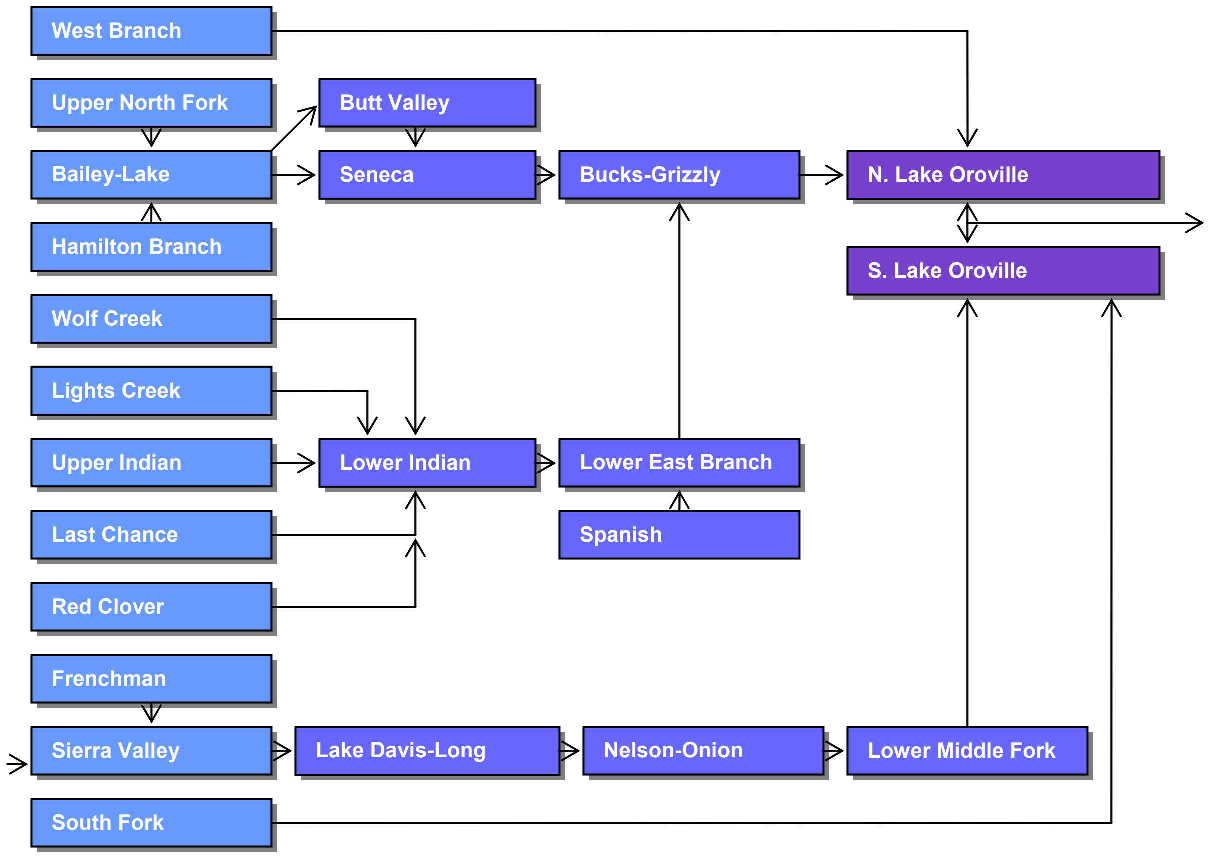

Figure 4.7: **Subwatershed Hydrology Schematic**
Schematic diagram of how subwatersheds and branches of the Upper Feather River are connected and how water is transported between and throughout the watershed.

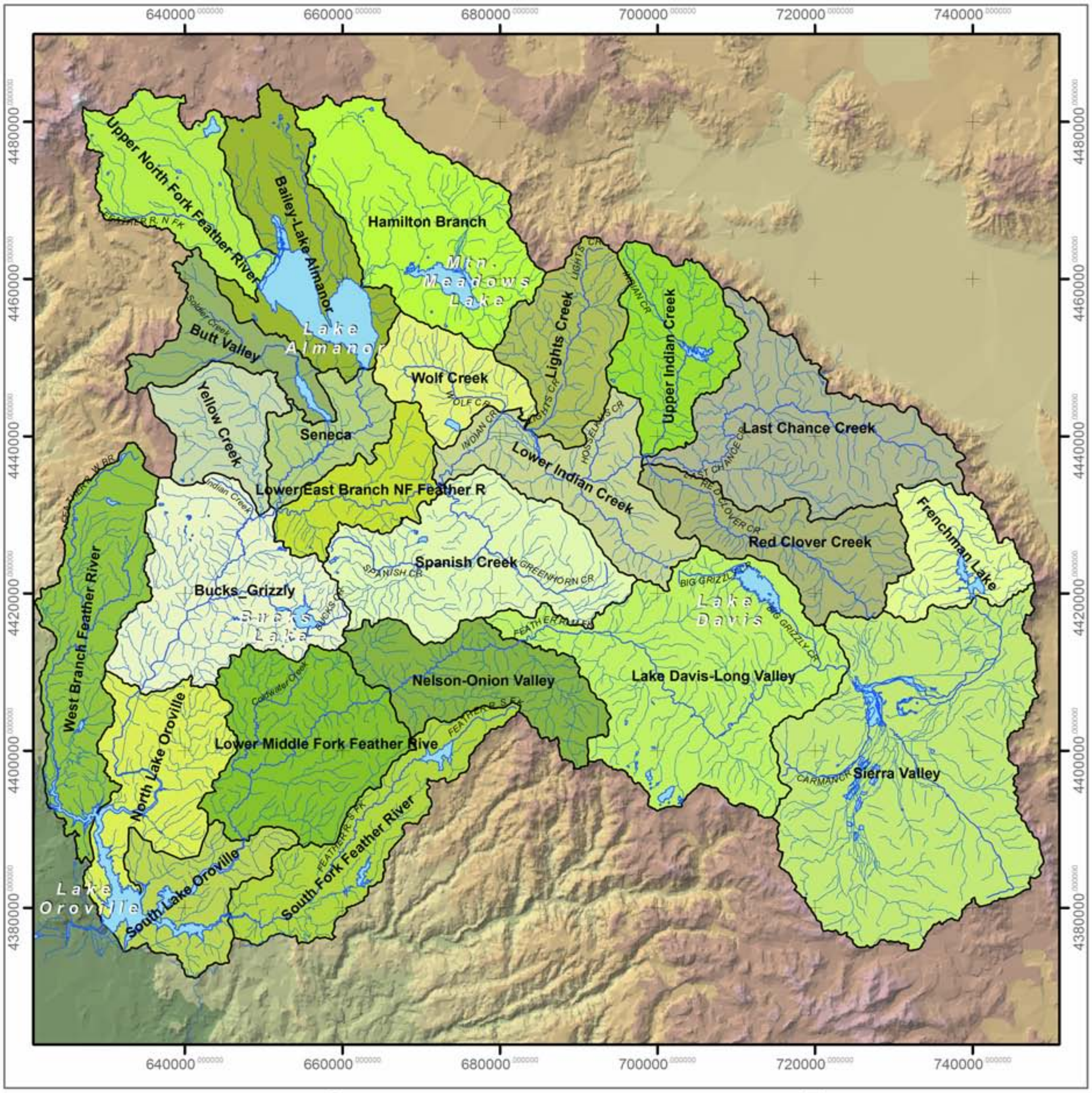

FIGURE 4.8

UPPER FEATHER RIVER SUBWATERSHEDS

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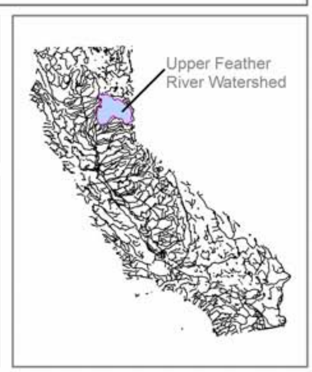
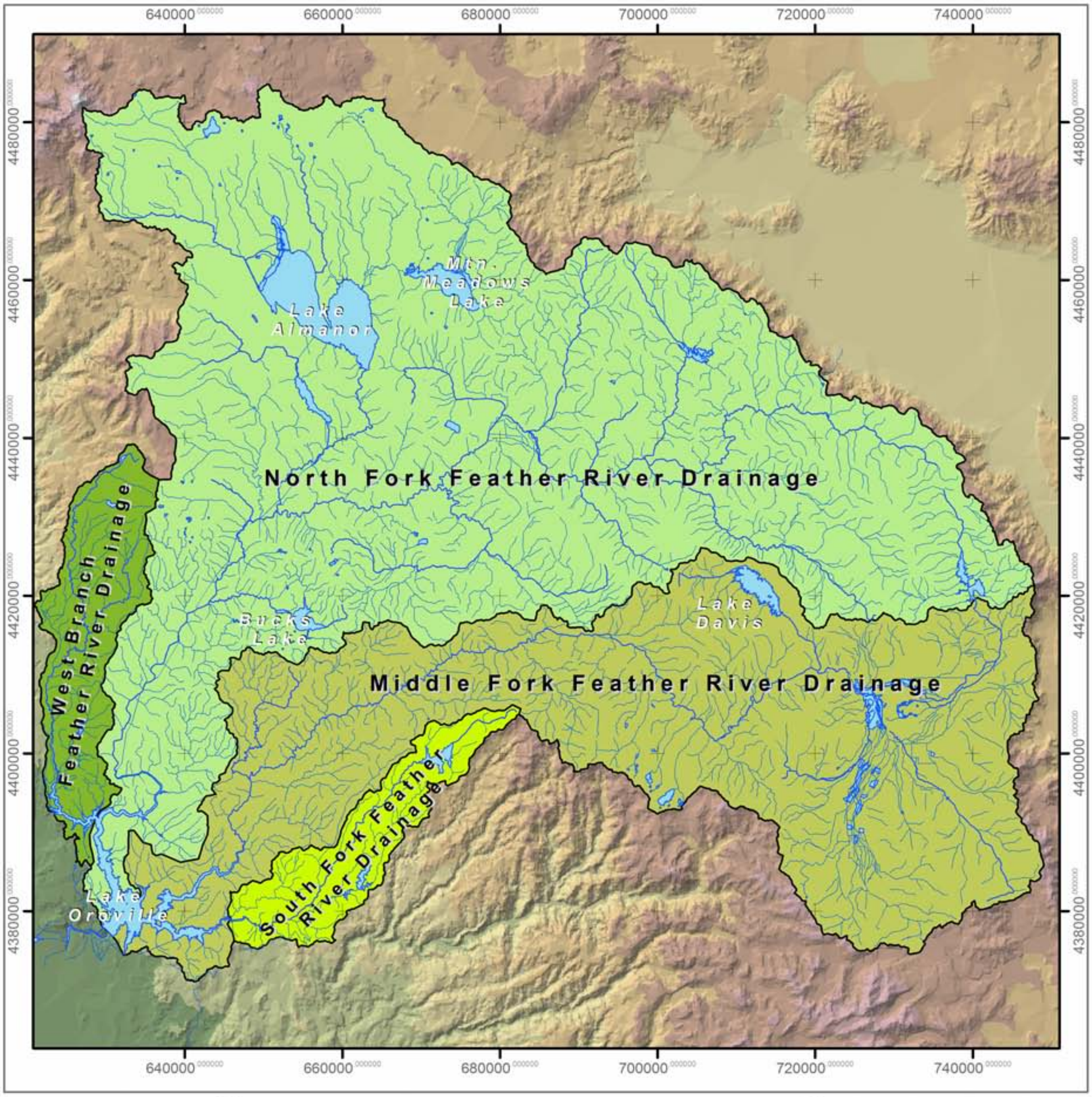
Subwatershed base map depicting smaller hydrologic catchments within the greater watershed.

GIS Metadata Information
Subwatershed delineation shapefile:
California Spatial Information Library CASIL





Legend

- Streams
- Lakes and reservoirs
- Rivers

Major River Drainages

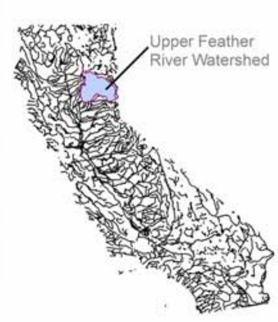
- Middle Fork Feather River
- North Fork Feather River
- South Fork Feather River
- West Branch Feather River

N

FIGURE 4.9

UPPER FEATHER RIVER MAJOR RIVER DRAINAGES

Watershed base map depicting the major river drainages of the North, Middle, South, and West Branch Feather River. The water from each major river drainage flows into Lake Oroville.



Precipitation

The crest of the Sierra Nevada is a 400-mile piece of the earth's surface and forms a near impenetrable barrier to storm systems moving in an easterly direction from the Pacific Ocean. Storm systems crossing the central valley of California meet the Sierra Crest and stop. These storms then deposit the majority of their precipitation along the west slope of the range, creating a rain shadow effect east of the Sierra Crest. This rain shadow is well documented in the Feather River Watershed, as precipitation ranges from over 90 inches (230 cm) on the mountain tops along the crest and on the slopes of Mt. Lassen, to less than 11 inches (28 cm) in the eastern part of Sierra Valley (see watershed precipitation map Figure 4.10). The plentiful precipitation west of the Sierra Crest provides rivers with enough flow and energy to carve deep V-notched canyons. The Middle Fork and North Fork canyons of the Feather River are excellent examples of the canyon formation west of the Sierra Crest.

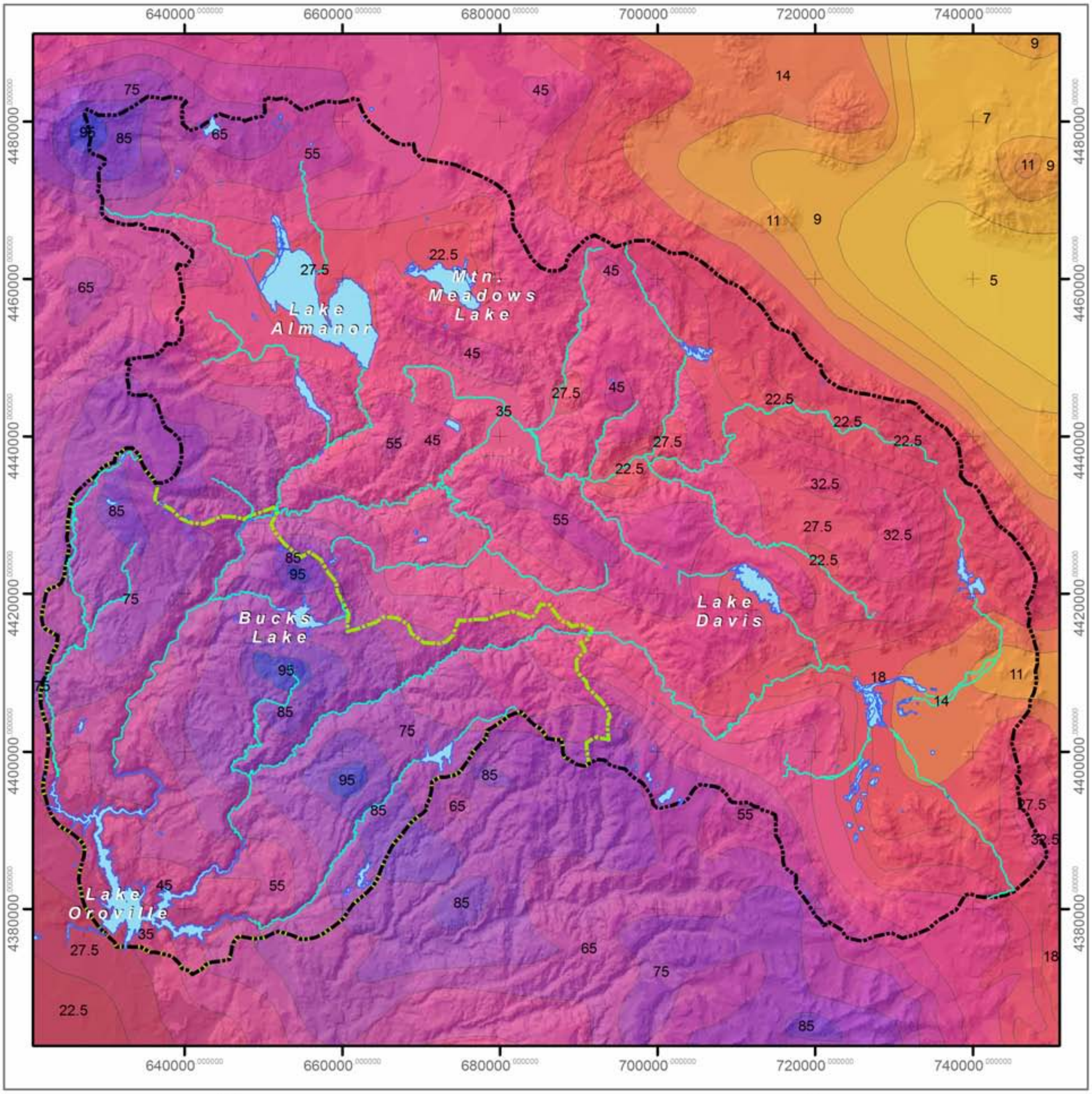
Much of the precipitation in the higher elevations of the Sierra Nevada and the high mountains and valleys of the East Branch of the North Fork is in the form of snow. Snowpack plays an important role in shaping the hydrograph of many east-side streams.

Infrastructure

The SWP depends on a complex system of dams, reservoirs, power plants, pumping plants, canals, and aqueducts to deliver water to users. The SWP infrastructure in the Feather River Watershed begins with Lake Davis, Frenchman Lake, and Antelope Lake, three small lakes on Feather River tributaries. The branches and forks of the Feather River flow into Lake Oroville and then through a complex system of power plants down the Feather River into the Sacramento River to the Sacramento-San Joaquin Delta. In the north Delta, some water is pumped into the North Bay Aqueduct to supply Napa and Solano counties. Water is also pumped into the California Aqueduct; some of it flows into the South Bay Aqueduct to serve Alameda and Santa Clara counties. The remaining water flows into the California Aqueduct to serve communities in southern California.[22]

Pacific Gas and Electric operates ten hydroelectric plants on the Feather River. The East Branch North Fork Feather River serves 4,363,414 electrical customers through its hydroelectric facilities. The Forrest Service operates five dams, while several small dams are owned and operated by private individuals. For more detailed information on the major dams within the watershed, including dam ownership, size, type, drainage area, and storage capacity, refer to Table 4.4 Dams.

[22] State Water Project Annual Report of Operations 2000



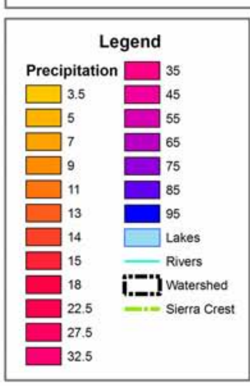


FIGURE 4.10

UPPER FEATHER RIVER PRECIPITATION

Watershed base map depicting the precipitation amounts throughout the region.

GIS Metadata Information
Percipitation shapefile:
California Spatial Information Library CASIL

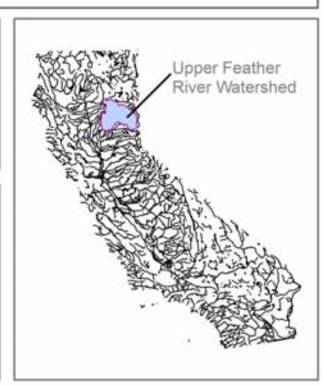


Table 4.4 Dams of the Upper Feather River Watershed

DAM NAME	OWNER	COUNTY	STREAM	TYPE	CAPACITY	HEIGHT	YEAR
ANTELOPE	STATE DEPT OF WATER RESOURCES	PLUMAS	INDIAN CREEK	ERTH	22566	113	1964
BIDWELL LAKE	THOMAS J AND VICKY K JERNIGAN	PLUMAS	NO CANYON CR	ERRK	5200	35	1865
BUCKS DIVERSION	PAC GAS AND ELECTRIC CO	PLUMAS	BUCKS CREEK	VARA	5843	99	1928
BUCKS STORAGE	PAC GAS AND ELECTRIC CO	PLUMAS	BUCKS CREEK	ROCK	103000	122	1928
BUTT VALLEY	PAC GAS AND ELECTRIC CO	PLUMAS	BUTT CREEK	HYDF	49800	84	1924
CARIBOU AFTERBAY	PAC GAS AND ELECTRIC	PLUMAS	NFK FEATHER RV	ERRK	2400	164	1959
CHESTER DIVERSN	RECL BOARD SAC-SAN JOAQUIN	PLUMAS	NFK FEATHER RV	ERTH	75	47	1975
CONCOW	THERMALITO TABLE MTN ID	BUTTE	CONCOW CREEK	VARA	6370	94	1925
CRESTA	PAC GAS AND ELECTRIC	PLUMAS	NFK FEATHER RV	GRAV	4400	103	1949
EUREKA	STATE DEPT OF PARKS AND REC	PLUMAS	EUREKA CREEK	ERTH	220	29	1866
FAGGS DEBRIS	FOREST SERVICE	PLUMAS	TRIB WILLOW CREEK	ERTH	50	10	1900
FORBESTOWN DIV	OROVILLE WYANDOTTE ID	BUTTE	SFK FEATHER RV	VARA	358	99	1962
FRENCHMAN	STATE DEPT OF WATER RESOURCES	PLUMAS	LAST CHANCE CR	ERTH	55477	129	1961
GRIZZLY CREEK	MR ROBERT W STEIN	PLUMAS	BIG GRIZZLY CR	GRAV	140	39	1915
GRIZZLY CREEK	MR & MRS RONALD T DREISBACH	BUTTE	GRIZZLY CREEK	ERTH	76	50	1964
GRIZZLY FOREBAY	PAC GAS AND ELECTRIC	PLUMAS	GRIZZLY CREEK	VARA	1112	92	1928
GRIZZLY VALLEY	STATE DEPT OF WATER RESOURCES	PLUMAS	BIG GRIZZLY CR	ERRK	83000	115	1966
INDIAN OLE	PAC GAS AND ELECTRIC	LASSEN	HAMILTON CREEK	FLBT	24800	26	1924
JAMISON LAKE	FOREST SERVICE	PLUMAS	LITTLE JAMISON CRK	ERTH	300	15	1902
LAKE ALMANOR	PAC GAS AND ELECTRIC CO	PLUMAS	NFK FEATHER RV	HYDF	1308000	130	1927
LAKE MADRONE	LAKE MADRONE WATER DIST	BUTTE	BERRY CREEK	ERTH	200	35	1931
LITTLE GRASS VY	OROVILLE WYANDOTTE ID	PLUMAS	SFK FEATHER RV	ROCK	93010	210	1961
LONG LAKE	GRAEAGLE WATER CO	PLUMAS	GRAY EAGLE CREEK	ROCK	1478	12	1938
LOST CREEK	OROVILLE WYANDOTTE ID	BUTTE	LOST CREEK	VARA	5680	122	1924
LOWER THREE LAKES	PAC GAS AND ELECTRIC	PLUMAS	MILK RANCH CR	ROCK	606	32	1928
OROVILLE	STATE DEPT OF WATER RESOURCES	BUTTE	FEATHER RIVER	ERTH	3537577	742	1968
PALEN	MR FREDERICK E BALDERSTON	SIERRA	ANTELOPE CREEK	ERTH	146	25	1951
PHILBROOK	PAC GAS AND ELECTRIC	BUTTE	PHILBROOK CREEK	ERTH	5180	85	1926
POE	PAC GAS AND ELECTRIC	BUTTE	NFK FEATHER RV	GRAV	1150	62	1959
PONDEROSA DIV	OROVILLE WYANDOTTE	BUTTE	SFK FEATHER RV	ERTH	4750	157	1962
ROCK CREEK	PAC GAS AND ELECTRIC	PLUMAS	NFK FEATHER RV	GRAV	4660	120	1950
ROUND VALLEY	PAC GAS AND ELECTRIC	BUTTE	W BR FEATHER RV	ERTH	1147	30	1877
SILVER LAKE	SOPER-WHEELER CO	PLUMAS	SILVER CREEK	ERRK	650	21	1906
SLY CREEK	OROVILLE WYANDOTTE	BUTTE	LOST CREEK	ERTH	65050	271	1961
SMITH LAKE	FOREST SERVICE	PLUMAS	WAPAUNSIE CREEK	ERTH	400	14	1909
SNAG LAKE	FOREST SERVICE	SIERRA	TRIB SALMON CREEK	ERTH	106	8	1885
SOUTH FORK DIV	OROVILLE WYANDOTTE ID	PLUMAS	SFK FEATHER RV	VARA	88	70	1961
SPRING VAL LAKE	STATE DEPT FISH AND GAME	PLUMAS	ROCK CREEK	ERTH	75	11	1979
TAYLOR LAKE	KATHLEEN G GARR	PLUMAS	TR INDIAN CREEK	ERTH	380	14	1929
WALKER MINE TAILS	FOREST SERVICE	PLUMAS	DOLLY CREEK	ERTH	1200	30	UNK

Subwatershed Descriptions

The State of California divides the Upper Feather River Watershed into 24 subwatersheds. Each of these subwatersheds, their stream reaches, lakes, dams, diversions, and reservoirs are discussed below. The descriptions are organized by the location within each of the four main forks – the West Branch, the North Fork, the Middle Fork, and the South Fork. The North and Middle Forks are described generally before their subwatersheds are discussed.

