BUTTE CREEK WATERSHED PROJECT

EXISTING CONDITIONS REPORT

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Butte Creek Watershed Conservancy

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Executive Summary

Background

Butte Creek originates in the Jonesville Basin, Lassen National Forest, at an elevation of 7,087 feet. Several small tributaries converge in the Butte Meadows Basin, an area characterized by a series of wide meadows and repeating series of pools and riffles. Butte Creek transitions from the Butte Meadows area approximately 25 miles through a steep canyon to the point where it enters the valley floor near Chico. The Sutter Buttes, located in the center of the Sacramento Valley divide the valley section of Butte Creek. The upper portion of this section is approximately 45 miles in length extending from Highway 99 near Chico to the point where Butte Creek first enters the Sacramento River at the Butte Slough Outfall Gates. Butte Creek in this reach is bordered almost entirely by agricultural lands, including several state and federal wildlife areas, and is generally contained by a series of levees. Butte Creek flows are regulated into the Sacramento River by the Butte Slough Outfall Gates to accommodate both flood flows and agricultural needs in the Sutter Bypass area. The Sutter Bypass section of Butte Creek is approximately 40 miles in length. Butte Creek splits into two channels, known as the East and West Barrows, as it enters the Sutter Bypass near Highway 20. During normal flow periods, Butte Creek enters the Sacramento River via Sacramento Slough, immediately upstream of the mouth of the Feather River near Verona (Mills et al., 1996).

The watershed's richly diverse and considerable resources of water, farmland, timber, and recreational opportunities enrich the lives of both its residents and visitors. However, increased urbanization and growing demands on the resource base have created issues of concern to all. They include, but are not limited to: endangered species protection, water supply demands, land use practices, fire and flood hazard, urban development, and natural habitat destruction. In an attempt to address these and other concerns, the Butte Creek Watershed Conservancy (Conservancy) was formed in September 1995 to encourage the preservation and management of the Butte Creek Watershed through watershed-wide cooperation between landowners, water users, recreational users, conservation groups, and local, state and federal agencies. The mission statement of the Conservancy reflects that dedication: "The Butte Creek Watershed Conservancy was established to protect, restore and enhance the cultural, economic and ecological heritage of the Butte Creek Watershed through cooperative landowner action."

The Conservancy received non-profit 501(c)3 status in November of 1996. Shortly thereafter, the Conservancy prepared a Memorandum of Understanding (MOU) (see Appendix A) to create a Butte Creek Watershed Management Strategy. The MOU established a voluntary and cooperative agreement between 24 signatories to work together in a watershed planning process. It is the Conservancy's belief that stakeholders working cooperatively have the greatest potential for streamlining resource management and minimizing conflict between landowners, water users, government agencies and conservation groups.

In 1996, the Conservancy enlisted the services of the California State University, Chico Department of Geography and Planning Department (CSUC) and the University Research Foundation to apply for State, federal and private grants for the development of a Watershed Management Strategy. Through the generosity of the US Fish & Wildlife Service, CALFED, National Fish & Wildlife Foundation, Bureau of Reclamation, and the Metropolitan Water District, the Conservancy set in motion the creation of the Butte Creek Watershed

Management Strategy. This document is the first volume of that strategy – its Draft Existing Conditions Report. The Watershed Management Strategy Document will follow.

General Stakeholder & Watershed Advisory Committee Process

Sustained resource protection and management requires the coordinated effort of many concerned individuals. The Conservancy and California State University, Chico invited through media releases, flyers and other public outreach efforts stakeholders representing landowners, timber interests, urban representatives, agriculture, recreational groups, irrigation districts, conservation organizations, waterfowl clubs, and local, state, and federal agencies, to participate in an initial General Public Stakeholder Meeting. From this meeting, nominations of individuals with diverse interests and representing different reaches of Butte Creek resulted in the creation of the Watershed Advisory Committee (WAC). Additionally, agency personnel with distinct expertise were invited to serve as members to the Technical Advisory Committee (TAC). For further input, stakeholders were invited to general membership meetings to participate in a scoping process (6 four-hour meetings) to identify watershed Issues and Concerns for prioritization. These issues were categorized into 15 groups, and from these, the top ten issues and concerns for the watershed were defined. These concerns were further refined by the Technical Advisory Committee and can be found in the *Issues and Concerns as Related to Existing Conditions* Chapter.

The WAC and TAC were charged to work with CSUC and the Conservancy in identifying and resolving important watershed issues. To date, information on existing conditions has been compiled by CSUC faculty and graduate students and presented to stakeholders and members of the WAC and TAC for review and comment. All meetings have been well attended and the diverse group has provided a full spectrum of viewpoints to all discussions, ultimately increasing the scope of issues that are covered in this report. Additionally, WAC and TAC members have been identifying data gaps, which will play a key role in the evolution of the already developing Watershed Management Strategy**.**

Existing Conditions Report

The purpose of the Existing Conditions Report is to gather together in one document as much descriptive information as possible about the physical, natural, and cultural resources of the Butte Creek Watershed. To a large extent, the compilers have had to rely on data and descriptions of resource conditions contained in prior reports. This information has been reviewed and incorporated into this report with the appropriate citations of source materials. In many cases, the information contained in the existing literature has been refined by the lead authors based on their knowledge of the resources of the Central Valley and the Sierra Nevada.

A similar effort, focusing predominately on physical and natural characteristics, has been undertaken in the lower portion of Butte Creek - *The Lower Butte Creek Project*. Stakeholders working with The Nature Conservancy and Jones & Stokes, Inc. have focused on developing mutually beneficial and acceptable alternatives to improve fish passage in the Butte Sink, Butte Slough, and Sutter Bypass sections of Butte Creek while maintaining the viability of agriculture, seasonal wetlands, and other habitats *(The Lower Butte Creek Project – Final Project Report*, June 1998). For this reason, the scope of this document has emphasized the existing conditions within the Butte Creek Watershed from its headwaters to Highway 162.

It is anticipated that this information will serve as a baseline for future investigations in the watershed. As an inventory of what is known about the Butte Creek Watershed, this document will also serve to point out what is not known about the resources in the watershed (referred to as “data gaps”). The long-term goal is that this report will provide the reader with an analysis of watershed conditions rather than just lists and maps of what is present. Therefore, to the extent possible, the authors of each chapter have attempted to evaluate the condition of each resource in order to clarify the present level of understanding of the “health” of the watershed and the specific resources within the watershed.

This Existing Conditions Report is intended to function like an open book, which explains why it is formatted to fit into a three-ring binder. The reason for this is simple, as this format will allow for the insertion of periodic updates as new information and interpretation of data are generated. In addition to the insertion of new material at the end of each chapter, it is expected that periodically certain, as of yet unfinished, chapters will be reissued.

Geographic Information System (GIS)

In addition to preparing an Existing Conditions Report and formulating a Watershed Management Strategy, the Conservancy obtained funding to develop a Geographic Information System (GIS) for the Butte Creek Watershed. The CSUC Geographic Information Center (GIC) deserves recognition for its leadership in developing these comprehensive resource maps. The nature and quality of the Butte Creek Watershed GIS maps are a direct result of the level of information that was generously shared by all cooperating public and private sources. The GIS provides the following features:

- Information management tool to assist in decision formulation process
- Quality mapping products for public presentation
- Record-keeping/Monitoring tool
- Potential to develop future resource information layers

The GIS maps contain a resource data inventory developed by gathering data layers from participating agencies and combining them in a common format for subsequent analysis and display. The GIS maps developed to date include:

- Base Map of Watershed
- Physical Features
- Hydrology
- Land Use
- Soils
- Vegetation
- Land Ownership
- 7.5 Minute Quadrangles
- Diversions (Inflows & Outflows)
- Fish Habitats
- Climate Stations
- Surface Water Flow Stations
- Surface Water Quality Stations
- Levee & FEMA Zones Map
- Groundwater Monitoring Stations
- Groundwater Quality Stations
- Recreation Facilities

These maps represent an important resource evaluation tool to be used concurrently with the Existing Conditions Report in the development of the Watershed Management Strategy. They can be found in the Appendix section of this document (see Map Appendix).

Education Program

The Butte Creek Education Project (BCEP) is a cooperative effort supported by funding from the US Fish and Wildlife Service, CALFED Category III, and Environmental Protection Agency 319h (EPA). The BCEP is administered by CSUC Watershed Project with the support of the Conservancy.

Essential aspects of the education program are to gain the support of teachers, schools, districts, and the community by providing the resources, equipment, personnel, and knowledge to facilitate involvement in watershed activities. Through the 1996 - 1997 and 1997 - 1998 school years, the initial core of 8 teachers has expanded to 20 teachers at all grade levels. This group has initiated a number of different projects. The first project was to develop and organize classroom ready curriculum on selected watershed themes. Workshops on using watershed curriculum in and out of the classroom were conducted with the number of workshops to increase in the coming school years. Many of the core teachers have begun using watershed curricula such as the Adopt-A-Watershed program in their classrooms. Integration of other existing education programs such as California Department of Fish and Game's "Salmon and Steelhead in the Classroom, Eggs to Fry" and the Sacramento River Discovery Center's river awareness programs have been used with great success.

Restoration work and field trips have also been important aspects of BCEP. Teachers from Bidwell Junior High have taken their students on a number of different field trips to Butte Creek and have participated in riparian plantings at a number of different sites including the Parrot-Phelan Dam and the Honey Run Covered Bridge. Chico High West, a school within a school, focused its studies on Butte Creek. Field trips and presentations by agencies and landowners were part of the curriculum, culminating in group presentations by the involved students on different aspects of Butte Creek. Pleasant Valley High's (PV) Colegio students were responsible for riparian restoration plantings at the Parrot-Phelan Dam, and other PV students did plantings at the Keeney Property in Durham. Once again, speakers were invited to PV to present and provide information to the students. As a part of the BCEP program, volunteer efforts provided by Americorps have been coordinated with core teachers and their students to clean up degraded areas, restore riparian areas and maintain these project sites. These Americorps members have been trained in watershed education, and their knowledge and expertise in watershed education has been a great aid to the BCEP.

Further involvement of the core teachers and their students in local community activities which educate the public about their watershed include Butte Environmental Council's *Endangered Species Fair*; the BCWC's *Spring Run Salmon Celebration*; and CSUC's *Earth Week Celebration*. Educational materials such as slide shows, videos, printed materials, and a presentation booth are also being developed for use at workshops and community events to further public education about their watershed. Specific workshops for teachers on mini grants for education, as well as for the public on general watershed information have been implemented.

Lastly, BCEP has involved the Chico Unified School District (CUSD) in supporting watershed education. With funding from EPA and CALFED, CUSD has hired, from within its own district, a science teacher trained in watershed education to be its Watershed Education Coordinator on a 2/5 basis to specifically develop and implement watershed curriculum, and train other teachers in this curriculum in grades K-12. This curriculum would include water quality monitoring, instruction in the life history of anadromous fish species, associated plant and insect life, non-point source pollution remedies, and riparian restoration. Further goals that are in progress are to establish a field classroom, make available the Watershed Resource Lending Library, and the adoption of classroom watershed curriculum by as many Butte County Schools as possible. Involvement of the teachers and the students, and in turn the public, throughout the watershed is an important element for broadening the awareness of and commitment to their watershed's health.

Watershed Management Strategy

The Watershed Management Strategy Report will be the sequel document to the Existing Conditions Report. The development of the Watershed Management Strategy is dependent on the continued cooperative effort of Conservancy, stakeholders, the WAC, the TAC, and California State University, Chico. Guided by the Draft Existing Conditions Report, GIS mapping, and the prioritized concerns and issues raised by the General Stakeholder meetings, the WAC plans to continue meeting monthly to discuss the nature and development of the Watershed Management Strategy.

Key pieces of information will continue to be available to the WAC decision-making body. This summer, two research efforts are due to commence: 1) Upper Watershed Road Survey; 2) Fluvial Geomorphology Analysis. Both of these reports will add significantly to the base of knowledge regarding the watershed and provide guidance to those individuals charged with creating the management strategy. As knowledge of the watershed increases, new management actions will also develop. The Existing Conditions Report and the Watershed Management Strategy will provide the framework for an "adaptive management" approach to achieve a reasonable balance among the diverse demands on the resource base of the Butte Creek Watershed. Therefore, both documents will never be fully "completed", but instead will live on to be continually updated and refined throughout the planning process.

We look forward to your review of this "draft" document and encourage you to make any needed additions or suggestions.

Chapter 1

Location and Overview of the Area

Butte Creek originates in the Jonesville Basin, Lassen National Forest, on the western slope of the Sierra Nevada Mountains, at an elevation of 7,087 feet. The upper watershed area comprises approximately 140 square miles and drains from the northeast portion of Butte County. Butte Creek enters the Sacramento Valley southeast of Chico and meanders in a southwesterly direction to the initial point of entry into the Sacramento River at Butte Slough. A second point of entry into the Sacramento River is through the Sutter Bypass and Sacramento Slough (see Map Appendix, Base Map DEM).

Several small tributaries converge in the Butte Meadows basin, an area characterized by a series of wide meadows and repeating series of pools and riffles. Pine, cedar, and fir dominate the upper portion of the area, whereas the predominant riparian vegetation types in the meadow areas are alder and willow. Butte Creek flows from the Butte Meadows area approximately 25 miles through a steep canyon to the point where it enters the valley floor near Chico. Numerous small tributaries and springs enter the creek in the canyon area. Deep, shaded pools are interspersed throughout the upper section of the canyon above Centerville, whereas the area below has a shallower gradient and riparian canopy of alder, oak, sycamore and willow.

Flows from the West Branch of the Feather River, diverted by Pacific Gas and Electric Company (PG&E) for power generation, enter Butte Creek via the Toadtown Canal at the DeSabla Powerhouse. Two existing dams were modified by PG&E in 1917 to divert water from Butte Creek for power generation. Another, the diversion for the Forks of Butte Hydroelectric Project, was built by the Energy Growth Partnership I in the 1980s. The lowermost structure, the Centerville Diversion Dam, located immediately below the DeSabla Powerhouse, is generally considered to be the upper limit of anadromous fish migration. Anecdotal reports suggest that under extremely high flows, steelhead have been observed traversing this dam. Small impoundments in the watershed, including Magalia Reservoir, Paradise Lake, and DeSabla Reservoir, store a combined 14.7 thousand acre-feet.

The upper watershed area above the valley floor comprises primarily private land holdings, with some national forest lands at the extreme upstream portion. Urban development in the upper watershed area of the mainstem of Butte Creek has been limited, although Little Butte Creek is regulated by two dams that provide domestic water for the town of Paradise. The Paradise area is being developed and is currently undergoing a severe water shortage. Currently, except under high winter flows, Little Butte Creek makes only a minimal contribution to the flows of Butte Creek. Increased infill development, primarily residential, is occurring in the lower canyon and along Butte Creek as far as Durham.

Upper Watershed: Butte Meadows

Butte Creek originates from snow and rain that fall on the western face of the Sierra Nevada. It is formed by four small streams that flow into the Jonesville Basin in Lassen National Forest in an area dominated by species of pine, cedar, and fir. The creek gathers flow as it drops into Butte Meadows Basin. Softwoods cover the hills around the creek while alder and willows comprise much of the riparian overstory. Butte Creek flows through a series of wide meadows and is characterized by repeating sequences of pools riffles. Riffle substrate is cobbles and gravel. The stream flows all year, but peaks in streamflow occur during storms and spring runoff. Stream temperatures remain cool all year and trout is the dominant species of fish (Leach and Van Woert, 1968).

Upper Watershed: Butte Creek Canyon

Butte Creek cascades from the mountains to the valley through steep canyons. Pine and fir dominate the flora at the head of the canyons, but as the stream reaches the valley floor oaks and willows are more common. PG&E owns two dams in the canyon which are utilized for hydroelectric generation. The first dam, Butte Creek Head Dam, diverts all but 17 cubic feet per second (cfs) of Butte Creek for hydropower generation during wet and normal years and all but 7 cfs during dry years. Tributaries add flow to Butte Creek in the canyon. The second dam, Centerville Head Dam, diverts all but 40 cfs during wet and normal years and 10 cfs in dry years. Water imported from the West Branch of the Feather River which passes through the Centerville canal returns to the creek at Centerville Powerhouse. The stream in the canyon between and below the dams is characterized by deep pools and steep rocky banks. The stream gradient is steep through the canyon (Hansen et al., 1940).

Salmon and steelhead migrated far into the canyons prior to construction of the dams in 1917. Steelhead probably went as far as Butte Meadows (Flint and Meyer, 1977). They are now restricted to the lower reaches of the canyon and tributaries such as Dry Creek (Brown, 1992b). Salmon now spend their summers between a natural barrier about 1 mile below Centerville Head Dam and the Covered Bridge. Most gradually swim up to the barrier during summer. Some spawn near their holding pools, but many drop downstream to areas richer in suitable gravel. Young salmon rear in the canyon below Centerville Head Dam for up to one year. Summer flows of 40 cfs generally keep water temperature below 68°F in the reach (Kimmerer and Carpenter, 1989). Water temperature often exceeds 76°F in the canyon between Butte Creek Head Dam and Centerville Head Dam in July and August. With improved flows and new fish ladders, fall run salmon are now moving into this section in the fall to spawn.

Lower Watershed: Valley Section

Butte Creek leaves the canyon and flows through a portion of the Sacramento Valley near Chico. Oaks, cottonwoods, and willows are common along the banks of the upper reaches in this section (CDFG, 1974). The creek is bordered by levees in most of the valley reach. Four dams and numerous diversions in the valley section remove water to irrigate rice fields and orchards (McGill, 1987). The upstream-most diversion, Parrott-Phelan, takes water all year (winter diversions are small and are made with the dam boards out), but most divert in April through September. Fall run chinook salmon spawn in this reach between Highway 99 crossing and Western Canal crossing in October and November. Adult spring run chinook salmon pass through this reach from February to June. Juvenile salmon from both races rear here in late winter though late spring on their way to the Pacific Ocean.

Lower Watershed: Butte Basin

Butte Creek water passes through the Butte Basin, Butte Sink, Butte Slough, and the Sutter Bypass before it joins the Sacramento River. Creek water flows through twin channels, the East and West borrow pits all year and Butte Slough Outfall during flood flows in the fall, winter, and spring. The borrow pits are regular, excavated channels on either side of Sutter Bypass. The creek gains flow here through the return of irrigation water. Gates on Willow Slough and the East-West borrow pit diversion structure are used to control water levels in the East borrow pit (Slebodnick, 1976). Dams also impound and divert water for wildlife and agricultural uses. The dams include: Sanborn Slough, White Mallard Dam, East-West Diversion weir, and weirs number 1 through 5. Willows are the dominant riparian plant species. Salmon and steelhead rear in these waters in spring and early summer. High water temperatures 70° - 85°F in late spring and summer are lethal to salmon and steelhead in this reach.

Chapter 2

Geology, Basin Morphology, and Hydrologic System

Introduction

The Butte Creek Watershed is characterized by a unique geologic and hydrologic setting that has influenced the stream morphology and current land uses of the watershed. The steep canyon sections provide opportunity to harness the creek for hydroelectric power production. The relatively flat and open valley section of the creek, with extensive clay soils, provides an ideal setting for rice production. The inclusion of intrusive and metamorphic geologic structures in the upper portions of the watershed produced gold bearing deposits that attracted miners as early as the mid 1800s. All of these land uses have modified the environment and the hydrologic regime of the watershed. The following section describes the hydrologic system of Butte Creek including diversions, surface water and groundwater augmentations from a variety of sources, and the structures involved. It profiles the geology and basic basin morphology of the watershed. This description starts at the upper elevations in the watershed, and proceeds downstream, incorporating diversions, feeder streams and structures as they are encountered. It also profiles and explains the geology of the watershed as the description runs through it. It has been designed to be used in conjunction with USGS quadrangles, geologic maps, or the Butte Creek Watershed Project's Hydrology map (see Map Appendix). The geologic descriptions correspond to the geology encountered at creek level, as this is where changes in geology are most visible, and the effects on stream morphology are immediately evident. The breaking of the watershed into component parts such as "Upper Watershed" and "Lower Watershed," with further subdivisions, was done merely to provide the reader a way to easily find descriptions of certain sections of the creek.

Upper Watershed: Butte Meadows

Beginning at an elevation of over 7000 feet near the Butte Meadows area, Butte Creek is fed by numerous source streams such as Scotts John, Jones, Colby, and Bolt Creeks, two separate Willow Creeks, and several smaller un-named tributaries. These are perennial streams, with base flows supplemented by numerous springs, particularly in the area of the more northern Willow Creek. Most of these streams begin on the flanks of steeper slopes such as Colby Mountain, Humboldt Peak, or Snow Mountain.

The geology of this headwaters area is composed of volcanic rocks, associated with the Pliocene volcano Mt. Yana. The area contains andesitic rocks, with flows light to dark gray in color, medium to coarse grained in texture, and composed of hornblende, pyroxene, and ferromagnesium-poor andesites; basaltic rocks, black to gray flows of aphanitic to medium-grained olovine basalts, along with andesitic basalts, pyroxene basalt and local, thin interbedded mudflows; and pyroclastic formations (Tuscan Formation) composed of basaltic and andesitic volcanic breccia, mudflow, tuff, tuff-breccia, and thin interbedded sediments and basalt flows (Lydon et al., 1960 Division of Mines and Geology, Westwood sheet). The Tuscan Formation, a major geologic feature in the watershed, is described in further detail later in this section.