West Branch Feather River Subwatershed

The West Branch of the Feather River's headwaters are along the Sierra Crest (see Figure 4.8). It flows southward through a steep canyon before flowing into the west side of Lake Oroville. The bottom of the reach is flooded by Lake Oroville. There are no major natural lakes within this region.

There are no major dams or impoundments along this reach; however, there are three small dams. The Round Valley Dam is on the West Branch of the Feather itself, while Philbrook and Concow dams are on tributaries bearing the same names. The Philbrook Dam, built in 1877, has the distinction of being the oldest existing dam within the watershed.

North Fork of the Feather River

The North Fork of the Feather River is the largest branch of the Upper Feather River. The large East Branch of the North Fork's catchment includes much of the east-side of the Sierra Crest. Its headwaters flow from the Diamond Mountains in the north and east. Headwater streams originate in high alluvial valleys, while the lower reaches plummet through steep canyons west of the Sierra Crest. There are several major dams along the North Fork that supply power and water for the highly populated cities to the south and west.

As described earlier, the North Fork of the Feather River is divided into two main branches, the main stem of the North Fork, and the East Branch of the North Fork (see Figure 4.8). The main stem of North Fork is divided into five subwatersheds above its confluence with the East Branch. The East Branch is divided into eight subwatersheds above the confluence. Two subwatersheds are below the confluence, and these two reaches, Bucks-Grizzly and North Lake Oroville are the subject of FERC #1962.

The East Branch of the North Fork watershed exhibits less steep terrain, more broad valley floors, and is more degraded by the loss of riparian and upland vegetation than the lower reaches of the main stem. Headcutting is common throughout the upper east side of the watershed and the source of a majority of sediments exported from the watershed.[23] Two of the subwatersheds, Spanish and Last Chance Creek were found to contribute large amounts of sediment to the East Branch, degrading water quality for fisheries and other biota.[24] The streams in the upper east side watersheds are characteristically gullied with little riparian vegetation. Deep channel incision has lowered the water tables beneath surrounding landforms, and desert vegetation has replaced meadow and wetland vegetation types. Consequently, the East Branch of the North Fork contains five of the seven priority subwatersheds identified for restoration. The incised stream channels, depressed water tables, and poor land management all contribute to poor ecosystem health in the East Branch watershed.

Upper North Fork Feather River Subwatershed

The Upper North Fork of the Feather River subwatershed is in the extreme northwest portion of the Upper Feather River Watershed (see Figure 4.8). The headwaters of the North Fork of the Feather River flow off the slopes of Mt. Lassen and Mt. Conrad southwest to Lake Almanor. This section of the watershed receives high precipitation; over 90 inches per year near Mt. Lassen Peak (see Figure 4.10). It has typical east-side stream characteristics, with streams flowing through alluvial valleys. The largest natural lake within the subwatershed is Juniper Lake in the northeast corner of the subwatershed, just north of Mt. Harkness.

The only major diversion within the watershed is the Chester Diversion on the North Fork just west of the town of Chester on the northwest shore of Lake Almanor. It diverts water south and west of the town of Chester and into Lake Almanor.

Bailey-Lake Almanor Subwatershed

Located between the Upper North Fork of the Feather River and Hamilton Branch subwatersheds, the Bailey-Lake Almanor subwatershed includes the

[23] Ecosystem Sciences 2004
[24] Plumas County 1989

drainage area of Bailey Creek (which drains from the north into Lake Almanor) and the catchment of the Lake itself (see Figure 4.8). Lake Almanor is the second largest lake within the watershed, covering over 28,000 acres.

The lake receives water from two major diversions, the Chester Diversion in the Upper North Fork subwatershed and from Hamilton Branch diversion from the Hamilton Branch subwatershed. Lake Almanor was created in 1914 and contains a hydroelectric facility. In 1927, Lake Almanor Dam was constructed and increased the lake's capacity to 1.3 million acre-feet. A tunnel connects Lake Almanor with Butt Lake to the southwest. Lake Almanor water levels, water quality, and recreation issues are addressed in FERC #2105.

Hamilton Branch Subwatershed

Bounded by the Diamond Mountains to the north, the Hamilton Branch subwatershed drains into Lake Almanor (see Figure 4.8). Several small creeks drain off of the Diamond Mountains. In 1927, Indian Ole Dam was built along Hamilton Creek, creating Mountain Meadows Reservoir. The reservoir has a capacity of 24,800 acre-feet, and is connected to Lake Almanor through a diversion canal. Mountain Meadows Reservoir is the only major water body within this reach.

Butt Valley Subwatershed

Located southwest of the Lake Almanor subwatershed, the Butt Valley subwatershed flows southeast into the Seneca reach of the North Fork (see Figure 4.8). The major stream is Butt Creek, which flows from its headwaters along the Sierra Crest east and then south into Butt Valley Reservoir. Just before it meets the reservoir, a tunnel from Lake Almanor connects the two subwatersheds at a powerhouse on the northwest side of Butt Valley Reservoir. The reservoir covers 1,600 acres and has a capacity of 49,800 acre-feet. Butt Valley Reservoir water levels, water quality, and recreation issues are addressed in FERC #2105.

Seneca Subwatershed

The Upper North Fork, Bailey-Lake Almanor, Hamilton Branch, and Butt Valley subwatersheds flow into this subwatershed (see Figure 4.8). The North Fork Feather River flows from the outlet below the Lake Almanor Dam south and west as it approaches the Sierra Crest. Just below the confluence of Butt Creek and North Fork Feather River, a tunnel connects Butt Valley Reservoir with the North Fork at Caribou Powerhouse. As the river flows southwest, the canyon becomes steeper and deeper, until the canyon is over a thousand meters from the ridgeline at the bottom of the reach, where the East Branch North Fork empties into the North Fork Feather River.

Pacific Gas and Electric operates a number of dams, diversions, penstocks, and powerhouses in the subwatershed; the operations of the facilities are the subject of the FERC #2105 document. Recreation management, reservoir operations, streamflow quantity and timing, stream habitat management, and water quality in Lower Butt Creek and North Fork Feather River are dictated by the FERC #2105 document, which has statutory authority.

Bucks-Grizzly Subwatershed

The Bucks-Grizzly subwatershed is part of the North Fork Feather River Watershed, starting just downstream of the confluence of the East Branch North Fork Feather River and the North Fork Feather River, and extending downstream to the Poe Hydroproject[25] diversion dam on the North Fork Feather River. Bucks-Grizzly subwatershed is bound to the west by the West Branch Feather River subwatershed, and to the East by Spanish Creek subwatershed, Nelson-Onion Valley Subwatershed, and Lower Middle Fork Feather River (see Figures 4.8 and 4.9). State Highway 70 runs alongside the North Fork Feather River throughout the reach.

Bucks-Grizzly subwatershed includes numerous diversions and hydropower projects on the North Fork Feather River. Water is released from the Belden Powerhouse into Rock Creek Reservoir at the top of the reach. Water diverted at Rock Creek Dam enters a penstock and electricity is generated downstream where the water is again diverted at the Cresta Dam to produce electricity even farther downstream near the top of the Poe Hydroproject. The Rock Creek and Cresta projects are collectively licensed by FERC. Water temperature, timing and quantity of flow, sediment management, and recreation management are addressed in the FERC #1962 document, which has statutory authority over these issues.

The Bucks-Grizzly subwatershed also includes numerous dams on tributaries to the North Fork

[25] FERC #2107

Feather River. Spring Valley Lake, operated by CDFG, is a 75 acre-feet reservoir behind an earthen dam located in the headwaters of Rock Creek at approximately 2,000 meters above sea level. Lower Three Lakes Dam is operated by Pacific Gas and Electric on Milk Ranch Creek. It has a capacity of 606 acre-feet and is adjacent to Buck's Lake Wilderness. Bucks Diversion and Bucks Storage are located on Bucks Creek, the largest tributary to the North Fork Feather River in the Bucks-Grizzly subwatershed. Both are operated by Pacific Gas and Electric, and together, impound more than 100,000 acre-feet of water. Grizzly Forebay is also operated by Pacific Gas and Electric, and is located on Grizzly Creek.

Buck's Lake Wilderness is situated in the Bucks-Grizzly subwatershed and encompasses approximately 21,000 acres. The Pacific Crest National Scenic Trail dissects the subwatershed and the Wilderness. Numerous campgrounds and other recreation trails are present in and around the Wilderness. Topography within Buck's Lake Wilderness ranges between 600 meters above sea level in the North Fork Feather Canyon to more than 2,100 meters above sea level at Spanish Peak.

North Lake Oroville Subwatershed

The North Lake Oroville subwatershed includes the most-downstream reach of the North Fork Feather River, starting downstream of the Poe Hydropower Project (FERC No. 2107) diversion dam, extending downstream to include Lake Oroville, and ending at Oroville Dam (FERC No. 2100). North Lake Oroville subwatershed is bound to the west by the West Branch Feather River subwatershed and to the east by the Lower Middle Fork Feather River subwatershed and South Lake Oroville subwatershed (see Figure 4.8). State Highway 70 runs adjacent to the North Fork Feather River from Lake Oroville to the northern extent of the reach and beyond. Poe Powerhouse dewaters nine miles of the North Fork Feather River in order to generate electricity during peak demand periods. Lake Madrone Water District operates one small reservoir of 200 acre-feet on Berry Creek in the southern portion of the subwatershed near Lake Oroville.

Wolf Creek Subwatershed

The Wolf Creek subwatershed, located southeast of Lake Almanor, is a tributary to Lower Indian Creek (see Figure 4-8). The watershed is separated from the Hamilton Branch subwatershed to the north by Keddie Ridge, which runs northwest to southeast. Wolf Creek, the main stream in the watershed, runs along Highway 89 east through the city of Greenville. The stream has blown out several times, and has been the focus of past restoration efforts. The creek is somewhat incised for much of the stretch along the highway and through the town. Past Greenville, it flows out into Indian Valley, where it empties into Indian Creek. Bidwell Lake Dam, on North Canyon Creek in the southern end of the watershed is the only major impoundment within the subwatershed.

Lights Creek Subwatershed

The headwaters of Lights Creek flow south off of Diamond Mountain and eventually make their way into the upper end of North Arm Indian Valley before entering into Indian Creek (see Figure 4.8). There are no major lakes, reservoirs, dams or diversions within this subwatershed. There was some mining along Lights Creek, and tailings can be found within the valley bottom sediments.

Upper Indian Creek Subwatershed

The Upper Indian Creek subwatershed is located east of the Lights Creek subwatershed. The headwaters of Indian Creek flow off the south flank of Diamond Mountain. Several small creeks that run off of the southwest side of the Diamond Mountains join the main stream in the Antelope Lake area. Antelope Lake is a reservoir created by Antelope Lake Dam, a 22,566 acre-feet capacity dam built in 1964. From the reservoir, Upper Indian Creek flows south into the head of Genesee Valley, just below the confluence of Last Chance Creek and Red Clover Creek. All of these waters come together to form Lower Indian Creek. The Upper Indian Creek subwatershed has been identified as a high priority watershed for restoration, with the main stem identified as a priority stream.

Last Chance Creek Subwatershed

This subwatershed drains the southwest slope of the Diamond Mountains from the Clark's Peak area in the north (adjacent to Upper Indian Creek), south to the Frenchman area (see Figure 4.8). Last Chance Creek flows east to west along the Diamond Mountains. The Creek and its many small tributaries flow though a network of high meadow systems. Clarks Creek drains the north end of the subwatershed and then joins Last Chance Creek as the stream turns south towards Squaw Valley.

Squaw Queen Creek flows east to west through the open meadows of Squaw Valley, roughly parallel to Last Chance Creek. Squaw Creek then flows into Last Chance, and the waters flow west toward the confluence with Red Clover Creek and then Indian Creek. There are no major impoundments, lakes, or other large water bodies.

Last Chance has been identified as a priority subwatershed for restoration (Ecosystem Sciences 2004). Many streams have downcut their channels, lowering the water table and disconnecting the stream from the floodplain. An old railroad grade runs up both Last Chance Creek and Squaw Queen Creek, further influencing ecosystem function. As mentioned above, Last Chance Creek was identified as a significant source of sediment for the East Branch of the North Fork.[26] Willow Creek, a tributary to Last Chance in the Squaw Valley Creek area, is one of the few remaining intact systems.

Red Clover Creek Subwatershed

The Red Clover Creek subwatershed is a narrow catchment flowing from the Frenchman area at the edge of Sierra Valley (see Figure 4.8). It runs west-northwest between Lake Davis and Squaw Queen Creek. Dixie Creek drains off of the mountain of the same name, into a meadow system nearly connected to Squaw Valley; it then spills into Red Clover Creek in the larger Red Clover Valley. Red Clover Valley is a large open valley separated from Lake Davis by Crocker Mountain.

The waters of Red Clover then flow west to their confluence with Last Chance Creek, and then into Lower Indian Creek. There are no major water bodies or substantial water infrastructure facilities within this subwatershed. Red Clover has been identified as a priority subwatershed for restoration. Both Dixie Creek and the main stem of the stream have been designated as priority streams.[27]

Lower Indian Creek Subwatershed

Lower Indian Creek begins when Last Chance and Red Clover Creeks, after coming together upon entering Genesee Valley, flow into Upper Indian Creek. The Creek flows west through Genesee Valley in a broad inset channel. Two main tributaries enter at the bottom of Genesee Valley: Hosselkus from the Kettle Rock-Eisenhower area to the north, and Little Grizzly from the Lake Davis area to the south. Dolly Creek, a tributary to Little Grizzly, was the site of Walker Mine. The Forest Service operates a small earthen dam at the tailings site.

After Hosselkus Creek and Little Grizzly Creek enter the stream, it leaves Genesee Valley and passes through a narrower valley between Mt. Jura and Grizzly Peak towards the town of Taylorsville and Indian Valley. Out of North Arm of Indian Valley, Lights Creek enters into Indian Creek. At the west side of the valley, Wolf Creek enters just after flowing past the town of Greenville. Indian Creek then flows south to its confluence with Spanish Creek to form the East Branch of the North Fork.

Lower Indian Creek has been identified as a priority subwatershed for restoration. Three streams within the sub-watershed have been identified as priority streams (Hosselkus, Indian Creek Taylorsville reach, and the main stem).

Spanish Creek Subwatershed

This subwatershed is centrally located within the Upper Feather River Watershed (see Figure 4.8). Spanish Creek's headwaters are high on the eastern side of the Sierra Crest in the Spanish Peak area above Buck's Lake. There are two impoundments built on Silver Creek and Wampanusie Creek, tributaries of Spanish Creek. Spanish Creek and its tributaries flow east from the crest through Meadow Valley and then into the western end of American Valley and the town of Quincy. From the eastern part of the watershed, Greenhorn and Thompson Creeks flow west down the Plumas Trench into Thompson Valley, and then into Spanish Creek at the eastern end of American Valley.

Because the headwaters of Spanish Creek flow from the high Sierra peaks, the western part of the subwatershed receives uncharacteristically high precipitation for the East Branch of the North Fork. It therefore has a large discharge compared with other subwatersheds of the East Branch.

Several factors, including the high discharge, proximity to the American Valley and the town of Quincy, and the degraded condition, make the watershed a high-priority subwatershed for restoration. The main channel of Spanish Creek was relocated by a restoration project. Five streams within the subwatershed were identified as priority creeks: Thomson, Greenhorn, Meadow Valley, Upper Spanish, and the main stem.

[26] Plumas County 1989

[27] Ecosystem Sciences 2004

Lower East Branch of the North Fork of the Feather River Subwatershed

The confluence of Spanish Creek and Lower Indian Creek form the East Branch of the North Fork of the Feather River. The river runs roughly east to west through Butterfly Valley. As the river approaches the Sierra Crest to the west, the river enters one thousand meter Serpentine Canyon along a railroad grade and Hwy. 70. The East Branch of the North Fork of the Feather River meets the North Fork at the end of the canyon at French Bar, the western end of the subwatershed.

Middle Fork of the Feather River

The Middle Fork of the Feather River headwaters flow from the Frenchman area of the Diamond Mountains and the mountains surrounding Sierra Valley. The upper watershed is characterized by the large meadows of Sierra valley, but after it flows through Mohawk Valley it plunges into a wilderness canyon that has earned the river the distinction of being classified as Wild and Scenic. The two subwatersheds that contain broad valleys are heavily impacted by land management (Sierra Valley and Lake Davis-Long Valley) have been identified as priority subwatersheds for restoration.

Frenchman Lake Subwatershed

This small subwatershed is north of Sierra Valley, from the Diamond Mountains in the east to Dixie Mountain in the west. Little Last Chance Creek flows southeast from the divide with Last Chance Creek into Frenchman Lake, a reservoir that floods over 1500 acres of Little Last Chance Valley. The 55,000 acre-feet capacity reservoir is managed primarily for recreation.

Sierra Valley Subwatershed

Sierra Valley is the largest valley within the watershed. The valley is a broad expanse of meadows crossed by a network of stream channels. Although there is only one small dam (on Antelope Creek) within the subwatershed, there is a network of irrigation canals throughout the valley. An old lakebed, the valley has several seasonal and perennial standing water bodies. The many Sierra Valley channels, along with Little Last Chance Creek (from the Frenchman area) come together to form the Middle Fork of the Feather River in the northwest corner of the watershed.

Sierra Valley has been identified as a priority subwatershed for restoration. Water tables have been lowered over recent decades and the Sierra Valley groundwater district was created to better manage the groundwater.[28]

Lake Davis-Long Valley Subwatershed

The Middle Fork flows out of Sierra Valley in the east southwest and then northeast toward the Sierra Crest and the Nelson-Onion Valley subwatershed. In the northern part of the watershed, Big Grizzly Creek flows off of the Grizzly peak and through a valley of the same name. It empties into Lake Davis, an 83,000 acre-feet capacity reservoir. Below the reservoir, there is a small private dam on the creek before it flows into the Middle Fork.

Downstream of Big Grizzly Creek, the Middle Fork flows through the town of Portorola and Humbug valley. The river enters the Mohawk Valley and the town of Graeagle as it turns northwest to parallel the Sierra Crest. Above the Mohawk Valley to the southwest, four small dams exist up in the high lakes area. Several natural lakes exist in the vicinity, including the largest, Gold Lake. After following Mohawk valley northwest the river turns west and begins to cut through the high sierra. This is the beginning of the Middle Fork Canyon, which downstream exceeds 1000 m from ridge to river in some areas.

The Lake Davis-Long Valley subwatershed is a high priority subwatershed for restoration. Four of its Creeks (Sulphur, Jamison, Poplar and Smith) have been identified as high priority streams.

Nelson-Onion Valley Subwatershed

The Middle Fork flows west out of the Lake Davis-Long Valley subwatershed to be joined by Nelson Creek at the east end of the Nelson-Onion Valley subwatershed (see Figure 4.8). Nelson Creek drains a basin between the north slope of the Sierra Crest and Eureka Ridge. After gaining the substantial flow of Nelson Creek, the Middle Fork plunges through a deep wilderness canyon. This confined, bedrock streambed, wild and scenic river flows through the crest of the Sierra into the Lower Middle Fork subwatershed.

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[28] SVGMD 1980

Lower Middle Fork Subwatershed

The Middle Fork flows from the northeast to southwest through the canyon as west-side tributaries like the Little North Fork and South Branch of the Middle Fork add to its flow. It then empties into Lake Oroville just below Bald Rock Canyon in Feather Falls National Scenic Area.

South Lake Oroville Subwatershed

This small subwatershed encompasses the uplands surrounding the arm of Lake Oroville that flooded the bottoms of the Middle Fork and South Fork canyons (see Figure 4.8). Lake Oroville is the largest water body within the entire watershed, with a 3.5 million acre-foot capacity. Its 15,805 acre surface spans the subwatersheds of South Lake Oroville and North Lake Oroville subwatersheds.