These creeks drain into a relatively flat area between the settlements of Jonesville and Butte Meadows, communities comprised mostly of vacation homes and cabins. Flowing through the Butte Meadows area, the creek is essentially in its first flood plain. As the Butte Meadows area is surrounded by uplands at elevations that hold a significant amount of snow during the winter and spring months, the area is subject to flooding during high intensity, warm precipitation events on top of snow, such as the early 1997 event.

Upper Watershed: Upper Butte Creek Canyon

As the creek leaves the Butte Meadows area, it begins to incise into the Pre-Cretaceous metavolcanic and (older) Paleozoic marine sedimentary and metasedimentary geologic structures. Known as the Sierra Nevada Basement Series or Basement Complex, these rocks underlie the volcanic structures that dominate the drainage basin. This formation is composed of massive greenstones, tuffaceous schists, dark schistose metasedimentary and metavolcanic rocks of the "Calaveras Formation," slates, dark phyllite, quartzite, serpentine, and graywacke (Lydon et al., 1960; Harwood, Helley, and Doukas, 1981).

Approximately two miles into the canyon, the first of many unnamed tributaries enters Butte Creek from the east. The creek averages a drop of over 100 feet per mile in this section (USGS Provisional "Butte Meadows" 7.5' quadrangle, 1991) and canyon walls can average 40-60% gradient (Andrew Conlin, 1997 Pers. Com, NRCS). Over the next two miles, two more unnamed tributaries enter from east, each spaced approximately a mile apart. Almost three and one-half miles downstream, the first major named tributary enters from the east. Bull Creek is joined by Bottle Creek about one and one-half miles above the Butte Creek confluence, and joins Secret Creek about three-quarters of a mile above the Butte Creek confluence.

It is in this area that the interface between the Tuscan (mudflow) Formation and the underlying Basement Series geology, in part containing the "Tertiary Auriferous gravels", begins to become exposed (USGS, 1894). The Tertiary Auriferous gravels are ancient, gold-bearing (auriferous) stream deposits, with their deposition occurring in the Tertiary period of the geologic time scale.

Below the Bull Creek confluence, it is approximately one and one half miles before another tributary enters from the east. It is followed about one half mile later by another small tributary coming in from the east, and less than a quarter of a mile after this, the first major diversion structure on Butte Creek, the Butte Creek Diversion Dam, is found.

The Butte Creek Diversion Dam (also known as the Butte Creek Head Dam) was constructed in its current configuration in 1917. Most likely it existed in another smaller form since the days of the gold rush and surely since 1903, when Eugene J. DeSabla Jr. began to operate the DeSabla/Centerville hydroelectric system. As the dam stands today, it is a 95 foot long, concrete arch structure, with a spillway crest elevation of 2884 feet, and stands 42 feet above the streambed (Flint and Meyer, 1977). The area behind the dam is completely filled with sediment, although it still functions to divert water into the canal.

Water diverted by the dam is directed along the canyon wall through a series of canals, flumes and tunnels known as the Butte Creek Canal. The 11.53 mile-long Butte Canal has a capacity of 91 cfs (Flint and Meyer, 1977), is joined by the Toadtown Canal (described later in this text), and enters the DeSabla Reservoir, PG&E's forebay for its DeSabla/Centerville Hydroelectric System.

Haw Creek, the first tributary to enter the canyon from the west, drains the middle portion of Carpenter Ridge, dropping off the plateau and entering the creek just below the Butte Creek Diversion Dam and just above the Inskip Creek confluence. Inskip Creek enters from the east, just downstream from Haw Creek, and drains an area smaller in size than the Bull Creek drainage.

Continuing downstream 3/4 of a mile, Cape Horn, a geologic feature that dominates the canyon landscape, is visible. This outcropping of more resistant metavolcanic material has forced Butte Creek to flow around the rock outcrop, while the Butte Creek Canal, some 180 feet above the creek, enters a tunnel through the rock itself.

In the next 1.5 miles, several small, unnamed tributaries enter Butte Creek from the east and west. Coming in soon after, on the east, is Clear Creek. Clear Creek is joined by Kanaka Creek about one mile before its confluence with Butte Creek. Downstream of the confluence with Clear Creek, numerous small tributaries, many of them spring fed, begin to enter from both sides of the creek.

Upper Watershed: Middle Butte Creek Canyon

Looking again at the creek and its associated landscape in the area below Clear Creek, the increasing amounts of mining debris, broken equipment, and old homesites bear evidence of past Euro-American habitation. Extensive faulting of the Basement Series in this area intrusion of the interface between the Tertiary stream gravels and the overlying Tuscan Formation mentioned earlier are probably what account for the concentration of mining activity and settlement in this area in the days of the Gold Rush. There are many mines in the area, several indentified on USGS 7.5' quadrangles (Dix, Royal Drift, Black Diamond, etc.). The natural topography of the inner gorge of Butte Creek Canyon in the area around the Forks of Butte (the confluence with the West Branch of Butte Creek) has been modified by the mining of the stream and terrace gravel in the area of the confluence itself. Tailing piles and old sluice channels are scattered along the banks. The interface between the Tuscan and Basement Series rocks was exploited extensively on the Platte Ravine, off the West Branch of Butte Creek, accounting for headcuts and some hardrock tunneling in this area. Although many of the cutbanks in the area now have 100+ year old trees growing out of them, the landscape is still visibly altered.

Less than 1 mile downstream from the Forks of Butte is Doe Mill Road Bridge (also known as Ponderosa Way or Garland Rd.), which crosses Butte Creek. About the same distance below the bridge is the intake structure for the Forks of the Butte Hydroelectric Project, operated by Energy Growth Partnership I. This intake takes water through the dam and into the east canyon wall where an 11 foot diameter, 11,000 foot long tunnel and penstock system drops the water to produce electricity at the Forks of Butte Powerhouse, located just upstream from PG&E's DeSabla Powerhouse. During the 1993 wy, Energy Growth Partnership I diverted 80,370 acre-feet of water at the Forks of Butte diversion site for power generation. In the 1994 wy, 17,070 acre-feet was diverted, and for the 1995 wy, 79,852 acre-feet of water was diverted (USGS California Hydrologic Data Reports, 1993, 1994, 1995). Just across from the dam, a large serpentine belt is visible as it runs through the canyon wall. This feature is large enough to be identified easily on aerial photographs and geologic maps.

In the next 3.5 miles of creek from the Forks of the Butte intake structure down to the Forks of Butte and DeSabla Powerhouses, Butte Creek drops an average 215 feet per mile (USGS Paradise West and Cohasset 7.5’ Quadrangles). This section of the creek is punctuated by several large waterfalls, has primarily bedrock substrate and banks, and is "pool-drop" in nature. The 1998 report by Johnson and Kier provides heights and locations of the numerous natural and anthropogenic barriers located within this reach. The Forks of Butte Powerhouse, and, just downstream, the DeSabla Powerhouse, lie at the bottom of a 5-mile road coming down from PG&E's DeSabla Reservoir (shown as Lake DeSabla on many maps). The reservoir, which is located in Magalia, is the terminus of the Butte Creek Canal and has a capacity of 188 acre-feet, covering 14.9 acres (Flint and Meyer, 1977). The Toadtown Canal, as mentioned earlier, ties into the Butte Creek Canal just upstream of where the Butte Creek Canal passes below Understock Road. The Toadtown Canal, built in the gold rush era of the late 1800's, transfers water from the Hendricks Head Dam (elevation 3256') on the West Branch of the Feather River across the watershed divide into the Butte Creek Watershed by way of a series of tunnels, flumes, and canals. The system also provides water for Stirling City's Breedlove Reservoir, the city's water supply. The rated capacity of this canal is 125 cfs (Flint and Meyer, 1977). According to USGS records, the average flow of the Toadtown Canal has been 65.8 cfs for a period of record spanning wy 1987 to wy 1996, and the maximum daily discharge was 127 cfs on both February 12 and May 20, 1995 (*USGS California Hydrologic Data Reports*, 1996). Spanning the period of record of wys 1931 to 1993, the average annual flow, in acre-feet, for the Toadtown Canal is 46,727 cfs (Hillaire, 1993). It should be noted that the canal is often without flow during late summer and fall, and due to the nature of the landscape that the canal runs through, it is often shut down for cleaning and maintenance after large precipitation events. All the data mentioned above was taken at a station 600 feet upstream of the confluence with the Butte Creek Canal, a point which is below Breedlove Reservoir; therefore, consumptive use by Stirling City does not affect the recorded data.

Water from the West Branch of the Feather River is commingled with Butte Creek water in DeSabla Reservoir and enters Butte Creek through the DeSabla Powerhouse, changing its hydrogeochemical composition from this point downstream. The powerhouse operates with water dropped over 1,400 feet through penstocks. The

DeSabla Powerhouse discharged 93,330 acre-feet in 1993, 77,670 acre-feet in 1994, 88,310 acre-feet for 1995, and 86,700 acre-feet for 1996 (USGS California Hydrologic Data Reports, 1993, 1994, 1995, and 1996).

Downstream from DeSabla Powerhouse, 0.2 miles, the waters of Butte Creek are diverted again by PG&E at the Centerville Diversion Dam. The Centerville Diversion Dam is considered the upper limit for anadromous fish migration, although anecdotal evidence suggest that some fish may have cleared this barrier at higher flows (Holtgrieve and Holtgrieve, 1995). In the 1993 wy, the Centerville Diversion Dam diverted 93,690 acre-feet of water into the Lower Centerville Canal, conveying it to the Centerville Powerhouse. In 1994, 74,870 acre-feet of water was diverted, and in 1995, 75,450 acre-feet (USGS California Hydrologic Data Reports, 1993, 1994, and 1995). The 7.97 mile-long Lower Centerville Canal is rated at 180 cfs above Helltown Ravine, and 192 cfs below (Flint and Meyer, 1977).

Water diverted from Butte Creek at the Centerville Diversion Dam is supplemented by DeSabla Reservoir water conveyed through the 5.1 mile-long Upper Centerville Canal dropping into the lower canal by way of Helltown Ravine. This upper ditch, with a capacity of 35 cfs, supplies a number of properties on the Nimshew Ridge and in Butte Creek Canyon (Flint and Meyer, 1977).

Upper Watershed: Lower Butte Creek Canyon

In this section, below Centerville Head Dam, the canyon has similar characteristics until the creek flows into valley sediments below the Skyway. This section is visually dominated by the towering canyon walls, composed of the Tuscan Formation, rising over 1500 feet above creek level in some places. The predominant geologic unit in the watershed, the Tuscan Formation covers all other geologic formations in the mid-section of the watershed and effectively "caps" the landscape. Its estimated 300 cubic miles of material are spread out over a range of 2,000 square miles, covering an area from Oroville to Red Bluff. This formation was created by a mudflow deposit of late Pliocene age and is composed of angular to subrounded volcanic and metamorphic fragments, up to 3 meters in diameter, in a matrix of gray-tan volcanic mudstone. This mudflow, is theorized to have been mobilized by a lahar from magmatic or meteoric water, and has a maximum thickness of about 1700 feet (Harwood, Helley, and Doukas, 1981; Lydon, 1968).

Continuing downstream from the Centerville Diversion Dam, the stream is entrenched in the metamorphic and igneous rocks that comprise the Basement complex of the Sierra Nevada (shown in white, with cross hatching, on the Geology Map). The sides of the creek show signs of past mining by way of tailings piles and tunnels through bedrock banks. More, small, unnamed tributaries enter the creek through this section.

The creek changes its character markedly about 1.25 miles above the Helltown Bridge. This is the point where the Sierran Basement geology is covered by the Chico Formation (see formation indicated with purple on Geology map). The Chico Formation, a unit of Cretaceous age associated with the inland seas of the Sacramento Valley, is composed of fossiliferous marine sandstone, tan, yellowish-brown to light-gray in color (Harwood, Helley, and Doukas, 1981). Gravel bars begin to form on the insides of meander bends, and the banks are covered with vegetation as roots more easily penetrate the softer sandstone. Homes begin to appear on the terraces of the creek beginning at the Helltown Bridge.

Due to a large landslide sometime within the last 11,000 years, the creek is forced up against the west side of the canyon just below the bridge, cutting deeply into the Chico Formation, leaving well-exposed tan sandstone cliffs. Directly below this landslide area begins a unit known as the Modesto Formation (shown in bright yellow on Geology Map). It is composed of gravel, sand, silt and clay derived from the Tuscan and Chico Formations, and is thought to have been deposited by the same stream system as today, as the formation tends to border existing channels. The unit is perched atop the Chico Formation all along the creek, and is prevalent along the canyon bottom, leading through to the Sacramento Valley. There is an excellent example of this formation exposed on the left bank of the creek about one quarter mile below the Centerville Powerhouse.

Down the creek below the Helltown landslide area is the Centerville Powerhouse. Construction began in 1898, and the powerhouse was operational in 1900. It is now PG&E's oldest operational powerhouse. Just upstream from the powerhouse, below the overflow channel for the penstocks, are the remnants of a CDFG fish barrier dam, constructed in 1969. This dam was formerly used to keep spring run chinook salmon from entering the low-flow zone created by the diversion of water at the Centerville Diversion Dam. The powerhouse itself discharges into a shaded holding pool, and the comparatively cooler, and substantially larger flows of water attract up-migrating chinook salmon.

Although mining debris and cobbles from are visible along the creek around the Forks of Butte, this area in particular reveals the first obvious signs of dredge tailings. These tailings, consisting of cobble-sized and larger rocks, sit in piles where they were left after being sluiced through by miners looking for gold. The tailings continue down the canyon along the creek, and are visible on the Geology Map.

From the Centerville facility down to the Parrott-Phelan Diversion Dam, the creek flows through the highest concentration of homes lining its banks. The creek passes under a Bailey Bridge which replaced the Steel Bridge in January of 1997, three private bridges, the Honey Run Road Bridge, and the historic Honey Run Covered Bridge on its way to the Parrot-Phelan Diversion Dam. Within this section, numerous federal and private bank stabilization projects (rip-rap) were constructed after the high flow event of early 1997.

Less than one half mile above the Covered Bridge, Little Butte Creek enters on Butte Creek's left bank. Little Butte Creek drains the ridge and plateau-like area of Paradise, and the regions that extend further up this ridge area to the north. The creek has two water storage reservoirs located on it: Magalia Reservoir (usable capacity 796 acre-feet), and upstream, Paradise Lake (usable capacity 11,500 acre-feet). The two reservoirs serve as water supply for the Paradise Irrigation District, which supplies water to the town of Paradise. The two reservoirs do not function as flood control facilities. The use of water for domestic use by PID diminish the base flow of Little Butte Creek during the summer and fall months. Paradise Irrigation District is required to release 5 cfs down Little Butte Creek as a minimum base flow per an agreement with CDFG.

The USGS maintains a surface water gauging station just below the Covered Bridge, known as "Butte Creek near Chico, #11390000." Foreign water from the West Branch of the North Fork of the Feather River is included in this gauge reading, raising the flow, on average, by 65 cfs. In the summer, this rate of augmentation is approximately 110 cfs. Despite the fact that foreign water is included in its assessment of streamflow, this gauge is the best source of data for finding quantities and rates of water coming out of the upper, primary water-generating part of the watershed. Below this area, much of the creek down to and below Highway 99, has been mined for gold using dredging techniques and later gravel mining.

Lower Watershed: Valley Section and Butte Basin

Parrott-Phelan Diversion Dam

The Parrott-Phelan Dam is the upper-most agricultural and wildlife enhancement diversion on the creek. This diversion is also the beginning of California Department of Water Resources' (DWR) Butte Creek Watermaster Service Area (see Appendix B), with the diversion itself being Diversion No. 50.

Diversion No. 50 feeds into a ditch that goes by many names: Edgar Slough, Crouch Ditch, and Comanche Creek. The discrepancy comes from the fact that Comanche Creek is an intermittent stream that drains lower Doe Mill Ridge, and crosses under Honey Run Road approximately three-quarters of a mile above the Skyway. Under natural conditions, the stream functioned as an overflow of Butte Creek during peak flow conditions. In essence, Comanche Creek was a distributary or natural bypass of Butte Creek floodwaters. However, this did not occur at the present site of diversion, as evidenced by the very unnatural low-gradient canal that cuts across slopes coming from the dam. Most likely, Butte Creek had a series of sloughs created through channel abandonment and avulsion. One or more of these sloughs connected into what is now known as Comanche Creek or Edgar Slough, as it is known in its valley reach. Although no record of exactly where Butte Creek waters flowed into the lower portions of Comanche Creek exist, evidence from the mapping of soils and old channels show that it most likely occurred between the Skyway and Highway 99. This area was dredged for gold in the early part of this century, then leveled for aggregate processing and residential and commercial development. These anthropomorphic alterations make it difficult to determine the exact site of the confluence of the two waterways.

After widespread agricultural development in the valley in the early part of the 20th Century, the need for irrigation water increased, and the Parrott-Phelan Diversion Dam was constructed and a low-gradient channel was dug to carry water over into Chico and out into the agricultural region beyond. The bypass channel is relatively straight with steep banks 6 feet high. It flows through low-density residential areas before meeting Comanche Creek, just below Honey Run Road. There is a weir with a gauge approximately 0.25 mile below the dam.

The following section describes the Comanche Creek/Crouch Ditch delivery system. Approximately 1.5 miles from the Butte Creek diversion, Comanche Creek enters a siphon with a spillway to the Little Chico Creek bypass (described later in this report), which diverts storm flow from Little Chico Creek to Butte Creek. Some water from the Crouch Ditch at this point is spilled into the diversion channel to be pumped out by Diversion No. 53, for use in the USDA Forest Service Genetic Tree Improvement Center. Below the siphon, Comanche Creek flows through part of the Chico urban area. Storm water from large commercial developments to the north flows through constructed and natural drainages into Comanche Creek. The channel is broader in this section with a 2-foot, incised, low-flow channel, meanders, and small vegetated islands and bars. Residents along the south bank have modified the creek by constructing pools, additional channels, and other features in the creek. As the creek enters the City of Chico, its channel is more constrained and more incised (Ayers & Associates, 1996).

West of Chico near Dayton Road (approximately 6.5 miles from the Butte Creek diversion), Comanche Creek is straight and incised between 10-15 feet with nearly vertical banks. This area is predominately agricultural but has some residential areas. South of Edgar Road, the channel has some meanders and is broader and less incised with three to five foot banks. Clay hardpan soils in this area may be preventing further deepening of the channel. There is a stage gauge in this area to measure water delivered to consumers (see Appendix B). Dayton Mutual Water Company has three points of diversion on the south bank not far below the weir. The north bank is part of M&T and water can be diverted from the creek to irrigate the ranch. The creek reaches the Parrrott-Phelan Canal approximately 2 miles past Crouch Avenue. At the intersection of Comanche Creek and this canal, water can be diverted south through the Parrott Canal (on to Llano Seco Rancho), north to M&T, or continue west in Edgar Slough. There is a surge pond at the intersection to provide temporary storage of water.

The system provides drainage for stormwater runoff from the area north of the channel. During winter storms, runoff from urban and range lands around Comanche Creek can produce high flows in the creek. During large storm events, diversions from Butte Creek are curtailed to prevent flooding in Comanche Creek. Diversions from Butte Creek are also reported to be curtailed from November through March because of a lack of demand and to allow for channel maintenance. In April, May, and June, large quantities of water (up to 10,950 acre ft/month) are diverted from Butte Creek into Comanche Creek to flood rice fields and wetlands, irrigate pasture for cattle, and irrigate nut/fruit trees and other crops. Bank storage and seepage may be significant with losses of 20-30% of the flow diverted from Butte Creek. When residents along Comanche Creek pump water, the loss is higher. Most of these conveyance losses recharge the groundwater and support riparian vegetation. These losses are to be expected, as the channel is traversing the edge of an alluvial fan. Other creeks in the Chico area exhibit this sort of reduction in streamflow. Big and Little Chico Creeks lose much of their flow as they travel across the fan.

As natural flows in Butte Creek drop, the availability of appropriated Butte Creek water utilized by M&T and Parrott Investment Corporation decreases. Dayton Mutual has a senior right to the natural flows of Butte Creek (see Appendix C) and can use water during periods when M&T, Llano Seco Rancho, and the Llano Seco wildlife refuges cannot. During summer, when flows in Butte Creek are low, Dayton Mutual may continue to receive water via Comanche Creek when deliveries to M&T, Llano Seco Rancho, and the Llano Seco wildlife refuges may be limited. This is because of limited flows from the West Branch of the Feather River or because of the inferior right to the natural flow of Butte Creek.

When water demand at M&T and Llano Seco Rancho exceeds available supply through Edgar Slough and Comanche Creek, water is pumped from the Sacramento River at the M&T pumps to supply water to the Phelan Canal. This pump is also necessary as certain portions of the M&T Ranch can only be serviced by Butte Creek water, and other portions of the ranch can only be serviced by Sacramento River water. Water in the canal can be delivered to M&T, Llano Seco Rancho, and the Llano Seco wildlife refuges. The ranches prefer to divert from Butte Creek because the system operates by gravity and the pumps on the Sacramento are expensive to operate; consequently, diversions generally decline in the late summer and increase again in early fall as fields are flooded for waterfowl habitat.