South Fork of Feather River Subwatershed

Like the West Branch, the South Fork contains only one subwatershed. The South Fork subwatershed is a roughly linear northeast to southwest drainage off the high Sierra.

This small sub-watershed has seven dams. The largest reservoir is Little Grass Valley Reservoir on the main stem of the South Fork. At 93,010 acre-feet capacity, Little Grass Valley is the forth largest water body within the Upper Feather River Watershed. The reservoir is just west of Gibsonville Ridge, the southern edge of the Upper Feather River Watershed. Downstream of the South Fork Diversion (owned by the Oroville Wyandotte Irrigation District), the river passes between Lumpkin and Mooreville Ridge. Lost Creek drains the area east of Mooreville ridge before entering at the deeper, 400 meter canyon south of Fields Ridge. Lost Creek passes through reservoirs before entering the South Fork. The largest, Sly Creek, has over 65,000 acre-feet in capacity. There is another small dam on Grizzly Creek, a small tributary to the south. After passing through Forbstown Diversion (owned by the Oroville Wyandotte Irrigation District), the South Fork spills into Ponderosa Reservoir, at the top of the southernmost arm of Lake Oroville.

4.5 Land use, Water use, Water Supplies

Land Uses

A variety of land uses occur in the Upper Feather River Watershed. Of these land uses agriculture is predominant, yet it only covers 3.5% of the total 2.2 million acres of the watershed. For this section, land use and water use data will focus on Plumas County as it constitutes over 72% of the watershed and has the most specific available data. Watershed-wide estimates of land use acreages, population numbers, and water use is presented in Chapter 5 Water Demand.

Within Plumas County, native vegetation accounts for 93% of the land area; native water, native riparian, agriculture and urban uses account for a small part of the land uses (see Table 4.5). The over one million acres of National Forest in Plumas County accounts for this high percentage of native vegetation land use. Native water, represented by over 1,000 miles of rivers and streams, hundreds of lakes, several reservoirs, and wetlands, accounts for just over two percent of the land use. Riparian areas, which interface between aquatic and terrestrial habitats, comprise less than two percent of land uses in Plumas County. The majority (over 95%) of montane riparian habitat in the county is unprotected from conversion to other land uses.

Land Use*	Acres	%
Agricultural lands (irrigated & non irrigated)	46,138	2.76
Semi-agricultural lands	522.75	.03
Urban (residential, commercial, & industrial)	10,553.44	.63
Native Riparian	20,837.49	1.25
Native Water	39,189.21	2.34
Native Vegetation	1,554,126.60	93
Native Barren	189.57	.011
TOTAL	**1,672,696.43**	

Table 4.5. Plumas County Land Uses

Data from California Department of Water Resources 1997 survey

Agricultural

Agriculture comprises less than 3% of the land use in Plumas County and consists mainly of field crops such as alfalfa hay, meadow hay, grain hay, irrigated pasture, non-irrigated pasture, and range pasture; there are few seed or vegetable crops.[29] The predominant agricultural use in Plumas County is cattle production. Cattle (stockers and feeders), irrigated pasture, and alfalfa hay are leading agricultural commodities in Plumas and Sierra counties. In 1997 there were 145 farms in Plumas County consisting of 118,075 acres or 6.7% of the total county land area (Note: these land area figures and percentages are not consistent with information provided by the California Department of Water Resources) (USDA-National Agricultural Statistics Service). In Sierra County, there were 57 farms consisting of 48,704 acres, or 7.6% of the total land area. From 1997 to 2002, the number of farms in Plumas and Sierra counties decreased by 2% and 9%, respectively. However, the amount of acres in farmland increased in both counties (44% for Plumas County and 20% for Sierra County), as did the average size of farms.

The increase in farmland acres does not reflect the trend in California as a whole, which experienced a decrease of approximately 100,000 acres in farmland from 1997 to 2002. Land use trends indicate that urbanization rates will continue to increase, mostly for residential and commercial uses, while the number of acres in farmland will decrease.[30]

The number of acres in land preservation contracts in Plumas County recognized by the California Land Conservation Act of 1965 (also known as the Williamson Act) is approximately 82,000.[31] This restricts these parcels of land to agricultural or open space use. A majority of pasture and crop lands (over 94%) in the county, however, are unprotected from conversion to other uses.

Plumas County contains many private and public timberlands and ranked fifth of California's leading timber producing counties in 2003. It produced 97,866 million board feet, which is 56% of the total agricultural value in the county.

[29] Plumas County Agricultural Report, 2003
[30] California Farmland Conversion Report, 1998-2000
[31] Plumas County Vision 2020 Project Report, 2002

Urban

Urban land uses, which include commercial, industrial, and residential, comprise less than one percent of Plumas County's total land uses. For Plumas County, industrial uses comprise 56% of urban land uses, while single family residential uses make up the majority of the urban land use in Sierra County (see Table 4.6). The main communities scattered throughout the watershed include Chester, Lake Almanor, Greenville, Indian Valley, Feather River Canyon, Portola, Sierra Valley, Mohawk Valley, Quincy, and Meadow Valley. Portola is the only incorporated city in Plumas County.

Industrial uses include construction and mining industries, lumber manufacturing, and communications and public utilities. Commercial uses are predominantly the service producing sector and retail businesses. Residential uses are primarily single family units. With residential development expected to continue to increase in Plumas County, the County Planning Department has set aside zones to protect production-based land uses, such as agricultural and timber preserves.[32]

Urban Land Uses	Plumas County	Sierra County
Residential- single family	33%	64%
Residential- multi family	4%	10%
Commercial	6%	12%
Industrial	56%	5%
Large Land	1%	9%

Table 4.6. Urban Land Uses
Urban Land Uses in Plumas and Sierra Counties

Water Use

Water use in the watershed is for agriculture, urban, industrial and commercial uses and for environmental lands. Water use presented here is focused on Plumas County for two reasons; an entire data set is available and the county covers over 72% of the watershed. Please see Chapter 5 Water Demand for watershed wide estimates of agriculture, urban and environmental water use.

[32] Plumas County General Plan

Agricultural

The amount of irrigated crop area in Plumas and Sierra counties is approximately 32,700 and 13,000 acres, respectively. Pasture and alfalfa account for most of the irrigated crop acreage in both counties. The amount of applied water for agricultural use expressed in acre feet per acre in Plumas and Sierra counties in 2001 was 5.87 and 11.54, respectively. Agricultural water use estimates are based on the sum of water use requirements for different crops multiplied by their irrigated acreage. For a discussion on future agricultural water demands, see the Water Demand section.

Urban

Urban water use includes industrial, commercial, and residential uses. A majority of urban water use in Plumas County is for industrial and commercial uses (62%): residential water uses (interior and exterior) account for the remaining 38%. For Sierra County residential uses comprise a majority of urban water use (75%), with the remaining 25% used for industrial/commercial. The Sacramento Hydrologic Region urban use (includes residential, commercial, industrial, and landscape uses) is 286 gallons per capita per day; per year, applied urban water use is 766 taf (thousands acre-feet). Per capita use is forecasted to remain at similar levels in 2020 for the Sacramento Region without implementing conservation measures, and is expected to decrease to 264 if Best Management Practices and other conservation measures are applied as stipulated in the Urban Water Management Planning Act. Forecasting takes into account population, per capita income and economic activity, water price, and conservation measures. Additional information on current and future urban demand is provided in Chapter 5 of this Plan.

The Feather River Watershed represents a significant component of the State Water Project, and as such, it is important to address future urban water use at a more regional scale. Statewide urban uses for average years (versus drought years) are expected to increase to 12 million acre feet by 2020, an increase of over three million acre feet from 1995.[33]

[33] California Department of Water Resources

Environmental

Environmental waters are waters set aside or managed for environmental purposes. Environmental water use is defined as the sum of: dedicated flows in state and federal wild and scenic rivers; instream flows (water maintained in streams or rivers for beneficial uses); Bay-Delta outflows, and applied water demands of managed freshwater wildlife areas. In California, flows in wild and scenic rivers constitute the largest environmental water use. Approximately 78 miles of the Middle Fork Feather River are designated wild and scenic. Though it is important to recognize environmental uses, specific data are not readily available and will not be discussed further. For more information see The California Water Plan Update Bulletin 160-98.

Water Supplies

Water supplies in the Sacramento River Hydrologic Region, which includes the Feather River Watershed, come from surface and groundwater. The average year water supply for this region is 11,881 taf of surface water and 2,672 taf of groundwater. Sixty six percent of supply waters for Plumas County are from surface sources, while groundwater provides the remaining supply. During drought years, additional groundwater is pumped to compensate for reduced surface water supplies. For Sierra County, a majority of supply water is from surface sources (94%), while 6% is from groundwater. SWP water sources, discussed below, comprise a large part of supplied water for these counties and for other parts of California.

Reservoirs that supply some of the surface water needs in the watershed are Lake Oroville, Antelope Lake, Frenchman Lake, and Lake Davis. The major streams that provide waters to these reservoirs are the Feather River, Indian Creek, Little Last Chance Creek, and Big Grizzly Creek, respectively. Water supplies vary seasonally and year to year, depending on the amount of precipitation and corresponding runoff.

Water produced from the Feather River Watershed represents a significant component of the SWP, supplying 3.2 million acre-feet per year for downstream urban, industrial, and agricultural use.[34] Antelope Lake, Lake Davis, Frenchman Lake, Thermalito Afterbay, Thermalito Forebay, and Lake

[34] Lindquist 1999

Oroville are part of the SWPs. Lake Oroville, created by the three major forks of the Feather River, is the largest of the SWPs storage facilities, with a storage capacity of 3.5 million acre feet of water per year. The East Branch North Fork Feather River, which is contained completely in Plumas County, provides 25% of SWP water, which provides 48% of the developed municipal and industrial surface water supplies in California.[35]

Other water bodies providing water storage for municipal and domestic water supplies include Round Valley Reservoir, Rock Creek Reservoir, Butt Valley Reservoir, and Lake Almanor.[36]

Groundwater sources in the watershed are from privately owned and publicly operated well systems. The majority of groundwater reservoirs occur in the valleys on the east side of the Sierra Crest. Sierra Valley, the largest valley in the watershed, contains a large aquifer that has suffered from overuse in recent decades.[37]

Water Supply Administration
The Plumas County Flood Control and Water Conservation District is responsible for administering waters in the county and as such, provide for the control and disposition of flood and other waters of the district, among others beneficial uses.[38] Territory includes all of Plumas County except territory in Last Chance Creek Water District. The Feather River Resource Conservation District is also involved in watershed administration, serving as a liaison between public regulators and private landowners. The District undertakes projects that address watershed issues in the Feather River Watershed. The Sierra Valley RCD is responsible for administering groundwater in the Sierra Valley basin.

35 Clifton 1994
36 The California Water Plan Update Bulletin 160-98
37 Vestra 2005
38 Plumas County Flood Control and Water Conservation District Act of 1959

4.6 Biological Resources

Vegetation Communities

The vegetation communities of the Upper North Fork of the Feather River influence the water quality and quantity of the Feather River. Improving upland habitats is a plan goal. According to the CALVEG project[39], over 50% of the watershed is covered by Sierran mixed conifer series, which includes Ponderosa Pine (*Pinus ponderosa*), Foothill Pine (*Pinus sabiniana*), Douglas-fir (*Pseudotsuga menzesii*) and Incense Cedar (*Calocedrus decurrens*) among many others (See figure 4.11 Vegetation Communities Map). In the upper elevations of the high Sierra and the Diamond Mountains, the Sierran mixed conifer series gives way to the Red Fir (*Albies magnifica*) dominated zone. These two community types comprise roughly 70% of the Upper Feather Watershed.

The Urban-Agriculture cover-type is the third largest in the watershed. The majority of the 177,932 acres of this cover-type occur in Sierra Valley, the Plumas Trench, and the American Valley. Sagebrush communities are found in east-side watersheds like Last Chance and Red Clover subwatersheds of the East Branch, and Sierra Valley in the Middle Fork. The sagebrush (*Artemisia tridentata*) communities are found on valley floors, and have been encroaching on the meadows due to lowered water tables caused by stream incision and degradation. Mixed chaparral is found on the west slope of the Sierra Nevada between the West and North Forks, as well as around Lake Oroville and in scattered pockets throughout the mountain areas of the watershed.

Oaks (*Quercus spp*.), willows (*Salix spp*.), and cottonwoods (*Populus spp*.) are common riparian trees. Jeffrey Pine (*Pinus jeffereyi*) and Lodgepole Pine (*Pinus contorta*) woodlands, Oak savannas, and Montane Chaparral are scattered in pockets thoughout the watershed. Refer to Table 4.7: Vegetation Communities of the Upper Feather River Watershed for a complete list of the communities found within the Upper Feather River Watershed.

39 California Gap Analysis 1998

Community Type	Acres	Percentage
Sierran Mixed Conifer	1200796.41	51.75
Red Fir	428655.04	18.48
Urban-Agriculture	177932.87	7.67
Sagebrush	114909.14	4.95
Mixed Chaparral	88897.56	3.83
Jeffrey Pine	84313.10	3.63
Montane Hardwood	80902.51	3.49
Montane Chaparral	50140.91	2.16
Water	46916.63	2.02
Lodgepole Pine	11604.12	0.50
Perennial Grass	9835.25	0.42
Juniper	9793.93	0.42
Barren	8886.87	0.38
Blue Oak Woodland	3800.12	0.16
Annual Grass	2784.53	0.12
Total	2320169.00	100.00

Table 4.7. Vegetation Communities
Communities of the Upper Feather River Watershed, including their acreages and percentage of the watershed. (source: California Gap Analysis 1998)

Fisheries

The Upper Feather River Watershed has a variety of aquatic habitats including natural ponds and lakes, reservoirs and canals, small alpine streams, and larger, canyon-enclosed rivers. The fisheries of the watershed are also varied with numerous species occupying the varied habitats. Both native and non-native fish species are present in most waterways. In general, there are two types of fisheries that exist in the watershed: cold water river and stream fisheries, and warm water lake and reservoir fisheries.

Historically, the Upper Feather River Watershed was habitat to chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*). The construction of Oroville Dam in the late 1950s prevented salmonids from entering the upper watershed, therefore ocean-run salmonids are no longer present. The Feather River Fish Barrier Dam, located just downstream of Oroville Dam, now diverts migrating salmon and steelhead to the Feather River Fish Hatchery Ladder. Once these anadramous fish reach the top of the ladder, they are gathered into a tank, tranquilized, sorted for sex, then artificially spawned and killed; the eggs are then fertilized, incubated, held for approximately a year, then steelhead are released downstream and salmon are transported via truck to the San Francisco Bay-Delta where they live in the ocean until returning upstream to spawn as adults. There are proposals to re-introduce salmon and steelhead to the upper watershed for natural spawning, but to date, this has not occurred.

The fisheries of the Upper Feather River Watershed are managed and manipulated by the California Departments of Fish and Game and Water Resources. Particular reservoirs and streams are stocked with game fish for recreational purposes, and a history of species plantings and removals exist at several sites within the watershed. Frenchman Lake, upstream of Sierra Valley and headwaters of the Middle Fork Feather River, has been stocked with rainbow and brown trout, which have emigrated downstream to Little Last Chance Creek.[40] Ten species of fish were identified emigrating from Antelope Reservoir to Indian Creek, including brown bullhead, bluegill, and hitch.[41] A special strain of rainbow, Eagle Lake, trout has been planted by CDFG, and is now found in many lakes in the Upper Feather River Watershed

Fish species in the Upper Feather River Watershed:
- Rainbow Trout
  Oncorhynchus mykiss
- Eagle Lake Rainbow Trout
  Salmo gairdnerii aquilarum
- Eastern Brook Trout
  Salvelinus fontinalis
- Brown Trout
  Salmo trutta
- Lake Trout (Mackinaw)
  Salvelinus namaycush
- Kokanee Salmon
  Oncorhynchus nerka
- Carp
  Cyprinus carpio

Channel Catfish:
- *Ictalurus Punctatus*
- Hitch
  Lavinia exilicauda
- Speckled Dace
  Rhinichthys osculus
- Brown Bullhead
  Ictalurus nebulosus
- Bluegill
  Lepomis macrochirus
- Redear Sunfish

[40] Rischbieter 1998
[41] Rischbieter 1996

Lepomis microlophus
Green Sunfish
Lepomis cyanellus
Black Crappie
Pomoxis nigromaculatus
Largemouth Bass
Micropterus salmoides
Northern Pike
Esox lucius

Species and Habitats of Special Concern

California Department of Fish and Game[42] has documented several species and habitats of special concern within the Feather River Watershed (see Figure 4.12 Map of Species of Special Concern). Five habitats are identified by CDFG to be of special concern within the Feather River Watershed. Darlingtonia Seeps harbor rare carnivorous plants and occur in the East Branch of the North Fork and Spanish Creek subwatersheds. Montane Freshwater Marsh are now widely scattered throughout the Sierra Nevada, including two areas in Sierra Valley. Northern Interior Cypress Forests are dry, upland forests associated with dry soils. The range of these forests extends from the northern Sierra Nevada into the Cascades and Klamath ranges. CDFG documents two Northern Interior Cypress Forests in the Feather River Watershed, located in the Lights Creek and Upper Indian Creek subwatersheds. Sierra Valley also harbors northern vernal pool habitat. These hydrologically distinct areas are filled with many endemic taxa. In the southwest part of the Yellow Creek subwatershed, a sphagnum bog is documented in the high country north of the Sierra Crest. Shagnum bogs occur in cold, highly acidic, permanently waterlogged soils, and low in available nutrients.

CDFG documents 91 species of special concern within the Feather River Watershed. The list includes four amphibians (all frogs), two yellow-legged frogs, a red-legged frog, and cascades frog (*Rana spp*.). Documented occurrences of these frogs occur mainly in the North Fork and West Branch watersheds. Seven birds of special concern are documented to different degrees within the watershed. Bald eagles (*Haliaeetus leucephalus*) and osprey (*Pandion haliaetus*) are quite well documented within the watershed while the black swift (*Cypseloides niger*) and great gray owl (*Strix nebulosa*) have been documented only once within the watershed. Three caddisflies and two beetles, including Valley Elderberry Longhorn Beetle (*Desmocerus californicus ssp. dimorphus)* are listed by CDFG. The California wolverine (*Gulo gulo),* western red bat (*Lasiurus blossevillii)*, Sierra Nevada snowshoe hare (*Lepus americanus spp. tahoensis),* American pine marten (*Martes Americana),* Pacific fisher (*Martes pennanti pacifica),* American badger (*Taxidea taxus),* and Sierra Nevada red fox (*Vulpes vulpes necator)* are the mammals of special concern that have been recorded within the watershed. The only listed reptile documented within the watershed is the northwestern pond turtle (*Emys (=Clemmys) marmorata marmorata*), which has been found on the west slope of the Sierra Nevada. Sixty seven plant species of special concern have documented occurrences within the Feather River Watershed, covering a wide range of habitats and locations. The full list of these species is found in Table 4.8 Species and Habitats of Special Concern.

[42] CDFG 2005

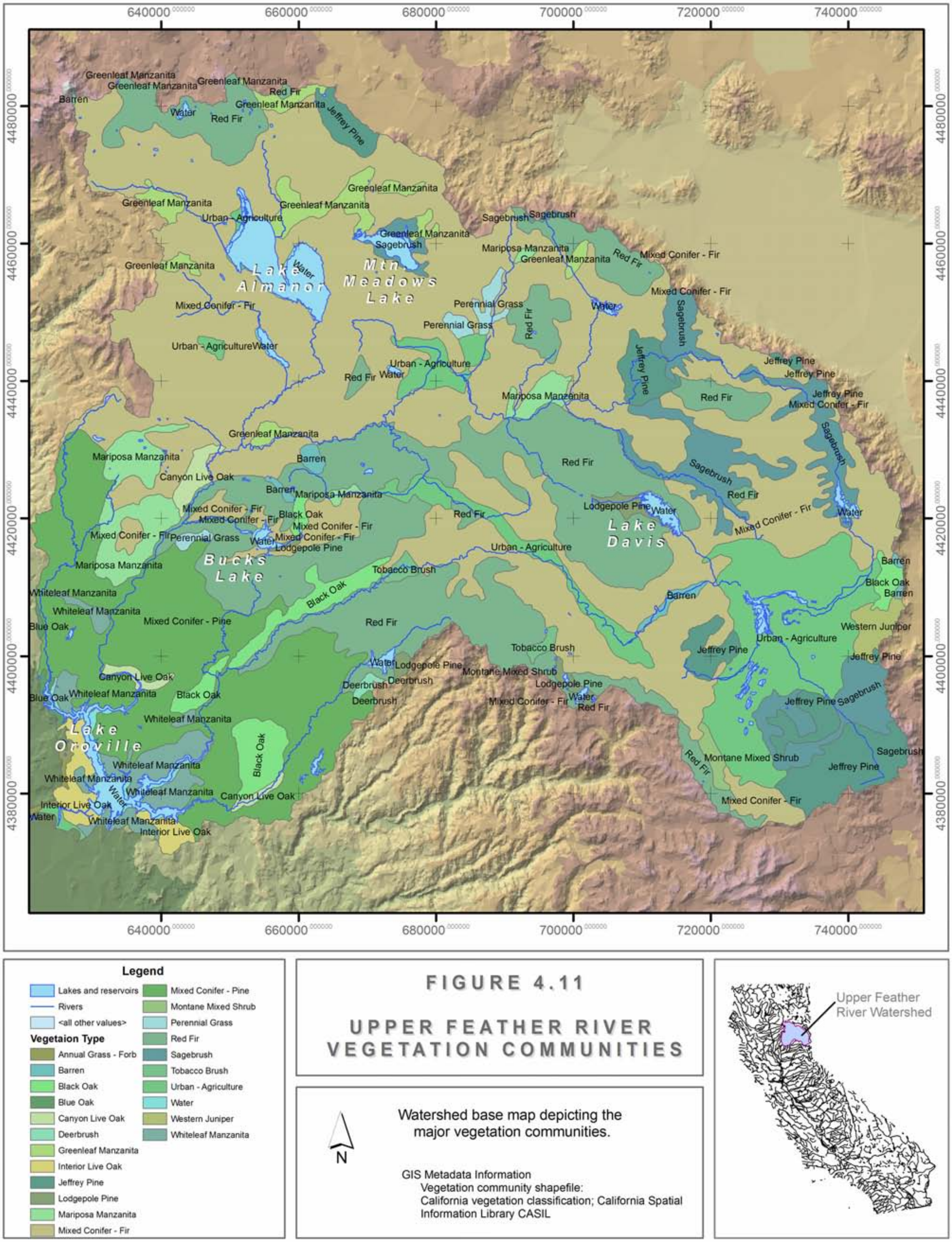

FIGURE 4.11

UPPER FEATHER RIVER VEGETATION COMMUNITIES

Watershed base map depicting the major vegetation communities.

GIS Metadata Information
Vegetation community shapefile:
California vegetation classification; California Spatial Information Library CASIL

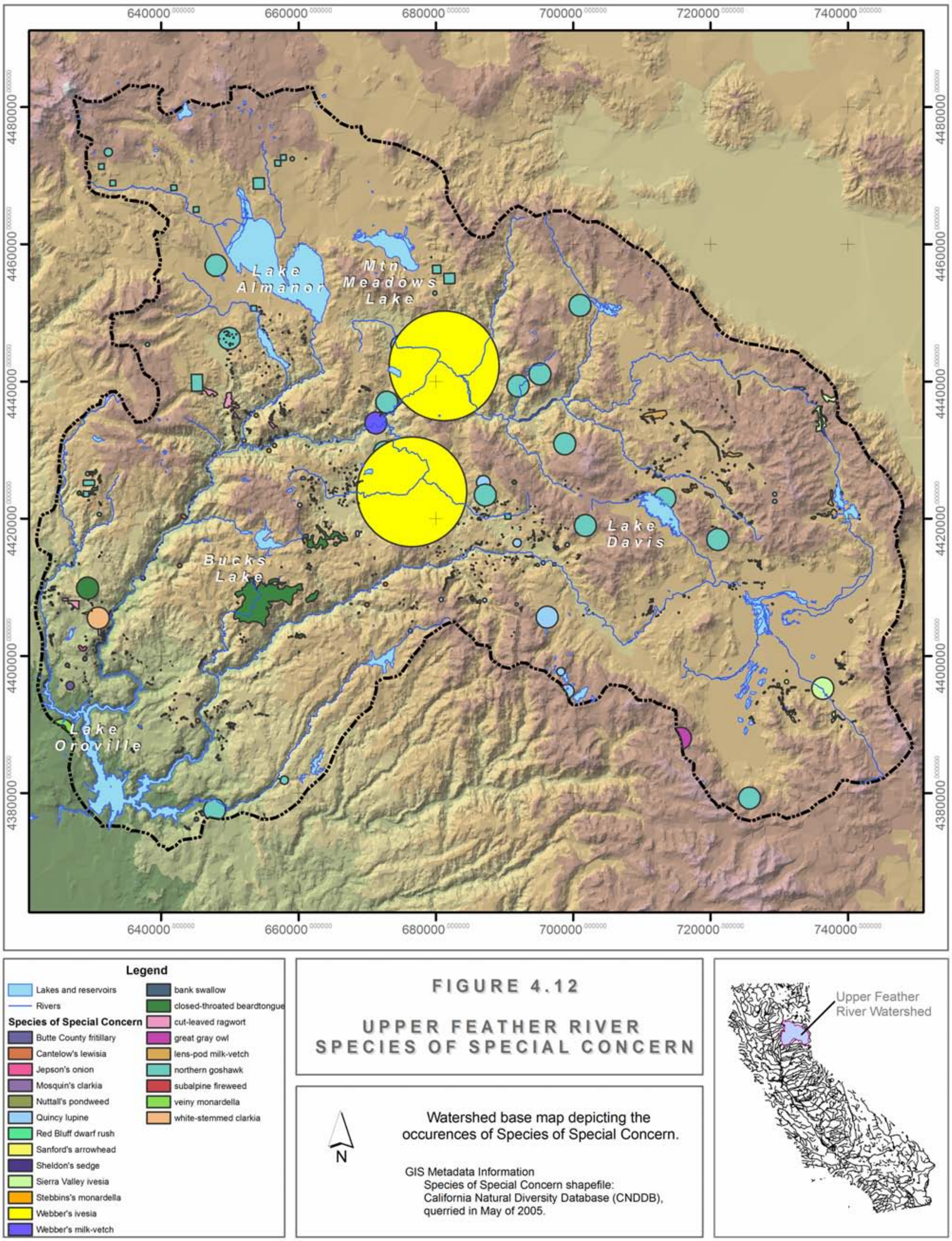

FIGURE 4.12

UPPER FEATHER RIVER SPECIES OF SPECIAL CONCERN

Watershed base map depicting the occurences of Species of Special Concern.

GIS Metadata Information
Species of Special Concern shapefile:
California Natural Diversity Database (CNDDB), querried in May of 2005.

Table 4.8. CNDDB Listed Occurrences of Species

Species and Habitats of Special Concern within the Feather River Watershed (CDFG 2005)

Life Form	Scientific name	Common Name	FEDLIST	CALLIST	# of Occurrences
AMPHIBIAN	Rana aurora draytonii	California red-legged frog	2	5	2
AMPHIBIAN	Rana boylii	foothill yellow-legged frog	7	5	5
AMPHIBIAN	Rana cascadae	cascades frog	7	5	13
AMPHIBIAN	Rana muscosa	mountain yellow-legged frog	1	5	16
BIRD	Accipiter gentilis	northern goshawk	7	5	46
BIRD	Cypseloides niger	black swift	7	5	1
BIRD	Empidonax traillii	willow flycatcher	7	1	16
BIRD	Haliaeetus leucocephalus	bald eagle	2	1	30
BIRD	Pandion haliaetus	osprey	7	5	40
BIRD	Riparia riparia	bank swallow	7	2	3
BIRD	Strix nebulosa	great gray owl	7	1	1
HABITAT	Darlingtonia Seep	Darlingtonia Seep	7	5	7
HABITAT	Montane Freshwater Marsh	Montane Freshwater Marsh	7	5	2
HABITAT	Northern Interior Cypress Forest	Northern Interior Cypress Forest	7	5	2
HABITAT	Northern Vernal Pool	Northern Vernal Pool	7	5	4
HABITAT	Sphagnum Bog	Sphagnum Bog	7	5	1
INVERTEBRATE	Desmocerus californicus dimorphus	valley elderberry longhorn beetle	2	5	1
INVERTEBRATE	Ecclisomyia bilera	Kings Creek ecclysomyian caddisfly	7	5	1
INVERTEBRATE	Hydroporus leechi	Leech's skyline diving beetle	7	5	1
INVERTEBRATE	Neothremma genella	golden-horned caddisfly	7	5	1
INVERTEBRATE	Parapsyche extensa	King's Creek parapsyche caddisfly	7	5	1
MAMMAL	Gulo gulo	California wolverine	7	2	3
MAMMAL	Lasiurus blossevillii	western red bat	7	5	1
MAMMAL	Lepus americanus tahoensis	Sierra Nevada snowshoe hare	7	5	1
MAMMAL	Martes americana	American (=pine) marten	7	5	10
MAMMAL	Martes pennanti pacifica	Pacific fisher	5	5	13
MAMMAL	Taxidea taxus	American badger	7	5	9
MAMMAL	Vulpes vulpes necator	Sierra Nevada red fox	7	2	5
PLANT	Agrostis hendersonii	Henderson's bent grass	7	5	3
PLANT	Allium jepsonii	Jepson's onion	7	5	15
PLANT	Arabis constancei	Constance's rock cress	7	5	50
PLANT	Astragalus lemmonii	Lemmon's milk-vetch	7	5	2
PLANT	Astragalus lentiformis	lens-pod milk-vetch	7	5	55
PLANT	Astragalus pulsiferae var. pulsiferae	Pulsifer's milk-vetch	7	5	17
PLANT	Astragalus tener var. ferrisiae	Ferris's milk-vetch	7	5	1
PLANT	Astragalus webberi	Webber's milk-vetch	7	5	11
PLANT	Balsamorhiza macrolepis var. macrolepis	big-scale balsamroot	7	5	1
PLANT	Betula pumila var. glandulifera	resin birch	7	5	2
PLANT	Bruchia bolanderi	Bolander's bruchia	7	5	2
PLANT	Calystegia atriplicifolia ssp. buttensis	Butte County morning-glory	7	5	6
PLANT	Carex lasiocarpa	slender sedge	7	5	6

PLANT	Carex limosa	shore sedge	7	5	8
PLANT	Carex petasata	Liddon's sedge	7	5	1
PLANT	Carex sheldonii	Sheldon's sedge	7	5	14
PLANT	Clarkia biloba ssp. brandegeeae	Brandegee's clarkia	7	5	2
PLANT	Clarkia gracilis ssp. albicaulis	white-stemmed clarkia	7	5	6
PLANT	Clarkia mildrediae ssp. mildrediae	Mildred's clarkia	7	5	39
PLANT	Clarkia mosquinii	Mosquin's clarkia	7	5	41
PLANT	Corallorhiza trifida	northern coralroot	7	5	1
PLANT	Drosera anglica	English sundew	7	5	9
PLANT	Eleocharis torticulmis	California twisted spikerush	7	5	2
PLANT	Epilobium howellii	subalpine fireweed	7	5	1
PLANT	Epilobium luteum	yellow willowherb	7	5	1
PLANT	Epilobium palustre	marsh willowherb	7	5	1
PLANT	Erigeron nevadincola	Nevada daisy	7	5	4
PLANT	Eriogonum spectabile	Barron's buckwheat	7	5	2
PLANT	Fritillaria eastwoodiae	Butte County fritillary	7	5	47
PLANT	Grus canadensis tabida	greater sandhill crane	7	2	43
PLANT	Hulsea nana	little hulsea	7	5	2
PLANT	Ivesia aperta var. aperta	Sierra Valley ivesia	7	5	40
PLANT	Ivesia baileyi var. baileyi	Bailey's ivesia	7	5	6
PLANT	Ivesia sericoleuca	Plumas ivesia	7	5	34
PLANT	Ivesia webberi	Webber's ivesia	5	5	3
PLANT	Juncus leiospermus var. leiospermus	Red Bluff dwarf rush	7	5	1
PLANT	Lewisia cantelovii	Cantelow's lewisia	7	5	29
PLANT	Lomatium foeniculaceum var. macdougalii	Macdougal's lomatium	7	5	2
PLANT	Lomatium hendersonii	Henderson's lomatium	7	5	3
PLANT	Lupinus dalesiae	Quincy lupine	7	5	158
PLANT	Mielichhoferia tehamensis	Lassen Peak copper-moss	7	5	1
PLANT	Monardella douglasii ssp. venosa	veiny monardella	7	5	1
PLANT	Monardella follettii	Follett's monardella	7	5	28
PLANT	Monardella stebbinsii	Stebbins's monardella	7	5	8
PLANT	Orcuttia tenuis	slender orcutt grass	2	1	4
PLANT	Oreostemma elatum	tall alpine-aster	7	5	10
PLANT	Penstemon janishiae	Janish's beardtongue	7	5	3
PLANT	Penstemon personatus	closed-throated beardtongue	7	5	22
PLANT	Potamogeton epihydrus ssp. nuttallii	Nuttall's pondweed	7	5	1
PLANT	Potamogeton praelongus	white-stemmed pondweed	7	5	1
PLANT	Pyrrocoma lucida	sticky pyrrocoma	7	5	53
PLANT	Rhynchospora alba	white beaked-rush	7	5	3
PLANT	Rhynchospora capitellata	brownish beaked-rush	7	5	4
PLANT	Sagittaria sanfordii	Sanford's arrowhead	7	5	1
PLANT	Scheuchzeria palustris var. americana	American scheuchzeria	7	5	4
PLANT	Scirpus subterminalis	water bulrush	7	5	6
PLANT	Scutellaria galericulata	marsh skullcap	7	5	3
PLANT	Sedum albomarginatum	Feather River stonecrop	7	5	16

PLANT	Senecio eurycephalus var. lewisrosei	cut-leaved ragwort	7	5	30
PLANT	Silene occidentalis ssp. longistipitata	long-stiped campion	7	5	1
PLANT	Silene suksdorfii	Cascade alpine campion	7	5	2
PLANT	Solidago gigantea	smooth goldenrod	7	5	1
PLANT	Stachys palustris ssp. pilosa	marsh hedge nettle	7	5	1
PLANT	Stanleya viridiflora	green-flowered prince's plume	7	5	1
PLANT	Trimorpha acris var. debilis	northern daisy	7	5	2
PLANT	Utricularia intermedia	flat-leaved bladderwort	7	5	9
PLANT	Utricularia ochroleuca	cream-flowered bladderwort	7	5	2
REPTILE	Emys (=Clemmys) marmorata marmorata	northwestern pond turtle	7	5	2

FEDCODE: 1: Federally listed as Endangered 2: Federally listed as Threatened 3: Proposed for federal listing as Endangered 4: Proposed for federal listing as Threatened 5: Candidate for federal listing 6: Species of concern 7: None - no federal status 8: Delisted - previously listed. CALCODE: 1: State listed as Endangered 2: State listed as Threatened 3: State listed as Rare 4: Candidate for state listing 5: None - no state status 6: Delisted - previously listed.

4.7 Social and Cultural Characteristics

Approximately 33,000 people inhabit the Upper Feather River Watershed. In Plumas County from 1990 to 2000, population increase was low (5.5%) compared to the state average (13%); however, the population is expected to increase by 8% from 2000-2010. There are no metropolitan areas within the watershed and the population density is low (8.2 people per square mile). The majority of people reside in small communities clustered around population centers such as Quincy, Indian Valley, the Almanor Basin, Portola, and Graeagle.

The population is made up of several predominant social groups including long time residents employed in the logging industry, lumber manufacturing, or agriculture, urban emigrants, government workers, retirees, the business community, and the Maidu Indians. The demographics are changing in response to the diversification of the local economy, which includes a shift in dependence upon resource based industries (i.e., timber, agriculture), to a more service based industry such as tourism.

A majority of inhabitants in the watershed are White persons not of Hispanic/Latino origin (89%); Hispanics/Latinos make up the biggest demographic group after Whites (6%). Other groups represented include American Indians and Alaska Natives (3%), Black or African Americans (.6%), Asians (.5%), and Native Hawaiian and other Pacific Islanders (.1%).

The Maidu Indians traditionally inhabited areas in the north-central part of California along the eastern tributaries of the Sacramento River, south of Lassen Peak.[43] Three groups of closely related peoples are referred to as the Maidu- the Maidu of Plumas and Lassen counties, the Konkow of Butte and Yuba counties, and the Nisenan of Yuba, Nevada, Placer, Sacramento, and El Dorodo counties. Archeological data and linguistic evidence suggests the Maidu speakers entered California from the north sometime around AD 500 and settled in the foothills of what is now the community of Oroville (McCombs, personal communication). At the time of the 1850 gold rush, an estimated 14,000 to 19,000 Maidu inhabited the area. Approximately 1, 500 Maidu people remain. A few families live on the Greenville Rancheria, but most are scattered around the traditional lands in the watershed, and around Oroville and Redding.

There are thousands of significant Maidu cultural sites in the watershed.[44] A significant sacred site for the Maidu is Homer Lake, which drains into Mountain Meadows. Survey data is available on file at the Plumas National Forest and with the private land records located at the Northeast Information Center at CSU Chico.[45]

Eighty-eight percent of the population are high school graduates. The portion of the population with a bachelor's degree is lower for Plumas County (18%) than for the State of California (27%).[46] Plumas County's population is older than the state as a whole (42 years) due to the large numbers of retirees and part time residents. Over the next 20 years, the percentage of older people is likely to grow as people between the ages of 25 and 44 leave the area in search of higher wages and more job opportunities.[47]

4.8 Economic Conditions and Trends

Communities within the watershed have traditionally been dependent upon resource-based industries such as agriculture, grazing, mining, and logging. Cattle production is a predominant agricultural use. Timber harvesting and lumbering, once predominant industries, are being replaced by service sector and trade jobs.

The unemployment rate in Plumas County is the highest in the region. It reached a peak in 1993 and 1994 at 22% due to a recession in the timber industry; in 2000 the unemployment rate averaged 8%. Diversification of the local economy has been necessary to offset the high unemployment rates. Areas of diversification include employment in ecosystem restoration projects, residential

[43] Young, 2003

[44] Archaeological surveys conducted in the watershed also suggest influences by the Washo people of the Great Basin.

[45] For more ethnographic information about the Maidu refer to Dixon 1905, Kowta 1988, and Riddell 1988.

[46] U.S. Census Bureau

[47] Plumas County General Plan, 2000

development, and tourism. An increase in recreational opportunities is fueling the growth in the service industry. Plumas County labor force and employment figures from 1997 suggest that the largest industry is in the services sector followed by mining/utilities and construction, and trade (wholesale and retail). Plumas County is working collaboratively with citizens and other interested parties to attract more businesses to the area.[48]

Personal income per capita in Plumas County is substantially lower than the state average ($26,170 and $40,367, respectively). From 1996 to 1998, per capita income was about 84% of state levels. This can be attributed to the low wage service jobs, which in 1996 accounted for 31% of all jobs in the county. Twelve percent of the county population live below the poverty level according to the 1990 census.

These income and employment factors qualify Plumas County as a disadvantaged community. Table 4.9 includes median household income figures for communities in Plumas County, percentages of the population in disadvantaged status, and percentage of California median household income, among others. According to this 2000 census data, 78% of the population in Plumas County qualifies as disadvantaged.

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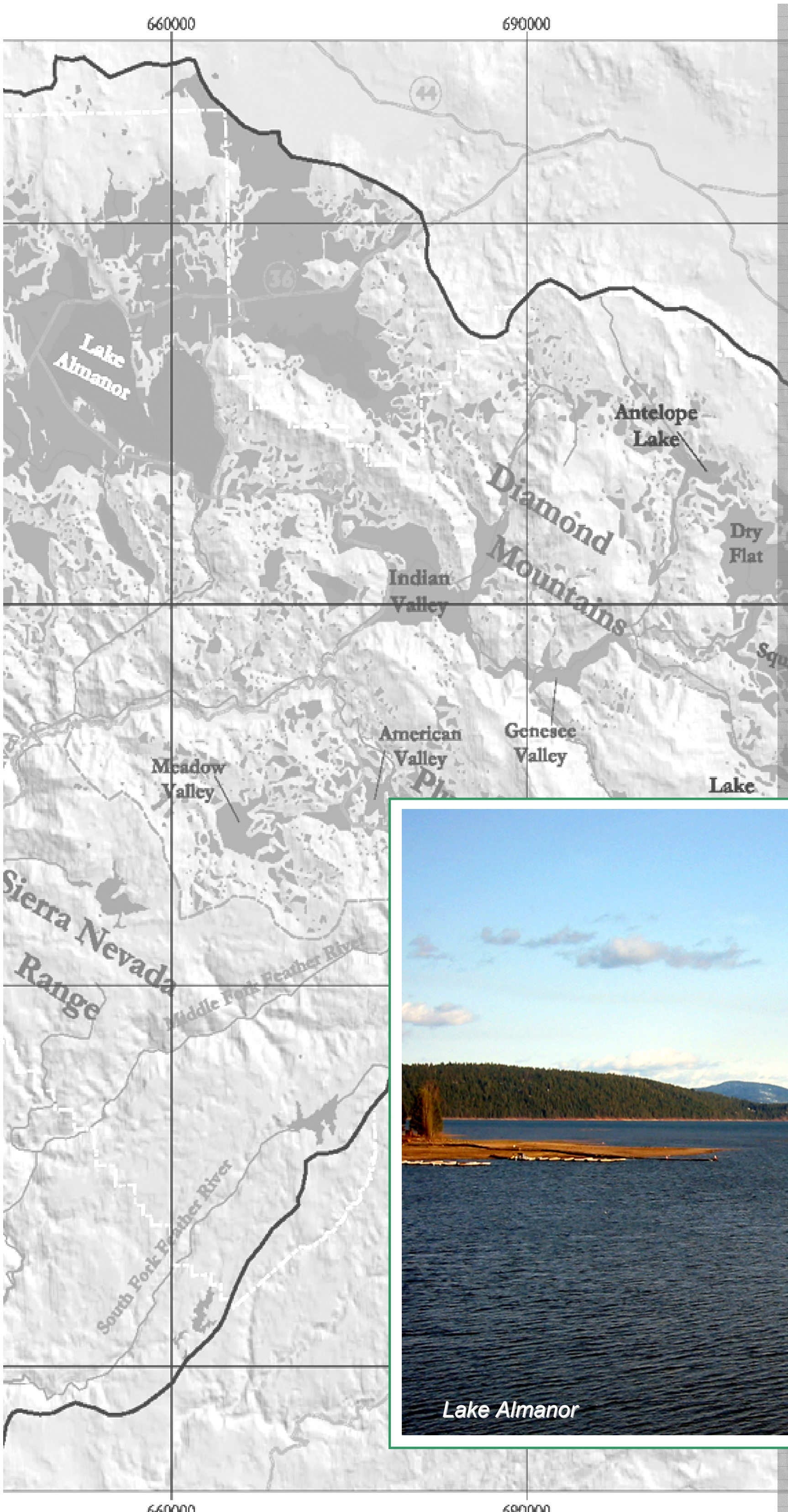
[48] Refer to the Plumas County Vision 2020 project for more information.