Parrott-Phelan Dam: Diversions and Issues

The Parrott-Phelan diversion has taken an average 27,274 acre-feet of water each year, calculated during the "watermaster period" (April to September), from a period of record running from the 1968 to the 1993 (Hillaire, 1993). It is important to point out that this average is only during the watermaster period, and the diversion does, and has operated during every month of the year. Until recently, with the addition of real-time telemetered gauging, good records for the full years diversion rates and volumes were unavailable. Summer diversions from Butte Creek to Comanche Creek range from 15-163 cfs; however average summer flows for the period 1968 through 1992 were approximately 88 cfs (USDI, USFWS et al., 1996). The diversion has been fitted with a high-flow fish ladder and self-cleaning fish screen that sends entrained juveniles back to the creek, or can be set to keep them in a holding tank for analysis and tagging by CDF&G personnel. During the high water event of early 1997, Butte Creek changed its course in the area of the Parrott-Phelan Diversion. Details regarding this avulsion and the subsequent channel modifications are contained in the Fluvial Geomorphology chapter of this document.

Thus far, diversions from Butte Creek may have created low-flow zones as water has been diverted around sections of the creek for hydroelectric generation, but they have, by definition, been non-consumptive because the flow is returned to the creek downstream. The Parrott-Phelan diversion is the first major diversion for agricultural irrigation, a consumptive use.

The Irrigation Season is defined by DWR to be the period starting in April and continuing through September. This also happens to correspond to the period of low precipitation, and resulting decline in natural flows as the season progresses. The Parrott-Phelan diversion takes 25.4% of Butte Creek flows during the Irrigation Season, averaged over the span of records from the 1968 wy to the 1993 wy. The majority of this diverted water is actually the West Branch of the North Fork of the Feather River import water that arrived in Butte Creek via the Toadtown Canal.

A more recent agreement that affects the diversions at Diversion No. 50 is the agreement between M&T Chico Ranch, Parrott Investment Company, CDF&G, and the USFWS. The *Agreement For Relocation Of M&T/Parrott Pumping Plant Providing For Bypass Of Flows In Butte Creek* relocates the M&T/Parrott pumps on Big Chico Creek to a location on the Sacramento River. This diversion has been granted the right to divert water that would normally be taken from Butte Creek Diversion No. 50. The water not diverted from Butte Creek is to be left in the stream for enhancement of instream flows, and is referred to as "Bypass Waters" in the aforementioned agreement. Bypass Waters are to be provided during the "Bypass Period," which is October 1 through June 30. Bypass Waters are to be "...the total amount of the flow of [the Butte Creek waters to which M&T and PIC have rights] or 40 cfs, which ever is the lesser" However, "the parties acknowledge that consummation of the exchange will depend upon assurance by the USBR and others that Bypass Waters in Butte Creek in fact returns to the Sacramento River (as they will be required to do in order to improve in-stream habitat for chinook salmon and steelhead. The DWR Watermaster Service Area can police diversions down to just above the Western Canal Siphon crossing, but cannot enforce against illegal diversions below that point (see Issues and Concerns chapter, #2).

Increased real-time telemetered streamflow gauges may be a solution. Even with increased gauging, it may be difficult or impossible to keep track of quantities of water being left in the stream for the fishery. Most conventional gauging techniques are difficult as low gradients, backwater effects, and the dynamic nature of agricultural returns and withdrawls interferes with normal operation.

Lower Watershed: Valley Diversions, Canals and Sloughs

Continuing downstream from the Parrott-Phelan Diversion, the creek passes under the Skyway, and just more than a quarter mile downstream of these bridges is the Durham Mutual Dam. This diversion, No. 56, takes water from Butte Creek on the left bank into the Durham Mutual Water Company (DMWC) Ditch, stretching down into their Durham service area. This ditch branches off into Robber's Gulch, which eventually ties into Hamlin Slough just below the upper Rancho Esquon Partners' Dam on Hamlin Slough. Before Robber's Gulch, the DMWC ditch supplies twelve small diverters and the Butte Creek Country Club's golf course. Recent funding from the Central Valley Project Improvement Act (CVPIA) Unscreened Diversions Program and DWR's Four Pumps fund has been approved to install a fish ladder and screening system similar to the one at the Parrott-Phelan Dam upstream.

A smaller, unscreened diversion on the right (north) bank of the dam sends water to several users on the west side of Highway 99. Deemed to be Diversion Nos. 54 and 55 of the Watermaster Service Area, the control valve for the screw gate on this northern diversion has been disabled. Plans to fix this valve or to screen this diversion are awaiting a decision on transfer of a water right.

Just downstream from this diversion, on the north bank, the Little Chico Creek Diversion Channel enters. In 1959 the Army Corps of Engineers installed a flood control structure on Little Chico Creek to limit flows through the City of Chico. (US Army Corp of Engineers, 1957) The flow of Little Chico Creek through Chico is limited to 1,200 cfs. The rest of the flow is diverted into diversion channel and on to Butte Creek. The Corp Design Memorandum details the levee system that begins at this point continuing downstream on both sides for 14.5 miles.

The creek then flows under the Highway 99 bridges, passing a short stretch of creek that was protected with rip-rap in the fall of 1997. About a mile below Highway 99, the Oro-Chico Highway Bridge crosses the creek, and DWR's "Butte Creek near Durham" stream gauge is located on the east bank, just below the bridge. Located near this gauge are the two pumps making up Diversion No. 58, with allowable diversions totaling 0.61 cfs.

Butte Creek then flows between the levees for almost 4 miles, past Durham, on its way to Diversion No. 60, the Rancho Esquon Dam. This large diversion is slated for an improved fish ladder and screening system funded by Proposition 204, Ducks Unlimited and the CVPIA Unscreened Diversions Program. This diversion provides water for to their farming operations. They also diverts from Hamlin Slough (Diversion No. 64, upper Rancho Esquon diversion on Hamlin Slough), which receives additional water from the Durham Mutual Water Company ditch,and at Diversion No. 65, about 1.25 miles downstream on Hamlin Slough.

Just above the Rancho Esquon Dam, an overflow channel branches off to the right of Butte Creek, running parallel for nearly 2 miles. Diversion No. 60A, a pump that is not in use at this time, is just above the Midway. Directly below the Midway is Diversion No. 61, the Gorrill Dam. Diversion No. 61 supplies water to the Gorrill ranch and Western Canal Water District (WCWD). It is currently being fitted with a screening system and new summer and winter fish ladders. Funding for this Project was provided by the same agencies involved in the Rancho Esquon Dam upgrade. Water ponds up for some distance above the Midway when the dam is operational. The Gorrill Ranch also diverts water from Hamlin Slough just below the Midway (Diversion No. 66).

Prior to the removal of the Western Canal Dam in the fall of 1997, water conveyed from Thermalito Afterbay crossed Butte Creek on its way to WCWD customers on the west side of the creek. An island in the middle of Butte Creek, splitting the creek into two channels for a short distance, served as an ideal spot to transfer water across the creek. Dams were placed on both channels, with Western Canal entering the creek just upstream of the eastern dam. Just above the western dam, there was a set of gates that let water back into the Western Canal on the west side of the creek. Water backed up behind the dams and flowed out through the gates into the canal. At this point, Butte Creek water was mixed with Thermalito water from the Feather River. WCWD personnel were responsible for gauging how much water was coming across the creek from the canal, how much was coming down the creek, and how much water they were allowed to divert at that time from the creek under their 8th priority water right (see Appendix C). Unneeded water spilled over the west dam back into Butte Creek.

The dams not only helped get canal water across the creek, they backed up Butte Creek into Hamlin Slough, a distance of over 1 mile. This allowed the pumps in Hamlin Slough (1048) at Diversion No. 62 to draw water. The elevated water level also allowed for the use of the Highline Ditch, a canal that directs water to some of the higher elevation lands in the northern part of the district.

Ladders on the Western Canal Dam in the past helped migrating fish clear this obstacle, but often times more water was coming across the creek from the canal than was coming down the creek from above. Fish could be confused into heading up the swift water Western Canal instead of the relatively stagnant Butte Creek, essentially a pond for over 2 miles.

In the fall of 1997, after completion of the siphon the two dams were removed. A new ditch leading off of the Western Canal, the Durnel Ditch, was constructed with a reverse gradient. It is now, under some conditions, filled with Western Canal water, with the pumps at Diversion No. 62 drawing out of this ditch. It also feeds the east side 1048 pumps, now called the 870 pumps, of the WCWD through pipelines. In another configuration, the Durnel Ditch can be used to take Butte Creek waters to the Western Canal. Water diverted at the Gorrill Dam under WCWD's water right to Butte Creek, can be run through Hamlin Slough, the Durnel Ditch and into the Canal.

On the west side of Butte Creek, the siphon feeds the Highline Ditch with a newly constructed extension. The Highline in turn spills water into the 1048 West Slough which has a newly constructed check dam on it that allows the pumps up in the 1048 West Slough to draw water. Just after the outlet structure of the siphon on the west side of the creek, there is a glory hole structure that allows WCWD to spill water back into Butte Creek for delivery of water to the duck and gun clubs of the Butte Sink area. Up to 200 cfs of Feather River water, by way of the Western Canal is conveyed for this purpose (Pers. com., Ted Trimble, 1997, WCWD).

Below the Western Canal Siphon crossing, lies the "Butte Creek below Western Canal" DWR stream gauge. Once a PG&E gauging station, it was reactivated in October of 1991 to monitor releases from WCWD for the duck clubs.

Butte Creek flows for approximately 7 miles until it reaches the McGowan Dam now operated by CDFG. The McGowan Dam, located approximately 1 mile upstream of Highway 162, will be removed under the current WCWD improvement plans. Instead, water will be conveyed to lands currently serviced by the McGowan Dam through a system that is, for the most part, currently in place.

Western Canal travels west from the siphon into a wetland area that is composed of many merging and then diverging channels. This is known as the WCWD Reservoir Area. In this area, a series of check dams and weirs disperse water into Little Butte Creek, the Main Canal, and the Ward Canal, all water conveyance structures for the WCWD. Little Butte Creek will be extended approximately 9,000 feet and connected to the Main Drain, which joins Butte Creek just above the McGowan Dam. Check dam structures will be placed on both Little Butte Creek and the Main Drain near their confluence with Butte Creek, eliminating flows into the creek that may mislead salmon into straying up these agricultural ditches. Howard Slough, located just above the McPherrin Dam will have a similar structure blocking flows from Butte Creek from entering the slough, as water will be provided via the Main Drain from above.

On the other side of the creek, Little Dry Creek will carry Western Canal water south from the point where it crosses the canal near Nelson Road, down to a point where it will be diverted into a drainage ditch on the Harris property. This ditch, to be enlarged and lengthened, will transfer water down to a point where it can be distributed onto the McPherrin Ranch. A check structure on the Little Dry Creek Overflow channel will keep flows in the Harris Ditch, and out of Butte Creek. The work on this eastern side of the creek will allow for the removal of the McPherrin Dam, located about 2 miles below Highway 162, and just below the upper confluence of Butte Creek with Howard Slough.

Below the McPherrin diversion site, Howard Slough, essentially a side channel, drains into Butte Creek. Campbell Slough empties into Howard Slough above this confluence. There are no fish screens or ladders below the McPherrin diversion site. About 3.5 miles downstream, Butte Creek reaches what is known as the Sanborn Slough Bifurcation, a point where the Butte Creek channel takes a hard right hand turn, and the slough opens up straight ahead. Much of Butte Creek's flow is taken straight down this channel into a series of water conveyance ditches that service the waterfowl clubs of the Butte Sink. Angel Slough enters Butte Creek a short distance downstream after taking a hard turn to the right. The creek at this point is flowing through the Butte Sink itself, and about 0.5 miles downstream the White Mallard Dam is reached. This structure diverts water into what is known as the White Mallard Canal. This canal sends water down to a place called "Five Points", where five water conveyance structures come together. It is at this point that water from Drumheller Slough containing water pumped from the Sacramento River is mixed with Butte Creek water and either redistributed to areas west of the creek, or is dropped into the creek through one of the five channels. Right below this outlet channel, the Cherokee Canal/Biggs-West Gridley Main Drain enters the creek on the east, after flowing through the Butte Sink.

The Colusa Bypass of the Sacramento River feeds into this lower portion of the Butte Basin just south of Laux Road. This break in the levees along the Sacramento River provides a point for flood flows to escape the river and flow into the Butte Basin, Butte Creek, then into Butte Slough, and eventually the Sutter Bypass system. Moulton Weir, located further upstream on the Sacramento River, is described later in this text.

Approximately seven miles after the confluence with the Cherokee Main Drain outlet from the Butte Sink, Butte Creek empties into Butte Slough. The slough, which originally was one of the major distributary points of the Sacramento River, used to accept a fairly large portion of the Sacramento River. The water flowed out into the Sutter Basin, creating a shallow inland sea. Now, the Sutter Bypass system, composed of two levees, their associated borrow pits, and the floodway in-between them sends flood waters on through to the confluence of the Feather and Sacramento Rivers near Verona.

Butte Slough now has a structure placed at its confluence with the Sacramento River, known as the Butte Slough Outfall Gates. This area is also known as Ward's Landing. No longer is the slough a place where the flood waters of the Sacramento River are slacked off before the river continues downstream. The gates, which regulate the water levels in Butte Slough, have a maximum outlet capacity of 3,500 cfs. This system keeps most of the flow of Butte Creek from going into the Sacramento River. It is instead diverted through the Butte Slough and eventually through either the east or west borrow pits of the Sutter Bypass, depending on the configuration of the East-West Diversion structure, a low weir located at the top of the east borrow.

Other Streams, Waterways, and Diversions

The following section describes waterways, some natural and others human-made, that affect flows in the Butte Creek Watershed. As many of them do not physically connect with Butte Creek, they are being discussed in a separate format:

Hamlin Slough, Nance Canyon, and Little Dry, Dry, Cottonwood, Gold Run, and Clear Creeks

These tributary streams to Butte Creek originate in the area south of Paradise and have the beginnings of their watersheds at less than 1700 feet elevation. They are all intermittent drainages in the lower reaches. The importance of these watersheds as recharge areas for the Butte Basin Aquifer, although considered important, has not been extensively evaluated. Little Dry Creek and Hamlin Slough are both used for water conveyance in their valley reaches. Cottonwood Creek, Clear Creek, Gold Run Creek and Dry Creek are consolidated into what is known as the Cherokee Canal. Gold Run Creek receives water from the Lower Miocene Canal, which originates at a dam on the West Branch of the Feather River below Magalia. Gold Run and Cottonwood Creeks also have on-stream storage in the form of irrigation ponds, regulating flows on these streams.

Cherokee Canal

This structure was originally constructed to protect agricultural lands and the towns of Richvale, Nelson and Biggs from mining debris created by mines in the Cherokee area (Carpenter et al., 1926). In that role, it was significantly larger than its present configuration, as evidenced by nearly 30 feet of accumulated debris through sections of the canal that lie in southern Butte County (Pers. com., Dean Burkett, NRCS, 1998). The canal is now used for irrigation, drainage, and to protect approximately 35,000 acres of agricultural lands, related buildings, and homes from flooding. It ties into Butte Creek after flowing through the Butte Sink. The canal is gauged by DWR's "Cherokee Canal near Richvale" gauge.

Western Canal

This canal begins at the northwest corner of the Thermalito Afterbay. Fourteen miles in length, the canal siphons under the Cherokee Canal and Butte Creek on its way to a sink area near Seven Mile Lane, known as the Western Canal Reservoir area, and referred to earlier in this text. From here, water is directed to the western areas of the district through three separate canals/ditches. "Average water year delivery to Western Canal from Thermalito Afterbay is 226,500 acre-feet for the period 1968 through 1992" (Hillaire, 1993). This figure does not include the average flow of 3,441 acre-feet coming from the PG&E Lateral (also known as the Western Canal Lateral), computed over the period 1968 through 1993

Richvale Canal

This canal services the eastern portion of the Richvale Irrigation District. The Richvale Canal Outlet, located adjacent to the Western Canal Outlet, recorded an average water year delivery from Thermalito Afterbay of 80,700 acre-feet during the period 1968 through 1992 (Hillaire, 1993). Drainage water from the district enters Butte Creek, Little Dry Creek, and the Cherokee Canal.

Main Canal Outlet

This convergence is the only outlet from Thermalito Afterbay that is on the south side. It has an average water year delivery of 459,900 acre-feet for the period 1968 through 1992 (Hillaire, 1993). The Main Canal becomes the Sutter-Butte Canal 12 miles below the outlet, near the town of Gridley. The Main Canal has several laterals that are major water delivery structures, with their tailwaters reaching Butte Creek: Belding Lateral, Biggs Extension Canal, Deitzler Lateral, and Lateral Eight. There are many laterals and diversions from the Sutter-Butte Canal to water districts outside the watershed boundary, in Sutter County. As a portion of the Main Canal Outlet water goes to these users, and much of the water used within the watershed goes to crop production with its associated losses from evapotranspiration, runoff and deep percolation, the vast majority of the 459,900 acre-feet does not end up in Butte Creek.

Biggs-West Gridley Main Drain

This drain also known as the R.D. 833 Drain, drains a large portion of the watershed south of the Thermalito Afterbay. This drain services the Biggs-West Gridley Irrigation District as well as the Gray Lodge Wildlife Management Area. It ties into the Cherokee Canal just above its confluence with Sanborn Slough.

M&T Chico Ranch Sacramento River Diversion

Recently moved from its location on Big Chico Creek, this diversion has, during the period 1970 through 1992, taken an average 20,345 acre-feet per year from a combined source of Big Chico Creek and the Sacramento River. The diversion has been relocated to a site on the Sacramento River. It is tied into the M&T Canal by a new pipeline. The M&T Canal becomes the Parrott Lateral below the confluence of the M&T Canal and Edgar Slough.

Edgar Slough

Also known as Crouch Ditch or Comanche Creek, this slough carries foreign (West Branch of the North Fork of the Feather River) water and Butte Creek water from Butte Creek Diversion No. 50 to Dayton Mutual Water Company, M&T Chico Ranch, and Parrott Ranch (Rancho Llano Seco).

Angel Slough

This slough is used as a drain by M&T Chico Ranch in the more northern portions of their property, but then appears to have been connected to Little Chico Creek, to function as a drain through the lower, more southern portions of the property. Angel Slough appears again separate from Little Chico Creek, outside the M&T Chico Ranch boundary, along River Road.

Little Chico Creek

This creek drains into the Llano Seco Rancho, and appears to be ponded in the USFWS easement along the east side of the Rancho. Angel Slough meander through the Rancho in a channel that appears to be unaltered. It then flows through agricultural lands, some reaches channelized, others in a more natural state, on its way to its confluence with Butte Creek in the lower Butte Basin.

Little Butte Creek

This creek forms in the area south of the terminus of Little Chico Creek. It still shows signs of the braided channel topography, formed from the Sacramento River overflowing this area. The flood waters were carried toward Butte Creek and the center of the Butte Basin by way of the numerous distributary sloughs, many still visible today. The sloughs flow away from the river in a south-easterly direction, indicative of the direction they took as they flowed out from the higher river flood terrace.

Moulton Weir

This structure is located on the east bank of the Sacramento River, about five miles below the town of Princeton, mimics this spilling of the Sacramento River to the Butte Basin in a controlled fashion. Essentially, at a low spot in the levees along the river the weir allows for water to enter the Butte Basin, but it does so over a weir surface that keeps the levees from being eroded as the water spills down into the Butte Basin.

Other controlled floodwater spill locations into the Butte Basin from the Sacramento River

Floodwater spillage occurs at three places along the Sacramento River between Chico Landing and Moulten Weir. According to Les Herringer, Manager of the M&T Chico Ranch, there are three flood relief structures on the Sacramento River in this area. The M&T weir is a spillway with an approximately eight inch concrete cap. Its waters spill into Angel Slough and continue down to meet Butte Creek. There is another spill area, known as the "Three B's" that is just downstream of M&T's property. It is earthen and is subject to erosion. Another area of spill is located on the Llano Seco Rancho. Concern by residents on the west side of Butte Creek, below Nelson Road and West of Little Butte Creek is for their property and agricultural lands as the water from the Sacramento River, during higher flows, is spilling through these three structures and flooding their lands. Herringer mentioned that these three structures are state designed, controlled, and mandated, and they were originally (30 to 40 years ago) to be the basis for a bypass structure similar to the Sutter Bypass. The construction of the three structures brought about the formation of Reclamation District 2106, but the state never continued with plans to complete the bypass structure.

Stream Flows

In terms of a long-term period of record, the most reliable stream gauging station for Butte Creek flows is the USGS gage 0.7 mile downstream of the confluence with Little Butte Creek, and upstream of the Parrott-Phelan Diversion Dam. This station, known as "Butte Creek near Chico" is USGS Gauge #11390000. From October 1931 through the present, stream stage heights (later converted to streamflows) have been recorded. Below are some of the statistics useful in examining the outflow from the upper watershed. Foreign water from the West Branch of the North Fork of the Feather River is included in this summary. For an indepth graphical representation and discussion of diversions and imports within the Butte Creek Watershed (see Appendix D).

Table 2.1
General Statistics for Butte Creek near Chico, CA; USGS Gauge # 11390000
Water Years October 1931 to September 1997

Statistic	Unit of Measurement	Time Period for Computation/ Date of Occurrence
Annual mean	409 cfs	1931 wy-1997 wy
Highest Annual Mean	834 cfs	1995
Lowest Annual Mean	94.0 cfs	1977
Highest Daily Mean	26,600 cfs	January 1, 1997
Lowest Daily Mean	44 cfs	August 23, 1931
Annual Seven-Day Minimum	44 cfs	August 23, 1931
Instantaneous Peak Flow	35,600	January 1, 1997
Annual Runoff	295,300 acre-feet	1931 wy-1997 wy
10 Percent Exceeds	842 cfs	1931 wy-1997 wy
50 Percent Exceeds	206 cfs	1931 wy-1997 wy
90 Percent Exceeds	100 cfs	1931 wy-1997 wy

Data taken from the USGS Hydrologic Data Report for the 1997 Water Year (Provisional).