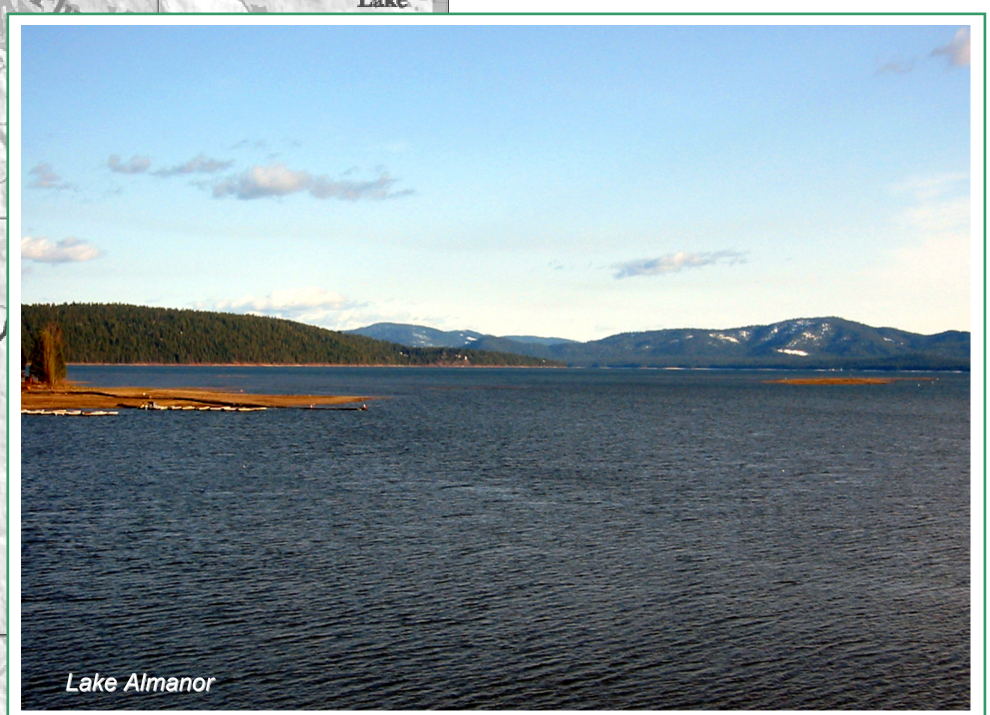
Table 4.9. Disadvantaged Communities (2000 Census Data)

U.S. Census "Place"	Median Household Income in 1999	Total Population	% of CA MHI
Plumas County	**$ 36,351.00**	**20824**	**76.5%**
Johnsville CDP, California	$6,042.00	37	12.7%
Belden CDP, California	$6,719.00	22	14.1%
Indian Falls CDP, California	$7,321.00	22	15.4%
Tobin CDP, California	$11,250.00	25	23.7%
Twain CDP, California	$16,071.00	61	33.8%
Clio CDP, California	$23,036.00	101	48.5%
Greenville CDP, California	$23,309.00	1217	49.1%
Lake Almanor Peninsula CDP, California	$26,000.00	378	54.7%
C-Road CDP, California	$26,250.00	139	55.3%
Portola city, California	$28,103.00	2251	59.2%
Iron Horse CDP, California	$30,208.00	347	63.6%
Crescent Mills CDP, California	$30,268.00	269	63.7%
Quincy CDP, California	$30,508.00	1849	64.2%
La Porte CDP, California	$30,781.00	40	64.8%
Blairsden CDP, California	$33,393.00	70	70.3%
Chester CDP, California	$33,413.00	2239	70.4%
Meadow Valley CDP, California	$33,571.00	569	70.7%
East Quincy CDP, California	$35,648.00	2390	75.1%
Chilcoot-Vinton CDP, California	$35,938.00	291	75.7%
Delleker CDP, California	$37,500.00	662	79.0%
Canyondam CDP, California	$40,104.00	35	
Mohawk Vista CDP, California	$40,893.00	103	
Lake Almanor Country Club CDP, California	$46,643.00	860	
Whitehawk CDP, California	$46,696.00	53	
Beckwourth CDP, California	$47,813.00	419	
Lake Almanor West CDP, California	$48,092.00	314	
Cromberg CDP, California	$51,250.00	314	
Greenhorn CDP, California	$51,513.00	174	
Graeagle CDP, California	$55,385.00	930	
Bucks Lake CDP, California	$56,250.00	14	
Plumas Eureka CDP, California	$58,571.00	287	
Keddie CDP, California	$64,583.00	79	
Percentage of Population in "Disadvantaged" Place		**78%**	
Sierra County Communities			
Loyalton	**$ 34,063.00**	874	71.7%

CHAPTER 5

Water Demand





Lake Almanor

5.0 Water Demand

The quantity, quality, and availability of water resources is vital to the natural and human activities within a watershed. Water is essential to the viability of the area. Wise use and prudent planning combined with management of surface and groundwater resources are fundamental to providing a substantial economic base for the residents of the Upper Feather River Watershed[1]. The following sections present a broad water demand forecast for the Upper Feather River Watershed. Understanding the magnitude and location of future water demands, and any potential changes to existing water demands, allows managers to make recommendations that will meet or manage demands for water quality and quantity into the future.[2] How growth is accommodated and the land use planning decisions made by cities and counties have important implications for future urban and agricultural water use.

The water forecast is calculated using county-wide estimates of population and agricultural data using region wide (Sacramento River) parameters, and under the assumption that the existing facilities and programs will remain in place. A more detailed watershed assessment with a more in-depth analysis is warranted. For example, water rights are not included in this water demand forecast. Yet, over 1,000 water rights, or water rights applications, exist within the Upper Feather River Watershed. Water rights are either appropriated or riparian. An appropriated right is an exclusive right to take a specific amount of water from a particular source for a specific use on a specific site for a specific amount of time. Riparian rights, on the other hand, belong to the land bordering a water source.[3] With over 1,000 water claims in the watershed, the amount of water, timing of use, and specified use of each water right must be known and analyzed to accurately assess future water availability within the Upper Feather River Watershed.

The Upper Feather River Watershed is located within the Sacramento River Hydrologic Region, which the Department of Water Resources defines as all basins draining into the Sacramento River system in the Central Valley (including the Pit River drainage), from the Oregon border south through the American River drainage basin.[4] The Sacramento River Region demand for water is significantly higher than that of the Upper Feather River Watershed simply because of its larger population and agricultural acreages. For this water demand forecast, the per capita water use parameter of the Sacramento River Region will be used to forecast urban water use and future demand. The agricultural water demand forecast parameters (estimated water use and estimated agricultural acreage change) of the Sacramento River Hydrologic Region are used to forecast future agricultural water demand. These region wide water use parameters may over-estimate the water demand for the Upper Feather River Watershed, as the Sacramento River Hydrologic Region is the second largest user of agricultural water and the third largest consumer of urban water of the ten California Hydrologic Regions.[5]

The endpoint of the Upper Feather River Watershed is Lake Oroville. Lake Oroville is the keystone of the SWP and has a maximum capacity of 3,537,580 acre-feet. Runoff from the Upper Feather River Watershed is collected and stored in the reservoir for release to the Sacramento-San Joaquin Delta through Oroville Dam, Thermalito Diversion Dam, and Thermalito Afterbay. The 30 year average annual inflow to Lake Oroville is 1,760,000 acre-feet.[6] Although Lake Oroville is in the re-licensing process this water demand forecast will assume that existing inflow and capacity for Lake Oroville will remain the same for 2020.

The Upper Feather River Watershed contains portions of 7 counties (Table 5.1). Plumas County comprises the most area of any county in the watershed covering over 1.6 million acres, which constitutes nearly 99% of the county and 72% of the watershed. Butte and Sierra counties comprise the next largest area of the watershed covering 341,476.18 acres and 164,979.02 acres respectively. The remaining counties (Lassen, Shasta, Tehama, and Yuba) cover only small portions of the watershed. These small portions are mainly in National Forest Land and are not be used in the water demand forecast.

Water demand in the Upper Feather River Watershed is derived for three categories; agriculture, urban, and environmental.

[1] Vestra 2005
[2] CDM 2004
[3] California Water Law & Policy 2003
[4] DWR 1998
[5] DWR 1998
[6] NOAA 2005

County	Total Size (Acres)	Acres in Watershed	% in Watershed	% of Watershed
Butte	1,072,692.12	341,476.18	31.83	14.9
Lassen	3,020,394.37	118,954.05	3.94	5.2
Plumas	1,673,682.02	1,651,084.83	98.65	72.1
Shasta	2,460,536.78	11,616.40	0.47	0.5
Sierra	615,880.38	164,979.02	26.79	7.2
Tehama	1,893,613.69	932.52	0.05	0.04
Yuba	411,972.86	1,333.06	.32	0.06
Total (Acres)		Feather River Watershed 2,290,376.07		100

Table 5.1. County acreages of the Upper Feather River Watershed

*Acreages derived from CASIL's county shapefile and watershed shapefile

5.1 Agricultural Water Demand – Current and Future

California's agricultural acreage is forecasted to decline slightly by 2020, along with agricultural water use. The total irrigated crop acreage in the state is forecasted to decline by 325,000 acres from 1995 to 2020. Reductions in crop acreage are due to urban encroachment, drainage problems in the west side San Joaquin Valley, and a more competitive economic market for California agricultural products. Even with the slight decrease California is still anticipated to lead the nation's agricultural production because of advantages such as climate and proximity to domestic and export markets.[7]

Consistent with the state findings, the Sacramento River Hydrologic Region will experience a slight decrease, approximately 1% (0.51), in agricultural acreage by 2020.[8] Correspondingly, the Sacramento River Hydrologic Region's water use, defined as acre-feet per acre, is expected to decrease by 1.6% in an average year and 2.6% in a drought year due to improved conservation practices and economic benefits.[9] These State and Regional trends are consistent with the rest of the country as water use is lower nationwide in 2000 than it was in 1975.[10] USGS data indicates that modest water conservation and efficiency efforts combined with other technological and economic changes has cut per capita use.

Agriculture in the Upper Feather River Watershed is a significant user of water. In fact, it is the largest developed water using industry in the Sierra Valley Watershed, a portion of the Upper Feather River Watershed.[11] Farms, pastures and other agricultural entities obtain irrigation water from many sources, as the streams, creeks and lakes of the watershed deliver water to agricultural lands. Agricultural acreage per county is consistent with the overall acreages per county in the watershed, with Plumas and Sierra counties containing the most agricultural area of the counties in the watershed. In fact, the other five counties (Butte, Lassen, Shasta, Tehama, and Yuba) contain no agricultural lands or only a very small amount (Table 5.2). Therefore, the agricultural acreages for Plumas and Sierra counties are used to forecast agricultural water demand in the Upper Feather River Watershed (Table 5.3).

[7] DWR 1998
[8] DWR 2004
[9] DWR 2000
[10] Pacific Institute 2004
[11] Vestra 2005

County	Total County Size (Acres)	Acres of County In Watershed	Acres of Agriculture in Watershed*
Butte	1,072,692.12	341,476.18	90
Lassen	3,020,394.37	118,954.05	Less than 5
Plumas	1,673,682.02	1,651,084.83	46,660.75**
Shasta	2,460,536.78	11,616.40	none
Sierra	615,880.38	164,979.02	33,613.23
Tehama	1,893,613.69	932.52	none
Yuba	411,972.86	1,333.06	none
Total Feather River Watershed (Acres)		2,290,376.07	

Table 5.2. Agricultural acreage per county within the Feather River Watershed

*Agriculture acreages derived from LCMMP mapping performed by the California Department of Forestry and Fire Protection except for Plumas County. Plumas County data from the Department of Water Resources.
**Agriculture acreage for Plumas County derived by summing irrigated, non-irrigated, and semi-agricultural land areas.

Agricultural fields are the most common vegetative community in the valleys of Plumas and Sierra counties. Pasture and alfalfa account for most of the irrigated crop acreage in both counties. Alfalfa (*Mendicago sativa*) grown for hay, is a perennial legume (e.g., pea family) and is a more efficient user of water than many other crops, yet irrigation is still a prerequisite for its growth.[12]

Agricultural Land	Plumas*	Sierra**	UFR Watershed
Irrigated and Non-Irrigated	46,138.00	30,181.33	76,319.33
Semi-agricultural	522.75	N/A	522.75
Total	46,660.75	30,181.33	76,842.08

Table 5.3. Agricultural Lands in Plumas and Sierra Counties

*Plumas County Agricultural land acreages from the California Department of Water Resources
**Sierra County watershed acres are from the Sierra Valley Watershed Assessment (Vestra 2005), which is based on LCMMP mapping. Data represents only the Sierra Valley portion of Sierra County.

Table 5.3 includes the total agricultural acreages for Plumas and Sierra counties within the Upper Feather River Watershed. The actual amount of irrigated crop area in Plumas and Sierra counties, according to the Department of Water Resources is approximately 32,700 and 13,000 acres, respectively.[13] In 2001 applied water for agricultural use in Plumas County ranged from 1.47 to 2.93 acre-feet per acre, with an average of 2.2 acre-feet per acre. Likewise in 2001, applied water for agricultural use in Sierra County ranged from 2.79 to 4.42 acre-feet per acre, with an average of 3.6 acre-feet per acre.

Agricultural water use estimates are based on the sum of water use requirements for different crops multiplied by their irrigated acreage. Water use varies for different crops ranging from 1.3 to 3.3 acre-feet per acre (Table 5.4). An example of estimates for applied water per crop is shown in Table 5.4 (DWR 2000 from Vestra 2005). A further analysis that determines water use by crop type is needed to perform a thorough water demand forecast. Acreages within the watershed for specific crop types are not available at this time.

[12] Vestra 2005
[13] DWR 2001

Crop	Unit ET Appl. Water	Unit Appl. Water (ac-ft/ac)		Net Irr.Acres (1,000's acres)			ET of Appl. Water (1,000's ac-ft)			Appl. Water (1,000's ac-ft)		
Grain	1.0	1.4	1.3	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.7	0.7
Alfalfa	2.0	2.7	2.6	3.5	1.8	5.3	7.0	3.6	10.6	9.5	4.7	14.2
Pas.	2.3	3.3	3.0	0.0	0.1	0.1	0.0	0.2	0.2	0.0	0.3	0.3
Meadow Past.	2.1	3.0	2.9	20.9	0.0	20.9	43.9	0.0	43.9	62.7	0.0	62.7
Meadow Pasture - X	1.0	1.4	1.4	6.0	0.0	6.0	6.0	0.0	6.0	8.4	0.0	8.4

Table 5.4. Applied water demand by crop type.*

*Source: Department of Water Resources 2000

Table 5.5 presents the forecasted water demand for agricultural uses in the Upper Feather River Watershed. Agricultural water demand will decrease slightly in 2020. This trend is consistent with California.

Year	Agricultural Acres _ - 0.51%	Water Use (ac-ft/ac)	Total (ac-ft/yr)
Plumas County – average use 2.20 ac-ft/ac (2001)			
2000	46,660.75	2.20	102,653.65
2020 Average	46,422.78	2.16	100,273.20
2020 Drought	46,422.78	2.14	99,344.75
Sierra County - average use 3.60 ac-ft/ac (2001)			
2000	30,181.33	3.60	108,652.79
2020 Average	30,022.41	3.54	106,279.33
2020 Drought	30,022.41	3.51	105,378.67

Table 5.5. Agricultural Water Demand in Plumas and Sierra Counties

*Forecast calculated using DWR 2001 acre-feet per acre data and DWR 2000 projections of agricultural acreage and water use change for 2020.

5.2 Urban Water Demand – Current and Future

Urban water use includes industrial, commercial, and residential use, and is forecasted on a per capita basis as gallons per capita per day (gpcd). Forecasting urban water demand on a per capita basis makes population the most significant indicator of urban water use. Present projections forecast the population of California to increase dramatically by 2020. Although the state is forecasted to experience a rise in population, the Sacramento River Hydrologic Region is not.[14] With limited population growth in the region, per capita water use is forecasted to remain at similar levels in 2020 without implementing conservation measures, and is expected to decrease if Best Management Practices and other conservation measures are applied as stipulated in the Urban Water Management Planning Act.[15] Presently, the urban water use of the Sacramento River Hydrologic Region is 286 gallons per capita per day. In 2020, the region's urban water use is forecasted to remain the same without conservation measures or decrease to 264 gallons per capita per day if conservation and economic measures are implemented. If successful conservation measures are implemented urban water use in the region would decrease by roughly 8% by 2020.

Population centers occur in four of the seven counties in the Upper Feather River Watershed. Plumas County accounts for the majority of population within the watershed (Table 5.6). Butte County is the second most populated county, with Lassen and

[14] DWR 1998

[15] DWR 1998

Sierra counties adding small amounts to the overall population of the watershed. In Plumas County, 62% of urban water use is for industrial and commercial uses, and the remaining 38% is used for residential water uses. For Sierra County residential uses comprise a majority of urban water use (75%), with the remaining 25% used for industrial/commercial purposes.

County	2000 Population	2000 Households	Est. % Change	2020 Population	2020 Households
Butte**	9,775	4,649	21%	11,828	5,625
Lassen***	1,998	1048	11%	2,218	1,163
Plumas*	20,829	20,209	0.7%	20,983	20,350
Shasta	N/A	N/A	N/A	N/A	N/A
Sierra****	1,054	906	0.5%	1,059	911
Tehama	N/A	N/A	N/A	N/A	N/A
Yuba	N/A	N/A	N/A	N/A	N/A
Total Feather River Watershed	33,168	26,812	8.1%[1]	36,088	28,049

Table 5.6. Population and Household estimates per county within the Upper Feather River Watershed.

*Plumas County population is the only county whose total population is included. Approximately 99% of Plumas County is within the Feather River Watershed. All other County population data are estimates of that county's population within the Upper Feather River Watershed.
**Butte County population estimated using the populations of the cities of Concow and Oroville East.
***Lassen County population estimated using the town of Westwood's population data.
****Sierra County population estimated using the U.S Census Bureau's West Sierra County Subdivision data.
[1]Estimated % Change is only for population. Estimated % change is not for households.

Urban water use in the Upper Feather Watershed is forecasted using population as the primary criteria and multiplied by parameters for the Sacramento River Hydrologic Region. Table 5.7 presents the urban water demand forecast for the Upper Feather River Watershed. Based on population projections urban water use in the Upper Feather River Watershed will increase 936 total acre-feet per year in 2020 if no conservation measures are implemented. If conservation measures are implemented and successful, urban water use will increase only 46 total acre-feet per year.

Year	Population	Per Capita Use/Day (gpcd)	Total Use/ Day (gpd)	Total Use/ Year (tac-ft)
2000	33,168	286	9,486,048	10,626
2020 w/o conservation	36,088	286	10,321,168	11,562
2020 w/conservation	36,088	264	9,527,232	10,672

Table 5.7. Current Water Demand and Estimated 2020 Urban Water Demand

*Per capita use data from the California Water Plan Update Bulletin 160-98 (DWR 1999).

5.3 Environmental Water Demand – Current and Future

Environmental waters are waters set aside or managed for environmental purposes and cannot be put to use for other purposes in the locations where the water has been reserved or otherwise managed.[16] The California Water Plan Update Bulletin 160-98 defines environmental water as the sum of:

1. Dedicated flows in state and federal wild and scenic rivers
2. Instream flow requirements established by water right permits, CDFG agreements, court actions, or other administrative documents.
3. Bay-Delta outflows required by SWRCB
4. Applied water demands of managed freshwater wildlife areas

Though it is important to recognize environmental uses as components of total water use, specific data are not readily available and will not be discussed in this chapter. Specific data that will not be discussed are; water rights, Bay-Delta outflow, and applied water demand for managed freshwater wildlife areas. Although over 1000 water rights or applications occur in the watershed, their volume, point of diversion, specified use, and timing of use are not known. Without this knowledge a comprehensive environmental water demand forecast cannot be calculated. The Bay-Delta outflows will not be examined because the terminus of Upper Feather River Watershed is Lake Oroville. And, although water from Lake Oroville is dedicated to the Bay-Delta, it is part of a forecast for the Lower Feather River Watershed and thus is not a part the Upper Feather River Watershed environmental demand forecast. Finally, five freshwater wetland areas occur in the Sacramento River Hydrologic Region; however none of these wetland areas occur in the Upper Feather River Watershed. The five wetland areas occur in the Central Valley portion of the region, which is downstream of Oroville Dam, the terminus of the Upper Feather River Watershed; therefore, the environmental water demand presented in this chapter will focus primarily on the dedicated flows in the Middle Fork Feather River, which is designated as a federal wild and scenic River, and the instream flow requirements for the Feather River.

In California, flows in wild and scenic rivers constitute the largest environmental water use. Designated flows for wild and scenic rivers are available to downstream users. The Upper Feather River Watershed contains approximately 78 miles of the wild and scenic Middle Fork of the Feather River. Once Middle Fork Feather River water flows into Lake Oroville it is designated for other uses. The Department of Water Resources calculated the water demand for Middle Fork Feather River for 1995 as 1,192 acre-feet per year in an average year and 497 acre-feet per year in a drought year. The Department of Water Resources projected that the same flows will be available to the Middle Fork Feather River in 2020.[17]

Instream flow is the water maintained in a stream or river for beneficial uses such as fisheries, wildlife, aesthetics, recreation, and navigation. Instream flow is a major factor influencing the productivity and diversity of California's rivers and streams. It is difficult to forecast future regulatory actions and agreements that could change existing instream flow requirements. Thus, for this environmental water demand forecast only the projected instream flow requirements for the Feather River that were calculated by the Department of Water Resources are presented. The Department of Water Resources states that their calculations are simplifications of reality, as their approach undercounts applied instream flow requirements on streams having multiple requirements, of which the Feather River does have. The Department of Water Resources calculated that the instream flow requirements for the Feather River in 1995 were 880 total acre-feet per year in an average year and 588 total acre-feet per year in a drought year. The Department of Water Resources projects that the same instream flow will be required in 2020.[18]

A complete environmental water demand forecast that analyzes the effect of water rights on water availability, and contains a reach by reach analysis of instream flow requirements will be completed as part of the implementation of the IRWM Plan. The Department of Water Resources estimates for instream flow requirements, presented above, are based on only the largest downstream requirement and are not cumulative for rivers with multiple instream requirements, of which there are many in the

[16] DWR 1998

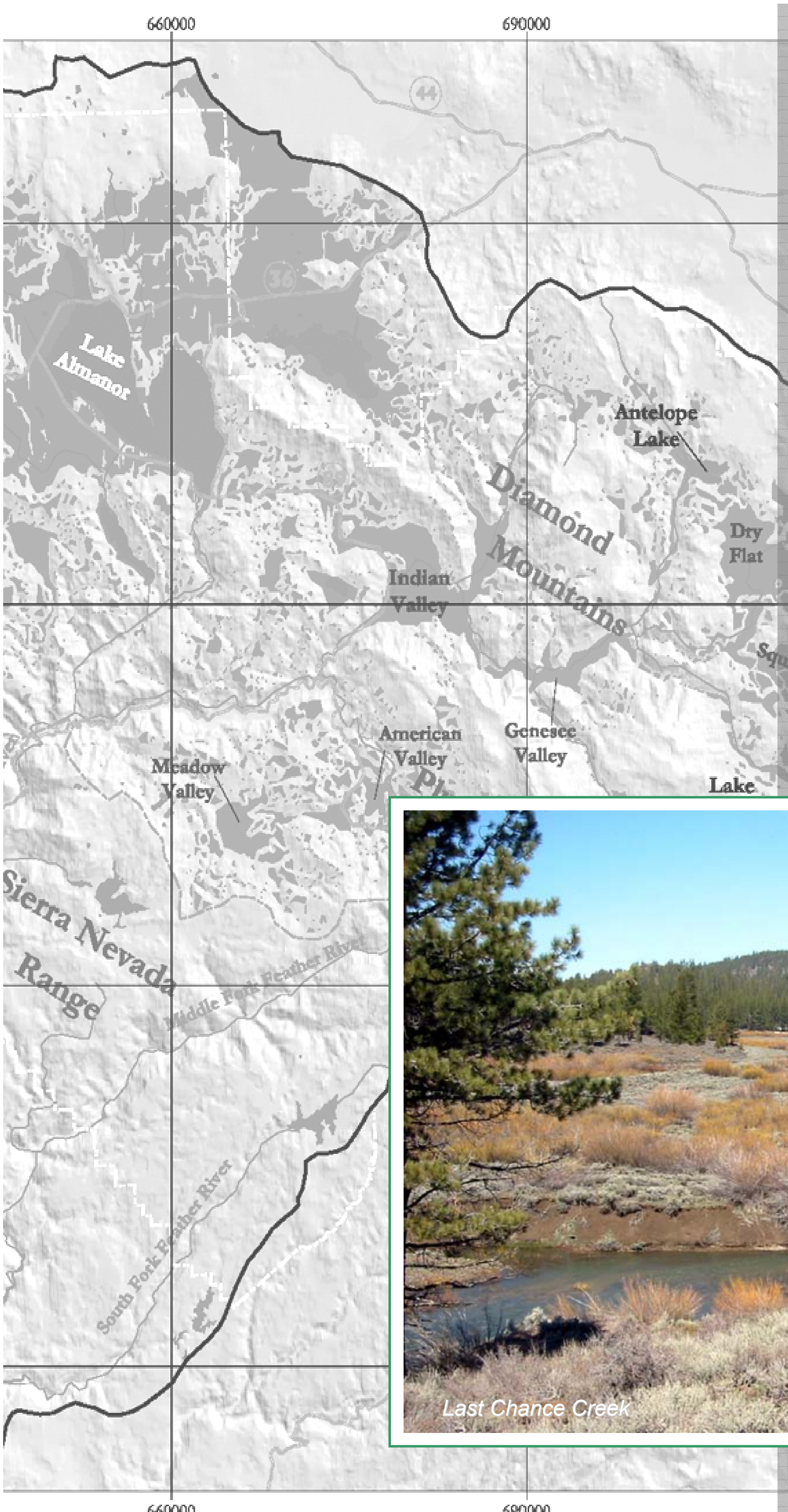
[17] DWR 1998

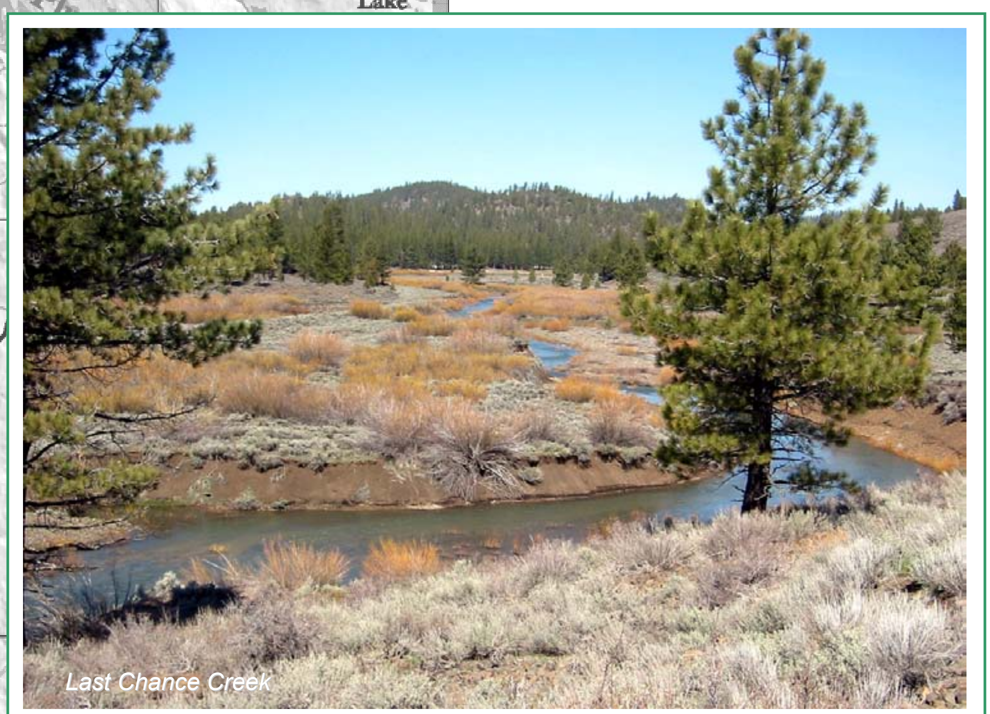
[18] DWR 1998

Upper Feather River Watershed. The most appropriate time to complete an environmental water demand forecast would be after the re-licensing of Oroville Dam is complete. It is expected that changes in Lake Oroville operations will have a direct effect on the environmental water demand for the Upper Feather River Watershed.

CHAPTER 6

Integrated Watershed Actions





Last Chance Creek

In order to achieve effective results in the Upper Feather River Watershed the goals of the IRWM Plan must be clear and supported by comprehensive objective and actions. Objectives are how the goals are attained, and objectives are implemented with specific actions. The actions described in this section are the most appropriate responses to watershed conditions. Actions that intervene to improve overall watershed management, water supply, and restore stream function are the tools decision-makers need to meet the IRWM Plan goals and objectives.

The IRWM Plan identifies actions that will assist Plumas County in meeting goals and objectives. An action, in the context of this plan, is a program, project, or policy that could be implemented to meet the County's present and future water management needs. The matrix of watershed management priorities consists of seven goals, 12 objectives, and 25 actions.

6.1 Watershed Management Actions

Actions in this category address basic data needs for longterm management, and habitat and water quality issues. County decision makers intend to use the IRWM Plan as their guiding document through time, not just for Prop 50. Therefore, the Plan must include actions to collect and assimilate data on watershed resources as environmental conditions change in response to management actions. This is adaptive management and is the fundamental approach needed for intelligent, longterm watershed management. Critical environmental issues like anadromous fish habitat and passage will require a longterm commitment to the acquisition of inventory data, monitoring, and adaptive management. For the most part funding for the programs in this category will include Prop 50 monies as well as settlement monies, and grant funding.

Inventory of Watershed Resources and Current Condition

Plumas National Forest has a large, but not necessarily up-to-date, database on their lands throughout the watershed. This information needs to be updated and combined with additional inventories of the Upper Feather River Watersheds physical, biological and water resources. The inventory will rely upon remote imagery as well as on-site surveys to measure and record resource quality and quantity.

Coordinated Data Warehouse and Resource Mapping Using GIS

The data from the inventory as well as future data collection and information will be stored in a data warehouse using a Geographic Information System like ArcInfo to retrieve, layer and map resource data and information. This will give decision makers and staff quick access to information throughout the watershed. A data warehouse built in this manner is an efficient method to update and display information.

Habitat Assessment for Coldwater Fish Species

Mandatory plans (FERC #1962 and #2105) will require the evaluation and determination of fish passage and habitat requirements for anadromous and other coldwater fish species throughout the N.F. Feather River. The N.F. Feather river tributaries must be assessed for existing habitat conditions, and life stage limitations such as spawning or rearing habitat.

Evaluation of Fish Passage

Restoring habitat to levels acceptable to anadromous and other coldwater fish species may be only marginally successful if passage of fish into river reaches and tributaries is blocked. Even non-anadromous fish species will require egress to upstream spawning habitat, for example, and blockages due to instream structures, landslides, channel incision, or insufficient instream flow all contribute to fish passage problems. Currently, little is known about all existing and potential fish passage issues. Successful reintroduction of anadromous fish will depend upon a thorough knowledge of passage conditions, and the requirement for evaluation of fish passage in the N.F. Feather River.

Temperature and Sediment Monitoring in Critical Instream Habitat

High stream temperatures and sediment deposition cause severe impacts on instream biota. Coldwater fish species cannot utilize stream areas with temperatures above their thresholds. Migratory coldwater fish species will not even enter stream reaches or tributaries where water temperatures create a thermal block. Successful spawning and incubation is dependent upon fish eggs not being buried by sediment deposition on redds. Macroinvertebrate production, aquatic insects that make-up the food base for salmonid species are especially vulnerable to deposition of fine sediments. Monitoring of temperature and sediment conditions is especially important in critical habitat; i.e., spawning and early rearing habitat for anadromous and other salmonid species.

Water Quality Monitoring Network

Currently the FRCRM has water quality and quantity measuring stations at ten locations throughout the watershed. These are continuous recording stations which can be remotely accessed to download data. This represents the most minimal network and cannot capture all of the changes in the watershed. The best measure of whether restoration projects are working is by monitoring changes in late season base flow, reduced sediment loads, and reduced water temperatures. A network of monitoring stations is needed throughout the watershed. The stations should be located at important confluences or below critical river reaches such that a complete picture of water quantity and quality changes can be seen over time.

Threatened and Endangered Species Assessment

Future management of the watershed will require detailed knowledge of the presence, abundance, and location of animals listed as threatened or endangered by the U.S. Fish and Wildlife Service. State listed species and species or concern must also be identified. Future urban and rural water uses, wetland treatment systems and groundwater recharge areas cannot interfere with or degrade existing habitat for listed species, and longterm planning and management must take these habitats into consideration.

6.3 Water Supply Actions

This action category focuses on management actions to build better understanding of existing water right conflicts between urban, agriculture, and recreational stakeholders by subwatershed. Only two basins in the Upper Feather River are decreed under California water right laws, the other subwatersheds and basins have not been evaluated in terms of over-drafted water or water rights. In addition to knowing the demand and uses of water throughout all subwatersheds for future planning, Plumas County in cooperation with Sierra County need to establish ways to protect and manage groundwater, municipalities will need guidance for stormwater management and wastewater treatment using wetlands. This category also includes one general action for managing the SWP allocations as a tool for enhancing instream and riparian habitat, improving water quality, and meeting downstream agriculture and recreational requirements. Increasing water use efficiency can provide additional available supply for future drought protection or other in-County beneficial uses. The County or local water districts can work with the California Urban Water Conservation Council, the Agriculture Water Management Council, or CALFED to implement efficient water management practices. In general, most urban and agriculture water use efficiency efforts would have granted funding opportunities.

Subwatershed Water Budgets

There are nine subwatersheds in the Upper Feather River Watershed, only two of which have been decreed. However, the analysis for the decreed basins is decades old. The other basins have not been evaluated in terms of water availability by season and water demand via water rights. There is some question as to whether subwatersheds are over-drafted and to what degree. Well modeled water budgets are needed for all of the subwatersheds before sound, reliable water management decisions can be made regarding existing and future supplies.

Recognize and Protect Agriculture Water Rights

Most of the water utilized within subwatersheds are the consequence of water rights for agriculture; crop and pasture irrigation. These rights need to be evaluated relative to the subwatershed water budgets and protected in current and future water management actions.

Recognize and Protect Urban Water Rights

Urban, municipal, water rights are typically for supplying potable water to communities. Other, individual water rights for domestic water use are included in this category. Existing water rights for domestic purposes need to be clearly identified and quantified as part of the information base for water management throughout the watershed.

Recognize and Protect Environmental Water Rights

Beneficial water uses include stream flows or water sources for environmental resources as well as for municipal and agriculture purposes. Environmental water rights for SWP releases (recreation) as well as for instream flow are necessary components of the overall water budget in subwatersheds, and water supply management must also protect these beneficial uses.

Protect Groundwater Recharge Areas

Certain areas within the watershed have a high potential for infiltration and storage that will improve and increase groundwater recharge. These areas must be identified and mapped so that future development or land use decisions take into account the need to protect those features which contribute to groundwater recharge.

Groundwater Monitoring

Balancing groundwater extraction with recharge will require reliable monitoring data of the important aquifer. Monitoring wells will provide necessary data on seasonal and annual water level changes, as well as changes in water quality. As aquifers are mined, drawn down without an equal recharge, water quality tends to decline with an increase in ions and minerals. Permanent monitoring sites and wells will provide critical data on trends necessary for current and future management of water supplies.

State Water Project Allocation Management

The Monterey Agreement specifies that SWP contractors may, on a short-term basis, transfer any unneeded supplies into a pool for purchase by other contractors. Based on subwatershed water budget analysis, management of current and future water supplies may require new mechanisms beyond the requirements of the Monterey Agreement to meet dry year demands, growth, or revenue opportunities for the county. Also, SWP flow releases from Antelope Reservoir, Lake Davis, and Frenchman Lake are signaled out in the Monterey Watershed Management Strategy for special attention in the restoration effort.

Stormwater Management

Stormwater pollution limits account for water quality values and discharge from urban areas. The EPA administers stormwater permitting for urban areas. Rain is relatively clean before it hits the ground. It is only after contact with land that stormwater picks up man-made or natural pollutants. The more quickly stormwater infiltrates the ground, the less it is to take on pollutants. A stormwater system that encourages infiltration I close proximity to where precipitation falls is simpler and easier to design than one farther from that location and attempting to treat more polluted stormwater. Small precipitation events occur much more frequently than large ones, and a stormwater system that can handle half of an inch of precipitation at once which occurs approximately once per year will handle 75% of all precipitation. Thus, stormwater management will utilize available precipitation and preserve the ecological values that it offers by focusing on BMPs that captures and infiltrates stormwater on-site.

6.4 Restoration Actions

Achieving the goals of the IRWM Plan requires a focused effort to maximize benefits with the resources available. Watershed restoration can be approached from two perspectives – passive and active intervention. Passive intervention relies upon those programs and policies described in the other action categories. Active intervention relies upon geomorphic techniques that focus or restoring stream channels from an unstable condition to a stable condition based on the dynamic and synergistic balance between bedload and sediment/discharge relationships and the landscape the stream occupies. The Feather River Coordinated Resource Management Group (FRCRM) has been employing a variety of geomorphic restoration techniques throughout the watershed for over 20 years and has identified several types of interventions that appear effective at halting headcutting, reducing sediment export, increasing riparian and upland vegetation, and recharging and retaining groundwater. The FRCRM's most promising geomorphic restoration techniques have been applied in tributaries to the major valley streams. These streams are the best candidates for these types of interventions because of their size and the fact that they occupy very sensitive landforms such as meadows, which are most susceptible to erosion, headcutting, and water table degradation. This action category provides the tools for identifying and prioritizing restoration projects as described in the Monterey Strategy; monitoring and evaluating those projects, and, along with research of new techniques applying what was learned to future restoration actions. Coordination between agencies, especially the PNF:LRMP, and maintaining public awareness and providing outreach to landowners are critical actions.

Project Development and Solicitation

Restoration projects can be expensive. The larger and more complicated the project the greater the cost. In some cases projects can be so large in an attempt to encompass a vast geographic area suffering severe degradation that the project is cost prohibitive. Nevertheless, an underlying assumption of the Monterey Settlement is that monies will be leveraged for other sources of funding. Contributing funds from the settlement can be matched with other sources to the extent that large, complicated restoration projects become feasible. The Central Valley Regional Water Quality Control Board (which includes the upper Feather River watershed) now requires farmers and ranchers to meet the requirements of Conditional Waiver of Waste Discharge from Irrigated Lands for discharge of irrigation and storm water from irrigated agricultural lands (i.e. the Ag Waiver program). These requirements include water quality monitoring and implementation of best management practices (BMPs) to minimize discharge of agricultural pollutants such as sediment, nutrients and other agricultural chemicals. In many instances, BMPs will include project activities such as riparian buffers, channel stabilization, creation of wetlands and marshes, and improved irrigation efficiency. There will likely be opportunities for restoration projects that are mutually advantageous to the agricultural community and to the objectives of the Monterey Settlement. Projects must also be socially feasible. Successful projects will have landowner support and willingness to participate. Also, public opinions are transformed and awareness is built with proven success; thus, highest priority should be given to those projects that include landowner participation and transparency; i.e., the project final report is open to public examination and review.

Project Prioritization

Given the time and money available for restoration of the Upper Feather River Watershed, comprehensive restoration is not possible. Restoring all streams and subwatersheds to functional ecological conditions would require decades and tens of millions of dollars. The strategy for watershed management must focus on priority areas and projects where restoration interventions will have the greatest beneficial impact on water quality and quantity.

Evaluation and Assessment of Completed Projects

At one level, project performance is measured by completion that is on time and within budget. Projects must also meet the stated objectives that justified the project. These measures, however, fail to provide feedback on the success or failure of specific active restoration techniques. Feedback is essential so that over the course of time those projects that most often succeed and those which frequently fail are understood. Naturally, those restoration techniques that exhibit poor performance will be excluded from funding. Monitoring measures project performance and provides data to evaluate success or failure. Project monitoring should not be a major cost item when the intent is to invest most of the available resources into the restoration action. Nor is project monitoring intended to be solely research, rather it is to simply generate sufficient data and information for project evaluation.

Research and Development

The Monterey Strategy encourages projects that are innovative. While there are known restoration techniques that work, not all techniques are suitable for all site conditions. Consequently, there must be opportunities for new, perhaps untried, techniques (including approaches to monitoring techniques).

Such projects, however, will need to be clearly and logically described with credible scientific and engineering arguments, research and exploration, and may include large-scale monitoring projects.

Education and Outreach

Watershed management will encourage the development of educational projects that convey the strategy and restoration effort into schools. Field trips, field exercises, and educational projects that familiarize young people with the watershed and the science and engineering that are part of the restoration will be encouraged.

Planning Policies

The policy actions to improve water management within the County, address regional water issues and local government actions to correlate with the IRWM Plan goals and objectives. Plumas County is experiencing significant growth in some areas, particularly the Middle Fork where golf courses and vacation homes are encroaching upon the floodplain and other flood-prone areas. Local government, with the guidance of the IRWM Plan, can address issues through zoning and ordnances. Policies and the IRWM Plan will give County government a mechanism for updating the County plan, developing a drought policy, and coordinated management with and between towns and communities throughout the watershed. Public awareness and input to County water policies will be critical through time.

County Ordnances and Zoning

County-wide comprehensive planning to protect floodplains, control encroachment from development, and manage stormwater is another important passive restoration tool. Most of the major valley streams and many of their tributaries flow through or near urban areas. Land in the valley bottoms is for the most part privately owned. New developments (residential housing, golf courses, municipal growth) all impact and exacerbate current watershed conditions. Comprehensive planning that includes codes and ordinances for the protection of streambanks, buffer zones for riparian systems, prevention of floodplain incursion, and limits to encroachment on stream fluvial processes are not only preventative actions against future degradation, but also allows natural process to begin restoring some reaches of these streams.

Drought policy

A policy will be developed for Plumas County that addresses short- and long-term impacts of drought. The policy will include a procedure for monitoring climatic conditions in cooperation with state and Federal agencies to predict drought. The goal is to minimize the effect of drought on residents through the early detection of drought conditions and the establishment of drought management procedures prior to experiencing the next drought.

Coordinated Management

The Feather River watershed management program will require considerable day-to-day participation and involvement. This means that administration and management responsibilities need to be delegated to existing county organizations with the infrastructure, personnel and structure in place.

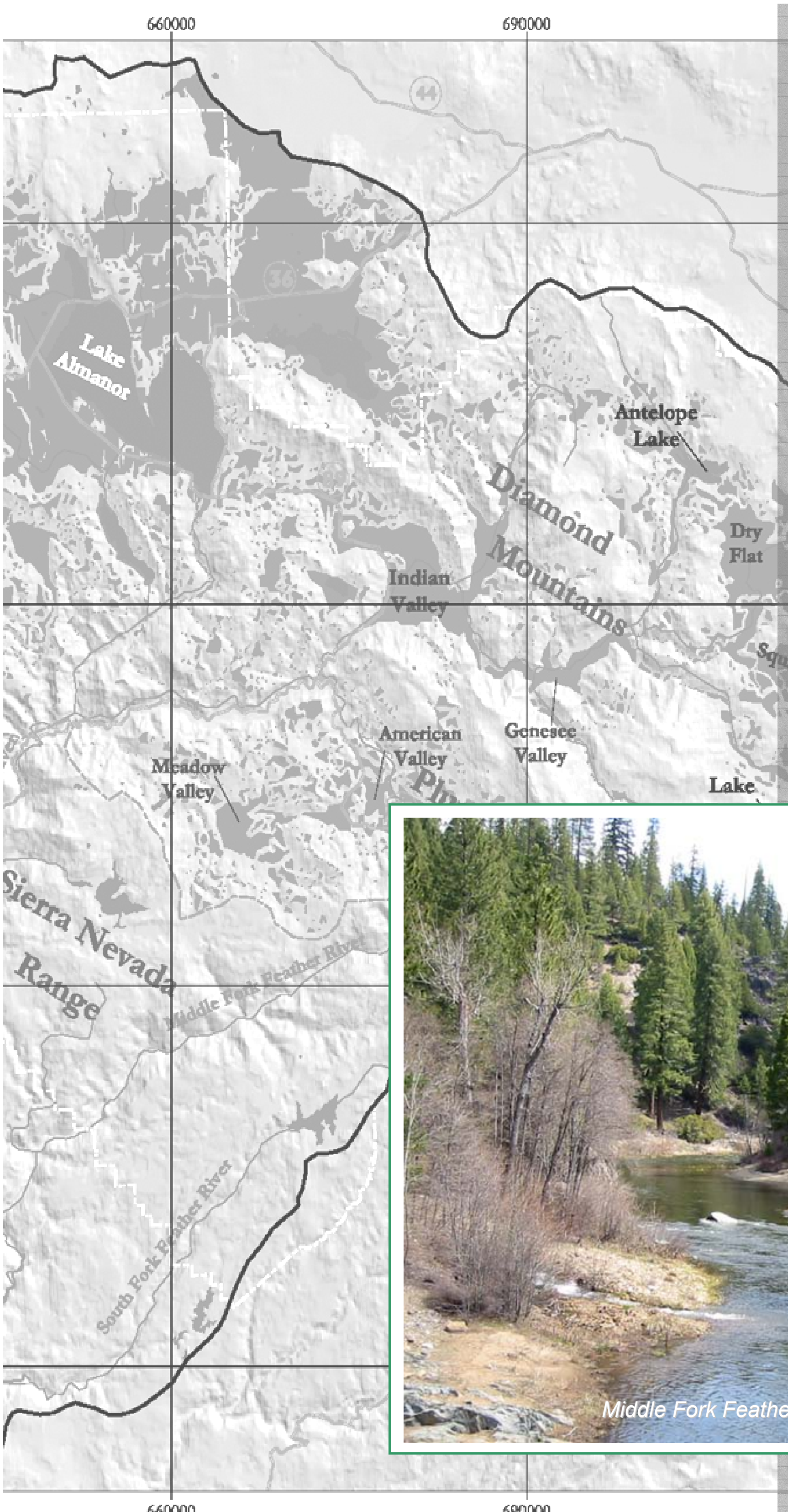
Administration and management of the program will require ability and experience in contract development, contract administration, budgetary control, public relations, coordination with the Watershed Forum, and county supervisors, day-to-day project management, technical problem solving and technical review, grant development and alternative funding sources, monitoring and evaluation, Federal and state agency coordination and cooperation, progress reporting, and land-owner coordination. A myriad number of issues will need to be addressed on an on-going basis, which will be beyond the capability of a single organization. Consequently, administration and management should be shared by those organizations with the necessary skills and experience. While there are numerous county organizations within which these responsibilities can be assigned, the need for expertise, efficiency and least-cost administration and management suggests that no more than two organizations share the responsibility. The two organizations best suited to the task, because of infrastructure capability and experience, are the Plumas County Flood Control District (PCFCD) and Plumas Corp. Additionally, at the regional level, coordination of watershed management planning with Butte, Sierra, and other county RCDs could achieve mutual benefits.