The data above was provided to the Project by USGS personnel at the Water Resources Division Redding Field Office, and is considered provisional until published in their annual report due out this year (see Tables 2.1 and 2.2). However, the data has been computed and checked, and is not expected to result in any major changes that would influence the statistics to any measurable degree. Table 2.1 shows general flow statistics from the 1931 wy through the 1997 wy. The 1998 wy, with record rainfalls during some winter months, will almost certainly set new maximum mean monthly values for certain months in Table 2.1 and Table 2.2.

Table 2.2
Summary Statistics of Mean Monthly Data: Butte Creek near Chico, CA. USGS Gauge # 11390000.
Water Years October 1931 to September 1997

Month	Mean (cfs)	Minimum (cfs)	Water Year	Maximum (cfs)	Water Year
October	138	65.8	1992	775	1963
November	224	77.8	1992	1269	1974
December	463	89.5	1991	2061	1956
January	691	91.0	1991	2847	1997
February	788	114	1977	2925	1986
March	761	123	1977	2601	1995
April	679	114	1977	1848	1982
May	498	134	1977	1314	1995
June	280	79.4	1977	667	1983
July	163	54.4	1977	321	1983
August	131	46.1	1931	223	1975
September	118	51.9	1992	175	1967

Data taken from the USGS Hydrologic Data Report for the 1997 Water Year (Provisional).

Surface Water - Water Flow/Stage Measurements

The Surface Water Flow Stations Map (see Map Appendix) indicates that there are 22 flow or stage measuring stations in the Upper Butte Creek basin still in operation. Pertinent data collected for each station (such as parameters, locations, and periods of record) are summarized in the Gauge Information Table (see Appendix E). The Diversions Map (also in the Map Appendix) shows numerous bypasses and diversions. The period of record for the flow/stage measurements varies from 1 to 73 years. Of the 22 stations still operating, nine have a period of record of 30 years or more and five have a period of record greater than 10 years (DWR, EarthInfo, 1998).

Climate, Precipitation and the Relation to Streamflow

Table 2.1 shows the mean monthly flows for the "Butte Creek near Chico Station". The variance in these flows follow a pattern that is in direct response to precipitation within the watershed, and characteristic of a Mediterranean climate. The four months having the highest average daily flows are December, January, February, and March. For comparative purposes, precipitation records for five different recording stations, increasing with elevation are included as Tables 2.3 – 2.7.

Table 2.3

Average Monthly Rainfall for Chico Experimental Station Period of Record: 1870-1989

Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Year**
4.9	4.0	3.3	1.8	0.9	0.4	0.0	0.1	0.5	1.4	3.0	4.4	24.8

Approx. 200 ft. above mean sea level (MSL)
Precipitation measured in inches

Table 2.4

Average Monthly Rainfall for Centerville Powerhouse Period of Record: 1931-1971

Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Year**
9.0	7.3	5.6	3.7	1.5	0.6	0.0	0.1	0.4	2.6	4.9	8.1	43.7

Approx. 520 ft. above MSL
Precipitation measured in inches

Table 2.5

Average Monthly Rainfall for Paradise Period of Record: 1957-1995

Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Year**
10.8	8.1	8.9	3.8	1.4	0.7	0.1	0.2	1.0	2.8	7.6	8.6	54.1

Approx. 1750 ft. above MSL
Precipitation measured in inches

Table 2.6

Average Monthly Rainfall for De Sabla (measured at Camp 1, near Magalia, not at Powerhouse) Period of Record: 1931-1995

Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Year**
12.0	10.5	9.4	5.1	2.2	1.0	0.1	0.2	1.0	3.8	7.8	10.9	64.0

Approx. 2700 ft. above MSL
Precipitation measured in inches

Table 2.7

Average Monthly Rainfall for Stirling City Period of Record: 1939-1966

Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Year**
10.5	16.6	10.2	5.9	4.9	0.8	0.0	0.0	0.6	5.8	9.6	10.2	75.1

Approx. 3500 ft. above MSL
Precipitation measured in inches

Information for the preceding tables was taken from the “World Climate” Internet site: [www.worldclimate.com]. The World Climate website assimilates climate data for over 85,000 sites in the United States and worldwide. Their data comes from the National Climate Data Center and the Global Historical Climatology Network, which is a part of NCDC and the Carbon Dioxide Information Analysis Center at Oak Ridge National Laboratory.

Measurable rainfall within the Butte Creek Basin increases with a corresponding increase in station elevation. This phenomena, known as orographic lift is caused by the forced ascent of air over high ground or mountains. Uplift of the air leads to cooling which, if the air is moist, may lead to condensation and eventually precipitation.

Data Gaps

While conducting research for this Project a large amount of information was amassed. However, the more that was learned, the more it was realized that there is much more to examine and study. The following are summaries of data gaps for Butte Creek in the areas of hydrology, geology, and overall stream morphology.

The lack of detailed geologic and soil maps during the preparation of this report was a hindrance. Geologic maps for the upper watershed are over 30 years old. General formations are fairly well understood, but more detailed mapping is still lacking. Geology, among many factors, influences soil types, their development and characteristics. Soils for Butte County were first mapped in 1926 and then only in a cursory fashion (Carpenter et al., 1926). There is currently an extensive soil survey being undertaken by the NRCS. The mapping that they are in the process of preparing can and should be incorporated into the planned roads survey (a future study to examine accelerated sediment transport due to roads), as well as the following proposed study.

A detailed stream-reach classification should be conducted, identifying stream orders, profiling geology, soils, streamside slopes, stream gradient and the characterization of the stream itself (composition of pools, nick points, etc.). The necessity for this type of information is determined by the canyon's unique geology, gradient, and other factors mentioned above which change as the creek flows from the mountains to the valley. Management practices in one section (or reach) of the canyon will not be the same as in another. Delineation or classification of these separate reaches should be undertaken in order to have a more detailed understanding of the current conditions so as to establish management strategies that will be site specific and ultimately the most effective.

A comprehensive survey for sediment transport corridors (areas that sediment, from a variety of sources, travels through on its way to waterways) could be incorporated into the detailed stream-reach classification. Such a survey will be conducted as a component of the road survey, but only for the sub-watersheds of Bull, Varey, and Scotts John Creeks (see Issues and Concerns chapter, #5).

In-stream Flow Inventory Modeling (IFIM) is a way to look at specific pools, rapids and runs and evaluate the aquatic habitat of these features at various water levels. Such a study would go beyond the temperature studies undertaken by PG&E by examining what the optimum flow needs for migration, spawning, holding and rearing would be for specific areas of the creek. While this method examines what is best for specific areas, it lacks the holistic approach to stream management that is needed to maintain species diversity and integrity, and as a tool, should be used with respect to this fact (see Issues and Concerns chapter, #2).

Additional stream-flow monitoring stations would greatly aid in understanding to what extent certain sub-watersheds contribute in terms of stream-flow to the main stem of Butte Creek. A station below Butte Meadows as well as several others through the canyon above the current USGS “Butte Creek near Chico” gauge would help to further characterize the watershed. This data could be used to assist in the analysis of runoff processes from certain sub-watersheds, ultimately leading to a better understanding of flooding and sediment contribution to Butte Creek (see Issues and Concerns chapter, #9).

A gap in climatological monitoring exists spatially in the area of the Stirling City/Inskip area, as well as for the Carpenter Ridge area in the north-western portion of the watershed. Although past measurements were made in some of these areas, valuable data is missing for drought periods and the recent periods of high rainfall. Although these temporal gaps (data for times past) cannot be filled, future monitoring could increase the understanding of these areas as source areas for runoff.

A complete analysis of the inflow and outflow of water to Butte Creek, from the Gorrill Dam to the mouth of Butte Creek, would improve understanding of problem areas in the section of the creek that is not adjudicated.

Chapter 3

Fluvial Geomorphology

This chapter is a cursory look at the fluvial geomorphology of Butte Creek. The areas of greaterst concern are areas where the creek has the ability to meander. These are: the Butte Meadows area, the canyon section above Helltown to Highway 99, and to some degree the valley section. In August and September of 1998, the consultant team of Matt Kondolf, Ph.D. of Berkeley and John Williams Ph.D. will complete a detailed fluvial geomorphology analysis. They will look at the area of the canyon from above Helltown down through the valley above Highway 162. These areas have the greatest potential for both beneficial and destructive meanders and also the greatest potential for restoration of the riparian corridor. To identify specific restoration areas and methodologies it is important to understand these dynamics. Also to afford the greatest protection to homeowners, agriculturalists, and infrastucture (i.e., bridges and levees) these dynamics need to be well understood. This was identified as a data gap early in the scoping process and funding is being provided by CALFED and USFWS to complete this analysis. This effort will guide restoration, protection, and enhancement efforts for years to come.

Introduction

Although a detailed stream morphology study has not been undertaken at the time this report was prepared, for descriptive purposes Butte Creek has been divided into three distinct sections. The first is the upper portion, from the headwaters to the Centerville Head Dam. The next is the middle section, from Centerville Head Dam to Highway 99. The lower section is from Highway 99 to the Sacramento River. Each section has distinct characteristics in geology, slope, and morphology, although in the future these sections can and should be broken down further for more focused management planning.

Flow Regime

Over the course of a year, Butte Creek sees a great range of discharge conditions. In the past, flows on the creek have ranged from an estimated 35,600 cfs, in January of 1997, down to 44 cfs in August of 1931. Upper Butte Creek drains 147 square miles, measured at the USGS stream gauge just below the Honey Run Covered Bridge and has an annual mean daily flow of 409 cfs, which equals a water yield of 2.78 cfs per square mile (USGS, 1998).

The flow stage that has greatest effect on the shape of the stream channel is bankfull discharge, also referred to as bankfull stage. This event occurs when the channel is entirely filled, but the stream has not yet spilled over onto the adjacent flood plain. Flows above the bankfull stage occur with less frequency. Once the creek spills out of its channel, its power to erode and transport its sediments is greatly reduced (Mount, 1995).

Chang (1979) has established a relationship between mean annual flow and bankfull discharge. The mean annual flow of Butte Creek is 409 cfs and, using Chang's relationship, the computed bankfull discharge is 3250 cfs (USGS, 1998). Using the formula developed by Williams (1978), the calculated bankfull discharge is 3097 cfs.

Butte Creek also experiences flows many times higher than that of the bankfull event. The Peak Flows Figure (see Appendix E) illustrates the annual peak flows for Butte Creek for the period 1931 to 1998. The highest flow occurred on January 1, 1997, when the flow at USGS stream gauge #11390000 reached an estimated 35,600 cfs according to provisional USGS data (USGS, 1998). Similar episodic flows include the February 1986 flow of 22,000 cfs, and the December 1964 flow of 21,200 cfs (USGS, 1996). Table 3.1 shows the *chance* that the peak flow for any given year will be above a given flow. The various *recurrence intervals* and their *flows* given in the table below were computed using the USGS data along with the USGS computer software program "PEAKFQ - Version 2.4 1998/04/03." This program performs flood-frequency analysis based on the guidelines delineated in *Bulletin 17B,* published by the Interagency Advisory Committee on Water Data in 1982.