Public Awareness and Stakeholder Input

PCFCD and Plumas Corp. staff will provide an active outreach and extension effort. The purpose is to keep the public and landowners informed about project goals, progress and how the strategy works. Presentation and information meetings will be given to civic organizations, irrigation districts, grazing associations and other user groups. Stakeholders will be afforded the opportunity to participate through the meetings and presentations.

CHAPTER 7

Implementation Strategies



Middle Fork Feather River

7.0 Implementation Strategies

7.1 Strategy Development

The mandatory plans set many of the goals and objectives for the IRWM Plan. Linking the mandatory plans with the IRWM Plan and extrapolating shared goals and objectives throughout the watershed is accomplished by integrating all of the goals, objectives, and actions into cohesive strategies that can be implemented independently or collectively.

The IRWM Plan consists of 7 goals, 12 objectives to achieve the goals, and 24 actions to meet the objectives. Section 7.2 lists the IRWM Plan goals, objectives, and actions. These incorporate the mandatory plan goals and objectives.

For every goal there is a mix of objectives and for every objective there is a mix of actions. These are not grab bags of goals, objectives and actions, but distinct strategies that structure specific actions to specific objectives to specific goals.

Each strategy is designed to be independent of other strategies, yet be linked through overlapping objectives and actions. Objectives within strategies are also independent; each with a suite of actions. This independence and linkage within and between strategies gives decision-makers the flexibility to implement the Plan piecemeal, if necessary (because of limited funding for example), without losing continuity or sacrificing goals or objectives.

Implementing the IRWM Plan strategy by strategy, however, can be prioritized. There is a hierarchy to the strategies such that water quality and water quantity strategies, if implemented first, create a basis and direction for the other strategies. Implementing these two strategies accounts for about 85% of the objectives (10 of 12) in the Plan and about 85% of the actions (20 of 24). Thus, the other goals can be achieved with little additional cost or effort if the strategies for water quality and quantity goals are implemented first and concurrently. Nevertheless, the large amount of funding necessary to implement water quality and water quantity strategies may not be available, and the strategies may have to be implemented piecemeal, which is why each strategy is independent and can be funded and implemented separately if necessary.

7.2 Implementation Goals, Objectives and Actions Illustrated

This section includes figures that illustrate the watershed strategies. These strategies will form the basis for managing the water resources in the Upper Feather River. The seven independent strategies will be identified by the integration of goals, objectives, and actions as follows:

STRATEGIES

Water Quantity Strategy
Water Quality Strategy
Flood Control Strategy
Temperature/Sediment Strategy
Groundwater Strategy
Land Management Strategy
Habitat Strategy

GOALS

- Improve Local Water Retention and Reduce Flood Potential and Ensure Adequate Local Water Supply
- Improve Dry-Season Base Flows
- Improve Water Quality (temperature and sediment)
- Improve Water Quality to Meet CVRWQCB Basin Plan/Agriculture Waiver
- Improve Upland Vegetation Management
- Improve Groundwater Retention and Storage in Major Aquifers
- Accommodate restoration of a Salmon Fishery in segments of the Upper Feather River Mainstems and Tributaries

OBJECTIVES

- Continuous Flow in Perennial Streams
- Streambank Protection
- Sediment Transport Reduction
- Stream Temperature Improvement
- Agriculture NPS Waiver Program
- Road Rehabilitation or Closure
- Grazing Management
- Groundwater Recharge and Extraction Balance
- Instream and Riparian/Wetland Habitat
- Wetland wastewater treatment
- Public awareness and stakeholder input
- Monitoring and Adaptive Management

ACTIONS

- Inventory of resources and current condition
- Data warehouse and resource mapping-GIS
- Habitat assessment for coldwater fish species
- Evaluation of fish passage
- Temperature/sediment monitoring
- Water quality monitoring network
- Threatened and endangered species
- Subwatershed water budgets
- Recognize and protect agriculture water rights
- Recognize and protect urban water rights
- Recognize and protect environmental water rights
- Protect groundwater recharge areas

ACTIONS

- Groundwater monitoring
- SWP allocation management
- Stormwater management
- Restoration project development/solicitation
- Restoration project implementation
- Evaluation and assessment of completed projects
- Research and development
- Education and Outreach
- County ordnances and zoning
- Drought policy
- Coordinated management
- Education and Outreach

WATER QUANTITY STRATEGY

Goal: Improve Dry-Season Base Flows

Actions

Objective 1:

Instream and Riparian/ Wetland Habitat

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Protect groundwater recharge areas
- Wetland wastewater treatment
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation
- Drought policy

Objective 2:

Continuous Flow in Perennial Streams

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Recognize+ of completed restoration projects
- Recognize and protect agricultural water rights
- Recognize and protect urban water rights
- Evaluate and protect environmental water rights

Objective 3:

Grazing Management

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Restoration project implementation

Goal: Improve Dry-Season Base Flows - *continued*

Actions

Objective 4:

Streambank Protection

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater Management
- Education and Outreach
- County Ordinance and Zoning

Objective 5:

Road Rehabilitation or Closure

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Objective 6:

Sediment Transport Reduction

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation

Goal: Ensure Adequate Local Water Supplies

Objective 1:

Reduce Water User Conflicts

Actions

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Public awareness and stakeholder input
- Recognize and protect environmental water rights
- Recognize and protect urban water rights
- Recognize and protect agricultural water rights
- Education and Outreach
- Drought policy

Objective 2:

Continuous Flow in Perennial Streams

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Objective 3:

Groundwater Recharge and Extraction Balance

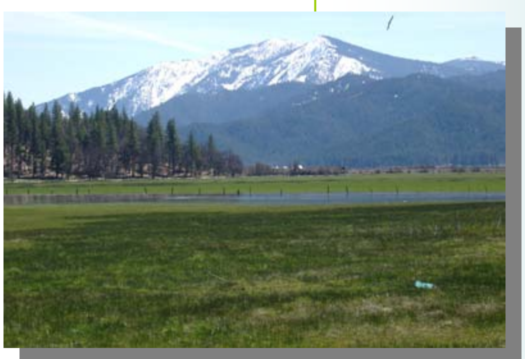
- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation

WATER QUALITY STRATEGY

Goal: Improve Water Quality to Meet CVRWQCB Basin Plan/Agricultural Waiver

Objective 1:

Agriculture NPS Waiver Program



Actions

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Research and development
- Subwatershed water budget
- Recognize and protect agricultural water rights
- Recognize and protect urban water rights
- Recognize and protect environmental water rights
- Water quality monitoring network
- County ordinances and zoning
- Drought policy
- Update county General Plan
- Coordinated management
- Public awareness and stakeholder input

Objective 2:

Wetland Wastewater Treatment

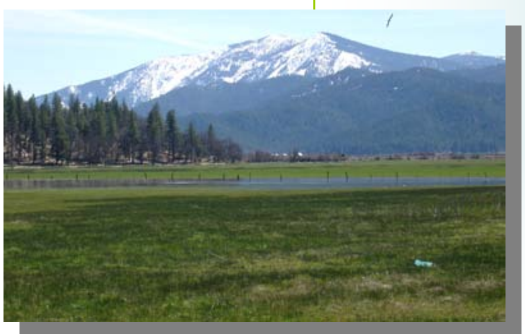
- Water quality monitoring network
- Stormwater management
- County ordinances and zoning
- Drought policy
- Temperature/sediment monitoring in critical habitat

Goal: Improve Water Quality to Meet CVRWQCB Basin Plan/Agricultural Waiver - *continued*

Actions

Objective 3:

Streambank Protection



- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater Management
- Education and Outreach
- County Ordinance and Zoning

Objective 4:

Stream Temperature Improvement

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Water quality monitoring network
- Temp/Sediment monitoring in critical habitat
- Protect groundwater recharge areas
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation

Objective 5:

Sediment Transport Reduction

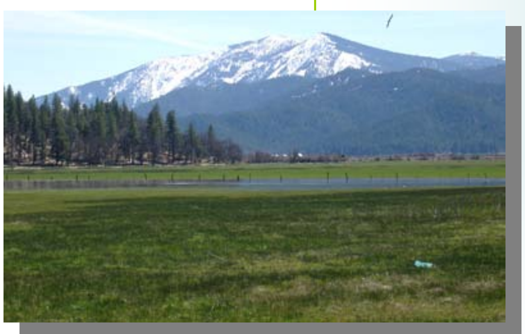
- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater management

Goal: Improve Water Quality to Meet CVRWQCB Basin Plan/Agricultural Waiver - *continued*

Actions

Objective 6:

Instream and Riparian/ Wetland Habitat



- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Protect groundwater recharge areas
- Wetland wastewater treatment
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation
- Drought policy
- Water quality monitoring network
- County ordinance and zoning

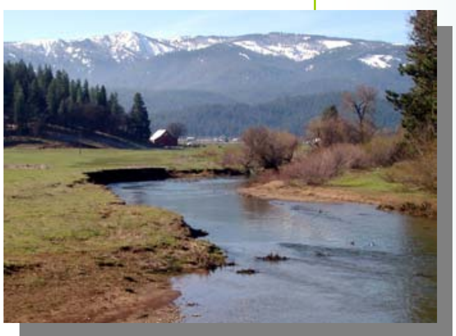
FLOOD CONTROL STRATEGY

Goal: Improve Local Water Retention and Reduce Flood Potential

Actions

Objective 1:

Streambank Protection



- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater Management
- Education and outreach
- County Ordinance and Zoning

Objective 2:

Road Rehabilitation or Closure

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Objective 3:

Grazing Management

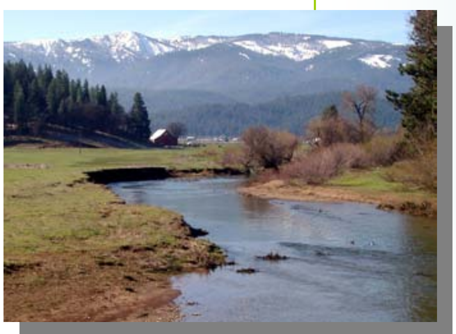
- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Protect groundwater recharge areas

Goal: Improve Local Water Retention and Reduce Flood Potential - *continued*

Actions

Objective 4:

Instream and Riparian/ Wetland Habitat



- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Water Quality Monitoring Network
- Protect groundwater recharge areas
- Wetland waste water treatment
- Restoration project development and solicitation
- Restoration project implementation
- County Ordinance and Zoning
- SWP allocation management

Objective 5:

Monitoring and Adaptive Management

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Water Quality Monitoring Network
- Evaluation of completed restoration projects

GROUNDWATER STRATEGY

Goal: Improve Groundwater Retention and Storage In Major Aquifers

Objective 1:

Groundwater Recharge and Extraction Balance

Actions

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Subwatershed water budget
- Recognize and protect agricultural water rights
- Recognize and protect urban water rights
- Recognize and protect environmental water rights
- County ordinances and zoning
- Drought policy
- Coordinated management
- Public awareness and stakeholder input
- Wetland wastewater treatment
- SWP allocation management

Objective 2:

Road Rehabilitation or Closure

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Goal: Improve Groundwater Retention and Storage In Major Aquifers - *continued*

Objective 3:

Instream and Riparian/ Wetland Habitat

Actions

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Protect groundwater recharge areas
- Wetland wastewater treatment
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation
- Drought policy
- Water quality monitoring network
- County ordinance and zoning

Objective 4:

Grazing Management

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Protect groundwater recharge areas

Objective 5:

Monitoring and Adaptive Management

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Water quality monitoring network
- Evaluation of completed restoration projects

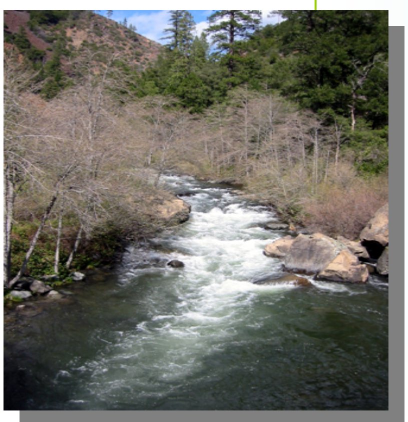
TEMPERATURE and SEDIMENT STRATEGY

Goal: Improve Water Quality (temperature and sediment)

Actions

Objective 1:

Instream and Riparian/ Wetland Habitat



- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Protect groundwater recharge areas
- Wetland wastewater treatment
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation
- Drought policy
- Water quality monitoring network
- County ordinance and zoning

Objective 2:

Road Rehabilitation or Closure

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Objective 3:

Sediment Transport Reduction

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater management

Goal: Improve Water Quality - *continued*

Actions

Objective 4:

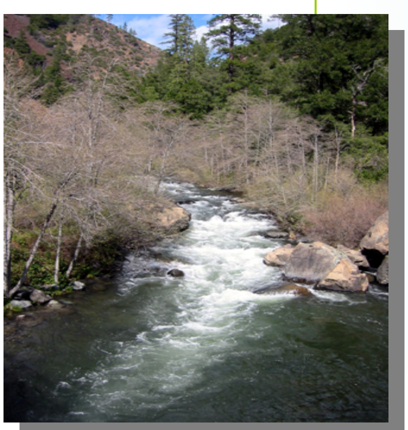
Streambank Protection

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater Management
- Education and Outreach
- County Ordinance and Zoning

Objective 5:

Stream Temperature Improvement

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Water quality monitoring network
- Temp/Sediment monitoring in critical habitat
- Protect groundwater recharge areas
- Wetland wastewater treatment
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation



LAND MANAGEMENT STRATEGY

Goal: Improve upland Vegetation Management

Actions

Objective 1:

Streambank Protection

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater Management
- Education and Outreach
- County Ordinance and Zoning

Objective 2:

Road Rehabilitation or Closure

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Objective 3:

Grazing Management

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Protect groundwater recharge areas

Goal: Improve upland Vegetation Management - *continued*

Objective 4:

Instream and Riparian/ Wetland Habitat

Actions

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Protect groundwater recharge areas
- Wetland wastewater treatment
- SWP allocation management
- Restoration project development and solicitation
- Restoration project implementation
- Drought policy
- Water quality monitoring network
- County ordinance and zoning

HABITAT STRATEGY

Goal: Accommodate Restoration of a Salmon Fishery in Segments of the Feather River Mainstems and Tributaries

Objective 1: Instream and Riparian/ Wetland Habitat

Actions

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Habitat Assessment for coldwater fish species
- Evaluation of fish passage
- Temperature/Sediment monitoring in critical habitat
- Water quality monitoring network
- Threatened and endangered species assessment
- Monitoring and adaptive management

Objective 2: Continuous Flow in Perennial Streams

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

Objective 3: Grazing Management

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Protect groundwater recharge areas

Goal: Salmon Fishery - *continued*

Actions

Objective 4:

Streambank Protection

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects
- Stormwater Management
- Education and Outreach
- County Ordinance and Zoning

Objective 5:

Road Rehabilitation or Closure

- Inventory of watershed resources and conditions
- GIS Database and resource mapping
- Restoration project development and solicitation
- Restoration project implementation
- Evaluation of completed restoration projects

7.3 Strategy Evaluation

Regional Priorities

Short-term priorities for implementing the IRWM Plan focus on (1) a suite of projects in each of the strategies funded through Prop 50: (2) initiation of projects committed to in the Watershed Strategy with Monterey Settlement funds; and (3) developing the watershed inventory and GIS database infrastructure required for all of the strategies. These short-term priorities will set into motion a range of watershed actions that address water quality and quantity issues.

In the long-term, implementation of the full plan is essential; however, as stated previously, the Water Quality and Water Quantity strategies will be overarching and of a higher priority for implementation than the other strategies. Priorities can, and will be, modified in response to the availability and emphasis of funding sources, and regional conditions that change over time. Implementation of a suite of projects in each of the strategies will be an important first step in adaptive management. Results and feedback from these projects will allow decision-makers to realign priorities, and specific projects, to meet on-the-ground realities. Adaptive management is an on-going process in which new information is constantly fed into decision-making; consequently, the IRWM Plan is expected to be vibrant, flexible, and dynamic such that priorities are always subject to re-examination.

Implementation

The Watershed Forum has approved funding (Monterey Settlement) for several projects; FRCRM watershed restoration projects have been funded by a variety of sources such as CALFED and have been on-going for many years; upland and forest vegetation management has been funded annually through the QLC; these projects are all mechanisms for implementation of the Plan. These projects and the responsible agencies demonstrate the economic and technical feasibility of implementing the IRWM Plan throughout the Upper Feather River Watershed. Not only is there the institutional capability to implement the Plan, but there is clearly the political foundation and public desire to tackle the water issues. Examples of projects which are on-going, planned, or proposed include the following:

- FRCRM Development and Monitoring – Coordination of activities between projects (Last Chance, Red Clover, Indian, Lights, Wolf, Spanish, and Sulphur creeks); field work; landowner organization; and expansion of monitoring of pre-and post-project flow and water quality conditions throughout the watershed.
- FRCRM Jordan Creek Restoration – Fence 2.5 miles around Jordan Creek Flat, pond and plug construction and revegetation.
- Beckwourth Ranger District Clarks Creek Aspen Restoration –Release and regeneration of aspen communities from conifer suppression in Clarks Creek subwatershed.
- Feather River College Corridor Protection and Environmental Education Project – Construction of dry lots and fencing for rotational grazing and education to improve water quality in Spanish Creek.
- Sierra Valley RCD – Allocation to improve services to Sierra Valley
- Plumas Geo-Hydrology – Pilot study to investigate methods to quantify the effect of forest canopy interception on baseflow.
- Plumas Geo-Hydrology – Installation of improved groundwater monitoring system at the Red Clover restoration project.
- Plumas Corp Vegetation Management – Coordination of activities under the Fire Safety Council and the QLG to improve water retention in and minimize fire risk in the watershed.
- Feather River RCD – Allocation to improve services to American and Indian Valleys
- Sierra Valley Groundwater Management District – Perform aquifer tests near Sattley, Beckwourth, and Loyalton to determine aquifer characteristics
- Plumas Geo-Hydrology – Red Clover Creek base flow augmentation assessment using environmental isotopes.

- FRCRM – Last Chance Creek watershed restoration project; Phase II.
- Indian Valley Community Services District – Upgrade water treatment system to recycle water and/or increase flow releases from Round Valley Reservoir.
- University of California Davis – Middle Fork Feather River modeling studies and watershed model development.
- Quincy Community Services District – Water quality improvement with expansion of wetland treatment.
- Feather River Land Trust – Genesee and Sierra Valleys integrated resources management project.
- FRCRM – Sulphur Creek Watershed Restoration Strategy.
- Proposition 13 – Lake Almanor Basin Plan.
- Geographic Information System (GIS) data infrastructure and warehouse for integrated watershed assessment and data sharing.

Impacts and Benefits

There will be specific impacts and benefits associated with the implementation of projects such as restoration actions. Projects that involve construction or other activities that have a direct effect on land and water resources will be evaluated under CEQA guidelines and the appropriate documentation prepared for each project.

The Plan's overall impact to the watershed will, as would be expected, be positive. Emphasizing water quality and quantity improvements as the Plan does means that connectivity will be restored throughout the watershed as well as with the adjacent Lower Feather River watershed. The larger ecosystem from Orofino Dam upstream to the headwaters of all branches of the Feather River is the focus of the Plan.

Implementing actions in which BMPs improve grazing, agriculture, and other land use activities to protect streambanks, reduce sedimentation and temperature, and address water quality concerns; actions that improve retention of precipitation in uplands, aquifers and water tables will attenuate flooding downstream; projects that increase wetlands, improve wastewater discharge, and provide better stormwater management; and restoration projects that lead to better fish and riparian habitat and reestablishing anadromous fish, all represent positive impacts and benefits.

The implementing strategies all address public awareness as critical to the success of any actions taken in the watershed. An informed public is, perhaps, the best way to advance the concept of environmental justice for the Upper Feather River Watershed. Improved habitat, water quality and flow throughout the mainstems and tributaries are actions that will translate into increased recreational uses throughout the watershed, which will create an economic benefit to disadvantage communities.

Technical Analysis and Plan Performance

The IRWM Plan was developed from the mandatory plans in place throughout the watershed. It is the mandatory plans which, as a consequence of debate, negotiations, public and agency input on water problems and solutions that set the goals and objectives of the IRWM Plan.

A critical component of the IRWM Plan is monitoring and adaptive management. A discussion of measures that will be used to evaluate project/plan performance, monitoring systems that will be used to gather performance data, and mechanisms to adapt project operations and Plan implementation based on performance data collected is described in Chapter 2.

Data Management

The Upper Feather Watershed consists of a large geographic area that is managed by multiple agencies, governments, private corporations and land owners, resource groups, and concerned non-governmental organizations. Each of these entities creates data (i.e. geographic, water quality and quantity, land use etc.) that pertains to their specific land holdings. Data creation by several groups means that there is a significant existing data set pertaining to the Upper Feather River Watershed. The problem with this existing data set is that it often exists in a vacuum. In other words, the existing data set is not available to the greater Upper Feather River Watershed community. For example, each entity has specific objectives for their data, and once those objectives are met, that data, often, is never used again. Another common problem with resource use data is that it is not readily shared. Usually the data creating entity is the only user of that data. This lack of coordination can lead to acrimony between groups, increased project costs due to redundant data gathering efforts, and an overall lack of knowledge of the resource in question due a deficiency of available data.

This data sharing and data centralization quandary has been solved in several locations. For example, the Land Management Information Center (LMIC) serves the state of Minnesota by helping government and non-government organizations achieve better, faster, and more cost-effective results for the state through the creative use of GIS and other geospatial information technologies (Minnesota Department of Administration). The LMIC serves as a state data archive, identifies data needs, promotes standards, develops and integrates data, and provides geographic data to the public (Minnesota Department of Administration). The LMIC emphasizes cost-effective data acquisition by providing download services over the internet. Data available through the LMIC enhances the understanding of social, economic, and environmental issues within Minnesota and is designed to support decisions that improve the state's natural resources and quality of life (Minnesota Department of Administration). A similar data warehouse exists closer to the Feather River Watershed and that is the Digital Geographic Data for the Sierra Nevada Region, which is part of the Sierra Nevada Ecosystem Project (SNEP). The Digital Geographic Data for the SNEP compiles and provides existing data and information to support assessment and modeling activities within the boundaries of SNEP and allows for information to be accessible at the local, state and federal level (Sierra Nevada Ecosystem Project). Another very successful data warehouse and distribution system is the California Environmental Resource Evaluation System (CERES). CERES is an information system developed by the California Resource Agency to facilitate electronic environmental data pertaining to California (California Resources Agency).

Future data management within the Upper Feather River Watershed should mirror the examples provided above. Geographic, water quality and quantity, land use, and other pertinent watershed data should be organized into a centralized data warehouse. This centralized data warehouse will require an investment in "infrastructure." The term "infrastructure" is key to understanding a data warehouse. Infrastructure is defined as the "underlying base or the basic facilities, equipment, services, and installations needed for the growth and functioning of a community or organization." In the same manner that roads are vitally important to a State's infrastructure, the data, systems, people, and institutional arrangements that comprise the data warehouse provide public and private organizations with the foundation for progress. The initial infrastructure investment for a successful Upper Feather River Watershed data warehouse will be computers, software, support personal and a location to house the warehouse.

At the core of an effective data warehouse is high quality, current data. Producing, maintaining, and distributing quality data is an important investment. The data creating entities within the Upper Feather River Watershed have a responsibility to ensure that their data is used and maintained properly so that organizations can capitalize on the investment. Ensuring quality data is done through the use of standards, procedures for data maintenance, and effective mechanisms for data distribution (such as a web-based interface). This will ensure that the data are widely used and that time and money will not be wasted on duplicate data creation efforts. The Upper Feather River Watershed data warehouse will be a program and process designed to accomplish this goal.

The Upper Feather River Watershed data warehouse will accomplish the following:

1. Support assessment and modeling activities within the Upper Feather River Watershed
2. Reduce redundancy of sampling and data gathering, thus reducing project costs.
3. Create a community atmosphere between often disparate groups by reducing the mystery surrounding each groups data.
4. Identify data gaps quickly since all data will be located in central location.
5. Make information accessible at the local, state, and federal level.

Financing

Water resource planning and management in the Upper Feather River Watershed has been and will continue to be financed and supported from a number of sources. Prop 50 funds will be one source among others. Because of the availability of funds for the watershed, the IRWM Plan has been designed to guide decision-makers through time, not through just a single funding cycle or opportunity.

Currently water resource projects are funded from the Monterey Settlement, CALFED, PG&E (implementing FERC requirements on the North Fork), USFS funds, BLM, and other state and federal sources.

Coordination

Coordination between state and federal agencies and other local entities (e.g. schools, non-profits, cities, service districts, RCDs etc.) in the Upper Feather River Watershed has a long history of success. That success is due primarily to an existing infrastructure that allows for open communication between often diverse and competing groups. This established coordination infrastructure enables its participants to create innovative and successful approaches to resource conservation and watershed management. Within the Upper Feather River Watershed the existing coordination infrastructure centers around three organizations; the Feather River Watershed Authority, which is administering the Integrated Regional Water Management Plan (IRWM Plan), the Feather River Coordinated Resource Management (FR CRM), and the Plumas Watershed Forum, which was established following the Monterey Settlement (figure 3.1 Diagram of Existing Coordination Structure). These three entities are discussed in detail in Chapter 3. The presence of these watershed management organizations allows a broad and diverse assemblage of agencies to coordinate and implement management strategies that not only benefit the watershed but are mutually beneficial to numerous groups.

Several state and federal agencies are currently involved in the coordination process within the Feather River Watershed. And, it is the presence of these federal and state agencies, within the three organizations mentioned above, that makes coordination in the Upper Feather River Watershed unique, innovative, and most importantly successful. The following state and federal agencies are currently involved in one or more of the three existing coordination organizations in the Upper Feather River Watershed: CDFG, DWR, Plumas National Forest, Plumas County, Butte County, U.S. Fish and Wildlife Service, and the U.S Army Corp of Engineers. Many of the agencies and local governments involved in the coordination process have statutory authority. Entities with statutory authority are Plumas County, Plumas National Forest, Plumas County Flood Control & Water Conservation District and Butte County. The coordination success in the Upper Feather River Watershed can be attributed to the fact that a vast majority of the watersheds land area is in the hands of the decision makers with statutory authority. In other words the three coordination organizations are so inclusive that integral decision makers are involved in every step of the process.

Coordination in the Upper Feather River Watershed centers around one federal agency, the Plumas National Forest, one local government, Plumas County, and one resource management group involving several groups and agencies, the FRCRM (Chapter 3 Diagram of Existing Coordination Structure). The Plumas National Forest, which comprises roughly 50% of the land area within the watershed, is a member of the three existing coordination entities, and the lead agency for the IRWM plan (figure xxx Diagram of Existing Coordination Structure). Plumas County, also a member of the three coordination entities, is a logical choice to be an integral part of the watershed planning process as nearly 90% of the Upper Feather River Watershed is located within the county. The Feather River Coordinated Resource Management Group is also a member of the three coordination organizations. The FRCRM incorporates a broad assemblage of agencies, non-profits, schools and other groups and coordinates with them to make informed watershed management decisions. The FRCRM then provides that knowledge to the other two coordination organizations.

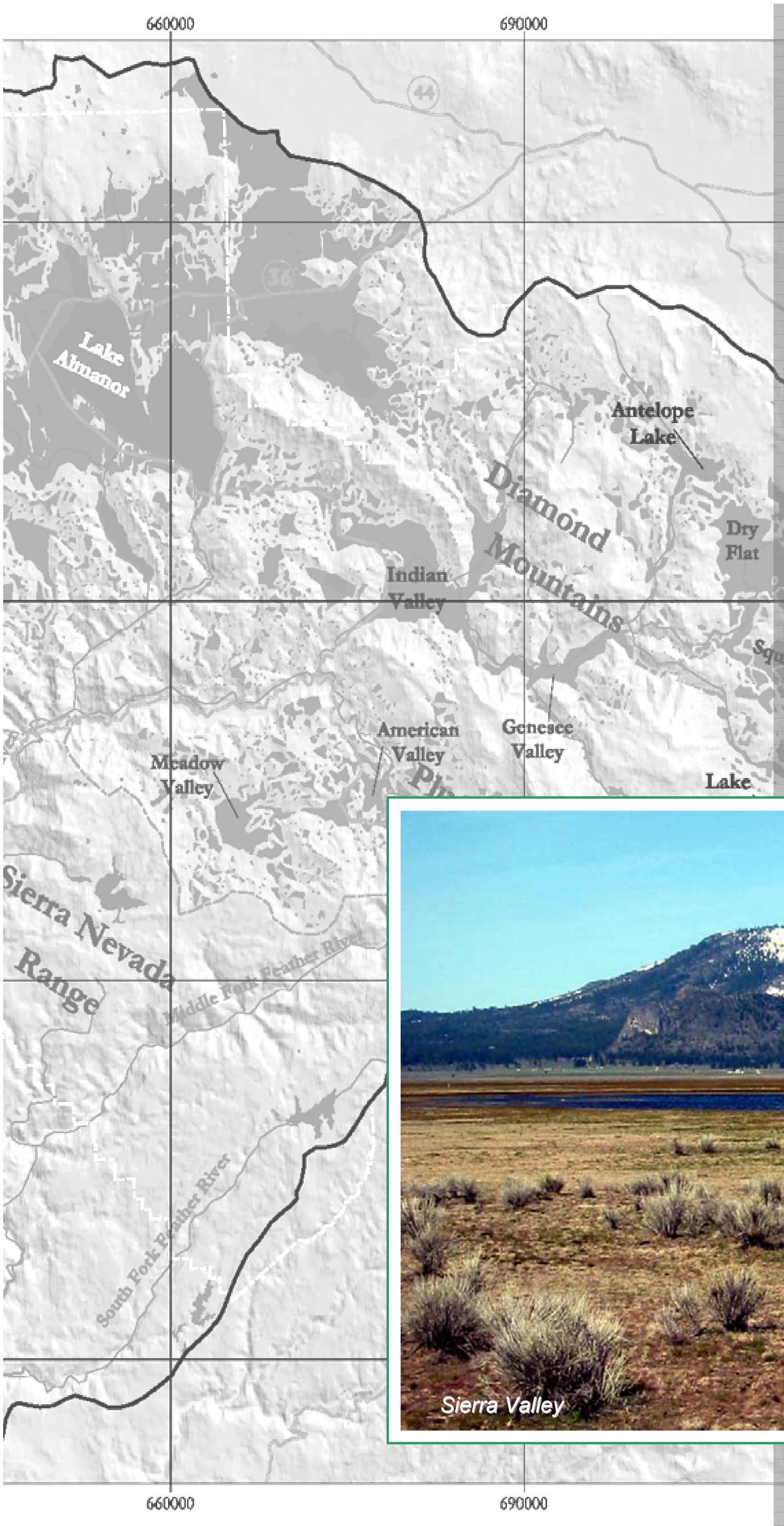
Several state and federal agencies are currently involved with projects in the Upper Feather River Watershed under the existing coordination infrastructure. In the future it is important that this trend continue. Maintaining state and federal agency involvement in the Feather River Watershed Authority, the FRCRM and the Plumas Watershed Forum will assure that state agencies or other agencies will be able to assist in communication, cooperation, or implementation of IRWM Plan components or processes. It is also extremely important that state or federal regulatory agencies that are required for implementation remain active within the three coordination organizations.

Statewide Priorities

The State agency priorities that will be met or contributed to by implementation of the IRWM Plan include reduction of water conflicts, implementation and furthering of the CVRWQCB Basin Plan, coordinate with and support RWQCB plans, support Sacramento Bay Delta water quality objectives, supports SWQCB NPS plans through the agriculture waiver components, implements floodplain management and assists state species recovery plans with improved habitats, and furthers environmental justice concerns.

Appendices

References and Glossary



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Glossary

Adaptive Management- An approach that considers the timing and quality of interventions used to restore health and functioning to an ecosystem. As restorative actions are applied, the effects of those actions are simultaneously monitored and adjusted.

Alluvium- Sediment deposited by flowing water, as in a river bed, flood plain, or delta.

Anadromous Fish- Fish that migrate from the sea to freshwater to reproduce.

Andesite- A gray, fine-grained volcanic rock such as plagioclase and feldspar.

Aquifer- An underground bed or layer of earth, gravel, or porous stone that yields water.

Basin Plan- The Water Quality Control Plan for the Central Valley Region, the Sacramento and San Joaquin River Basins.

Belden Reach- Portion of the North Fork Feather River between Belden Forebay Dam and Belden Powerhouse.

Beneficial Uses- An actual or potential use that may be made of the waters of the state that is protected against quality degradation. Beneficial Uses can include domestic, agricultural, and industrial water supplies, recreation, aquatic life, aesthetics, wildlife habitat, and salmonid spawning.

Best Management Practices (BMP)- Practices determined by the state to be the most effective and practicable means of preventing or reducing the amount of pollution generated by non-point sources.

Biotic- Of or having to do with life or living organisms.

Block Loading- Operational mode of a powerhouse in which the generation capacity (and resulting cfs release) is held at or near a constant level for an extended period of time.

Cap Flows- Maximum level to which the Minimum River Flow level may be adjusted.

Controlled Spill- Release of water from a Project reservoir at times when the release could have otherwise been controlled (not spilled) by increasing the flow through the generating units or controlling inflows by monitoring releases from upstream reservoirs.

Cresta Reach- Portion of the NFFR between Cresta Dam and the Cresta Powerhouse.

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FRCRM Group- Feather River Coordinated Resources Management Group

Feather River Watershed Authority- Made up of several groups that have statutory authority in the Feather River Watershed (Plumas County, Plumas National Forest, Sierra Valley Groundwater Management District, and Plumas County Flood Control and Water Conservation District) to administer the Integrated Regional Watershed Management Plan.

Feather River Watershed Management Strategy- document provides an overview of watershed conditions, identifies and prioritizes key problems, and prioritizes watershed management strategies and restoration actions.

Geomorphic- Of or resembling the earth or its shape or surface configuration.

Groundwater- Water beneath the earth's surface often between saturated soil and rock that supplies wells and springs.

Headcutting- The upstream movement of a channel bottom due to the erosion by rapidly flowing water.

Hyporheic Zone- Area below the streambed where water percolates through spaces between the rocks and cobble.

Minimum River Flows- Required minimum flows in the Rock Creek and Cresta reaches.

Monterey Agreement- The formal 1994 agreement by and among California Department of Water Resources and certain State Water Contractors that memorializes fourteen principles to address the distribution of water during shortages and various other issues under the State Water Project Contracts.

Monterey Amendment- The amendments to the long term water supply contracts for the State Water Project entered into by the California Department of Water Resources and most of the State Water contractors in 1995 and 1996 for purposes of implementing the Monterey Agreement.

Monterey Settlement Agreement- A 2003 agreement that established new guidelines for the Environmental Impact Report process, contract negotiations, disbursement of funds for watershed improvement and restoration projects, and review of water transfers resulting from the Monterey Amendments.

MOU- Memorandum of Understanding. The Feather River Coordinated Resources Management (FRCRM) MOU is a compilation of agreements among 22 groups that establishes the legal and institutional framework of the FRCRM group.

Plumas Watershed Forum- Created as a result of the Monterey Settlement to manage the monies allocated to Plumas County for projects and includes the following entities: Plumas County, California Department of Water Resources, and the California State Water Contractors.

Prattville Intake Modifications- Physical improvements in the vicinity of the Prattville Intake to attract cold water to the intake.

Proposition 50- The Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (signed into law in 2003) that requires that general obligation bonds be repaid from the State of California's General Fund to fund a variety of water projects.

Pulse Flows- Short term elevated levels of release from Project dams.

Pyroclastic- Composed chiefly of rock fragments of volcanic origin.

Ramping Rate- The rate of change in a flow release or spill from a dam expressed as an increase or decrease in discharge (in cfs) over a period of time.

Reasonable Control Measures- Measures to control water temperatures.

Refugia- An area that has escaped ecological changes occurring elsewhere and as such, provides suitable habitat for relict species.

Rill Erosion- Development of numerous small, closely spaced channels resulting from the uneven erosion of soil by running water.

Riparian Area- Area of vegetation growing adjacent to, or in close proximity to a watercourse, lake, swamp, or spring.

Rock Creek Reach- Portion of the NFFR between Rock Creek Dam and Rock Creek Powerhouse.

Sediment- Soil and rock debris that has been produced by natural or management activities, and that moves from its place of origin either due to gravity or to water flowing over the loosened debris.

Seneca Reach- Portion of the North Fork Feather River between Canyon Dam (Lake Almanor) and Caribou Powerhouse.

Sheet Erosion- Initial surface erosion by water running off as sheets, as distinct from channelized erosion in rills and gullies.

Total Maximum Daily Load (TMDL)- A calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, as well as an allocation of pollutant loadings amount point and non-point pollutant sources.

Ultrabasic- Containing magnesium and iron and only a small amount of silica. Used of igneous rock.

Uncontrolled Spill- Release of water from a Project reservoir at times when flow into the reservoir (excluding releases from upstream reservoirs that can be controlled) exceeds the sum of the instream flow release requirement, plus the current flow capacity of the generating units.

Watershed Forum- a stakeholder group consisting of one or more representatives from Plumas County, local community-based groups, DWR, and SWP Contractors.

Watershed Programs- Programs, studies or projects approved and implemented by the Watershed Forum.

GIS Metadata

The GIS shapefiles used in the creation of the IRWM Plan maps are presented below (Table A, GIS data). The GIS data were collected from various sources, most notably the California Natural Diversity Database (CNDDB), California Spatial Information Library (CASIL), Plumas County, California State Water Resource Control Board (SWRCB), the Plumas National Forest (PNF) and the Ecosystem Sciences Foundation (ES) .

Table A. Pertinent GIS data

GIS Data				
Shapefile Name	**Projection**	**Shapefile Description**	**Type**	**Origin**
cal_drains	NAD27_Z10	Streams of California	line	CASIL
Cal_bioregions	NAD27_Z10	Bioregions of California	Polygon	CASIL
calwater_FR_subbasins	NAD27_Z10	FR subabsins defined by CASIL	line	CASIL
Cal_eco_sub	NAD27_Z10	California Ecoregions sub areas	Polygon	CASIL
FERC_1962	NAD27_Z10	Rock Creek/Cresta Dam Relicensing	Polygon	ES
FERC_2105	NAD27_Z10	Belden/Canyon Dam Relicensing	Polygon	ES
FR_24K_grid	NAD27_Z10	FR 24K Map Index	Polygon	CASIL
FR_counties	NAD27_Z10	Counties comprising FR watershed	Polygon	CASIL
FR_dams	NAD27_Z10	Dams location in FR watershed	Point	CASIL
FR_divide	NAD27_Z10	Sierra Crest within FR watershed	line	ES
FR_east_west	NAD27_Z10	Feather River East Side West Side	Polygon	ES
FR_grdwater	NAD27_Z10	Groudwater Basins in the FR	Polygon	CASIL
FR_highways	NAD27_Z10	Highways in the FR watershed	line	CASIL
FR_lakes	NAD27_Z10	Lakes in the FR watershed	Polygon	CASIL
FR_major_watersheds	NAD27_Z10	NF, MF,SF and WB watersheds	Polygon	CASIL
FR_Ownership	NAD27_Z10	Ownership polygons within FR wateshed	Polygon	CASIL
FR_photo_pt_2004	NAD27_Z10	Photo Points from 2004 site visit	point	ES
FR_PLSA	NAD27_Z10	Public land survey lines Feather River	Polygon	CASIL
FR_precip	NAD27_Z10	Precipitation data for FR area	Polygon	CASIL
FR_restore_reaches	NAD27_Z10	Reaches of FR with restoration	line	CASIL
FR_rivers	NAD27_Z10	Major rivers of the FR watershed	line	CASIL
FR_Rivers2	NAD27_Z10	More refined river network - FR_rivers	line	CASIL
FR_streams	NAD27_Z10	Streams, creeks, rivers of FR watershed	line	CASIL
FR_urban	NAD27_Z10	Urban areas of the FR watershed	Polygon	CASIL
FR_valleys	NAD27_Z10	Areas <6% slope in the FR watershed	Polygon	ES
FR_veg_calveg	NAD27_Z10	Calveg classication of FR vegetation	Polygon	CASIL
FR_watershed	NAD27_Z10	Feather River Watershed	Polygon	ES
FR_hucs_5	NAD27_Z10	Level 5 Hydrologic units of the FR	Polygon	ES
FR_soil	NAD27_Z10	Soil (STATSGO) for FR watershed	Polygon	CASIL
Lassen_NF	NAD27_Z10	Lassen National Forest Land	Polygon	CASIL
Plumas	NAD27_Z10	Plumas County	Polygon	CASIL
Plumas_line	NAD27_Z10	Plumas County line file	line	CASIL
Plumas_NF	NAD27_Z10	Plumas National Forest Land	Polygon	CASIL
PNF_admn	NAD27_Z10	Plumas NF administrated area	Polygon	PNF

PNF_admn_arc	NAD27_Z10	Plumas NF administrated area line file	Line	PNF
PNF_fire97_pt	NAD27_Z10	Plumas NF fires 1997 point data	Point	PNF
PNF_FIRE_PLY	NAD27_Z10	Burned areas of PNF	Polygon	PNF
PNF_huc1	NAD27_Z10	Large Hydrologic Units of PNF	Polygon	PNF
PNF_huc5	NAD27_Z10	Smaller hydrologic units of PNF	Polygon	PNF
PNF_huc6	NAD27_Z10	Subbasins -small hucs- of PNF	Polygon	PNF
PNF_range_allot	NAD27_Z10	PNF allotments - grazing	Polygon	PNF
PNF_rd_route	NAD27_Z10	Roads and routes within the PNF	line	PNF
PNF_restore_pt	NAD27_Z10	Restoration point file of the PNF	point	PNF
PNF_roads	NAD27_Z10	Raods of the PNF	line	PNF
PNF_streams	NAD27_Z10	Streams of the PNF	line	PNF
PNF_veg	NAD27_Z10	PNF vegetation classification	Polygon	PNF
Tahoe_NF	NAD27_Z10	Tahoe National Forest Land	Polygon	CASIL
SN_meadow_type	NAD27_Z10	Sierra Nevada medow types	polygon	CASIL
SVGMD	NAD27_Z10	Sierra Valley Groundwater Management D	Polygon	ES
FR_elev	NAD27_Z10	Feather River Elevation	Grid	ES
SWRCB_R5_pts	NAD27_Z10	SWRCB points in the FR watershed	point	SWRCB
FR_precip_watershed	NAD27_Z10	Precipitation within watershed (clip)	polygon	CASIL
FR_grwater_watershed	NAD27_Z10	groundwater basins within watershed (clip)	polygon	CASIL

Projection Information – Spatial Metadata

All data and shapefiles are projected in the following projection system:

Horizontal coordinate system

Projected coordinate system name:

NAD_1927_UTM_Zone_10N

Geographic coordinate system name:

GCS_North_American_1927

Details

Map Projection Name: Transverse Mercator Projection

Standard Parallel: n/a

Standard Parallel: n/a

Longitude of Central Meridian: -123

Latitude of Projection Origin: 0

False Easting: 500000.000

False Northing: 0.000

Planar Coordinate Information

Planar Distance Units: meters

Coordinate Encoding Method: coordinate pair

Coordinate Representation

Abscissa Resolution: 0.000256

Ordinate Resolution: 0.000256

Geodetic Model

Horizontal Datum Name: North American Datum of 1927

Ellipsoid Name: Clarke 1866

Semi-major Axis: 6378206.4000

Denominator of Flattening Ratio: 294.97869