As measured at USGS stream gauge #11390000, the creek has a slope of 0.005, or 2.41' of fall in 512', a hydraulic radius of 135', and a measured velocity of 9-10 fps at a flow of 22,000 cfs (USGS, 1996). The USGS has also established a bed roughness figure, called the Manning roughness coefficient, of 0.048 for the main channel (USGS, 1996). These numbers may change slightly after the creek is resurveyed following high flow events.

Table 3.1
Recurrence Intervals for Butte Creek at USGS stream gauge #11390000

Recurrence Interval (years)	**Peak Flow (Q)** (cfs)
2	6,670
5	11,766
10	15,573
25	20,743
50	24,801
100	28,997
200	33,339
500	39,302

(Source: USGS, 1998)

Channel Morphology

For this section, USGS 7.5' quadrangles (topographic maps) and selected USGS geologic maps were used for interpretation.

As the creek flows from its headwaters to the Sacramento River, it becomes progressively wider, less steep, and travels over softer bed material. The rocks that compose the upper reaches of the canyon section of the creek are the oldest rocks of the creek (described in more detail in the Geology, Basin Morphology, and Hydrologic System chapter). These rocks make up the steep, narrow canyons that typify this section of the creek, and are found from well above the DeSabla Powerhouse to just above Helltown.

The section from Helltown to the Centerville Powerhouse is made up of the Chico Formation. This formation is composed of marine sandstone conglomerate with beds ranging from fine cobblestone to siltstone (Harwood et al., 1981). The creek is slicing through this formation, and the longitudinal profile of the creek begins to flatten. The upper canyon walls are just as steep as upstream, that the creek has moved through the softer Chico Formation and there are "terraces" along the creek providing slopes suitable for homes. The large, pre-historic landslide (described in the Geology, Basin Morphology, and Hydrologic System chapter) located in the Helltown area actually constricts the creek and pushes it up against the north-eastern side of the canyon, creating dramatic sandstone cliffs.

From the Centerville Powerhouse to Highway 99, the creek travels through an area composed of the Chico Formation, the late Pleistocene Modesto formation, and recent dredge tailings. The Modesto Formation is composed of gravel to sand-sized alluvium eroded from the Pliocene Tuscan Formation and the Chico Formation (the formations directly above the Modesto and the creek in this area), and is thought to be of recent deposition (Harwood et al., 1981). The creeks slope is much lower in this alluvial material and the canyon walls are less confining. The last section, from Highway 99 to the Sacramento River, is made up of the Modesto Formation as well, however it does not have areas of tailings.

The slope of Butte Creek changes dramatically from the upper watershed down to the valley. The creek's gradient averages 164 feet per mile from the headwaters areas to DeSabla. From DeSabla to Highway 99, the creek has an average slope of 56.2 feet per mile. The slope of the lower section, from Highway 99 to the Sacramento River, is 3.37 feet per mile, although the slope for the last 18.5 miles averages 1.08 feet per mile.

The slope of a river is often less than the land it runs through. The measure of this difference is called its sinuosity. The sinuosity (ratio of stream length to valley length) of Butte Creek from the DeSabla Power House to Highway 99, is 1.21 as defined by Mount (1995). This difference is caused by the stream wandering back and forth from one side of the canyon to the other, or meandering.

Channel Stability

The meandering of the creek is a subject of great concern for those who live and make their livelihood along its banks. Meander bends tend to migrate toward the outside of the stream channel, becoming more and more pronounced over time. Meandering is constrained by the resistant canyon walls in the upper reaches, and by human-constructed levees in the lower reaches. The middle section has the greatest potential for meander migration due to the naturally softer bed material, as well as the human introduced mining tailings.

From preliminary map analysis, using the 1948 and 1978 editions of the USGS Chico 7.5’ topographic map, actual channel migration exceeds the predicted values by a factor of five. Hooke (1980) developed two formulas to predict meander migration, which gave values of 1.17 and 1.7 feet per year. Nansen and Hicken’s (1983) meander migration model gives a similar value, of 1.6 feet per year. The various equations developed by Larsen (1995) give expected migration rates from 0.9 to 4.75 feet per year, with an average of 2.12 feet per year. Actual average migration rates in the middle section of the river range from 7.77 feet per year to 11.1 feet per year. The difference between the results of the models and the actual behavior of the creek is best explained by examining the factors that cause meander migration.

Meander formation is a complex phenomenon. In fact, hydrologists have not reached an agreement as to the elements that initially create meanders, but they are in agreement about the factors that cause them to migrate once formed. Meanders are caused by bank erosion, which occurs in direct proportion to the closeness of the high velocity core to the bank (Larsen, 1995). This high velocity core is related to the thalweg, or main flow of the stream. The thalweg crosses over from side to side of the channel, for at bends in the river it is thrown against the outside bank. Bank material also affects bank erosion. Banks with high clay content are the least erodible, due to their high cohesion. The banks of the middle stretch of creek are composed of dredger tailings which have very little erosional resistance.

While there have been many studies of the effects of hydraulic mining on streams, they have mainly concentrated on the migration of artificially introduced sediment downstream. The build-up of bed material in a channel, causing a rise in the elevation of the stream bed, is known as aggradation. Other studies of hydraulic mine debris have focused on the exacerbation of flooding due to stream bed aggradation. An examination of the relationship between gold dredging and its associated tailings and stream channel migration and stream bed aggradation is an obvious data gap for Butte Creek. The Fluvial Geomorphology Study, slated for the summer and fall of 1998, should help to uncover some of these relationships by examining Butte Creek from the Centerville Head Dam downstream to Highway 162 (see Issues and Concerns chapter, #9).

With the creation of a working Geographical Information System (GIS) that would incorporate all existing topographic maps as well as aerial photographs, the impact and extent of channel migration could be analyzed in much greater detail. Elements to examine should include rates and locations of migration, percent of river length undergoing migration, comparisons of migrating areas with land use, and the migration rates on tailings and non-tailings areas.

Erosion and Sedimentation

An area of future study is the erosion and sedimentation regime of the watershed. Studying the actual sediment transport rates, including bed load and suspended load, is an important part of this research. Factoring in sediment production, natural and anthropogenic erosion rates, and sediment inputs from the upper watershed are all key components. These factors, when looked at as inputs and outputs, can be formulated into a "sediment budget." Creating a sediment budget is difficult and time consuming. However, this information is needed to understand the creek's dynamic nature and to plan ecosystem restoration efforts (see Issues and Concerns chapter, #5).

Problem Areas

Flooding becomes an issue primarily in human-inhabited reaches such as the residential areas along the middle section of the creek. The middle section of Butte Creek, specifically from about the Steel Bridge to near Durham, is a section with numerous flooding problems. Certain areas within this reach also appear to have the highest amount of meandering, due to the nature of the bed material, the human-introduced mining tailings, and lack of intact and mature riparian vegetation (see Issues and Concerns chapter, #9).

This is also an area with heavy interactions between humans and the creek and its flood plain. The NRCS Emergency Watershed Protection" work completed in November 1997, constructed over 3,800 feet of rip-rap near the Parrott-Phelan Diversion Dam (Okie Dam). This particular project is outlined in a case study below. Three other NRCS projects were constructed upstream on Butte Creek, another two on Little Butte Creek, and numerous other private projects were undertaken as well. NRCS projects alone totaled 7,681 feet (1.4542 miles) within the watershed. Most of these bank stabilization projects consisted of large rock rip-rap and concrete, and are not conducive to productive riparian habitat. Further, they accelerate flows, increase bed scour in some areas, deposition in others, downstream bank erosion, and ultimately may cause future problems for those property owners located downstream. Sources of additional information regarding alternatives to conventional flood control and bank stabilization methods is available in the Annotated Bibliography pertaining to Butte Creek's Water Quality, Hydrology, and Diversions (see Appendix F).

Note: For a case study investigating the January 1997 flood event's effect on Butte Creek's channel in the Parrott-Phelan Diversion Dam vicinity and the subsequent stream alterations performed to return Butte Creek to its previous channel under the NRCS' Emergency Watershed Protection Project-Phase II, please refer to Appendix G.

Chapter 4

Water Supply and Service Areas of Water Suppliers

Historical Background

The Butte Creek Watershed is situated in an area generally considered to have sufficient water to supply both agriculture and domestic uses, as well as providing habitat for wildlife. The northern Sacramento Valley is actually considered by some to have a surplus of water, which prompeted the development of the State Water Project (Littleworth and Garner, 1995). The Oroville Dam on the Feather River was built and formed Lake Oroville, the main water supply source for the State Water Project. Water from Lake Oroville is passed down the Feather River to the Sacramento River, and continues down to the Delta. The water is then pulled through the Delta and pumped back out on the south side and passed through the California Aqueduct to serve areas of the San Joaquin Valley and Southern California. The moving of large amounts of water from Northern to Southern California has since been a major issue of concern. Most notably many persons in the agricultural community of Northern California feel that their water is being taken away while the Southern California urbanites desperately need a source of water to alleviate their deficiency. Water supply and demand issues for the state of California have been a concern for many years and will undoubtedly be a concern for many years to come as the population continues to grow. Although the entire state's needs have to be addressed, local needs are of great importance as well. The following text is a look into water supply issues for the Butte Creek Watershed.

The Butte Creek Watershed is considered by some to be an area with sufficient water supply to meet the local demand. Many resource managers however contend that there is not an adequate supply to meet the growing demands of agriculture, fisheries and future urban growth. Although the available water supply fluctuates from year to year, our watershed is dependent mostly on winter precipitation and ground water recharge. Years of drought will drop the amount of available surface water and put an increased strain on ground water use. Years of sufficient precipitation will provide plentiful surface water supplies and allow for recharge of ground water resources.

As the Butte Creek Watershed resources were being developed, beginning with the first settlers in the 1840's and 1850's, surface water from local creeks and streams were the first to be manipulated. Ground water, at this time, was used on a relatively small scale for domestic needs, and later for supplying livestock. Water supply was not a major issue for the early settlers of the area due to their small population and the abundance of water resources. Domestic use was small at this time and even the early forms of agriculture, animal husbandry and grain farming, used very little water. Even though large amounts of water began to be used in the 1850s for mining, it wasn't until the introduction of irrigation in the 1860's that water supply became a major issue of concern. In 1877 the Wright Act was passed which allowed individuals to form irrigation districts to bring water to land not directly bordering streams (McGee, 1980). This was followed in 1879 by the first well being dug, near Woodland, to utilize ground water for irrigation (DWR, 1978). These events laid precedence in the development of water supply issues that exist today.

Water Suppliers

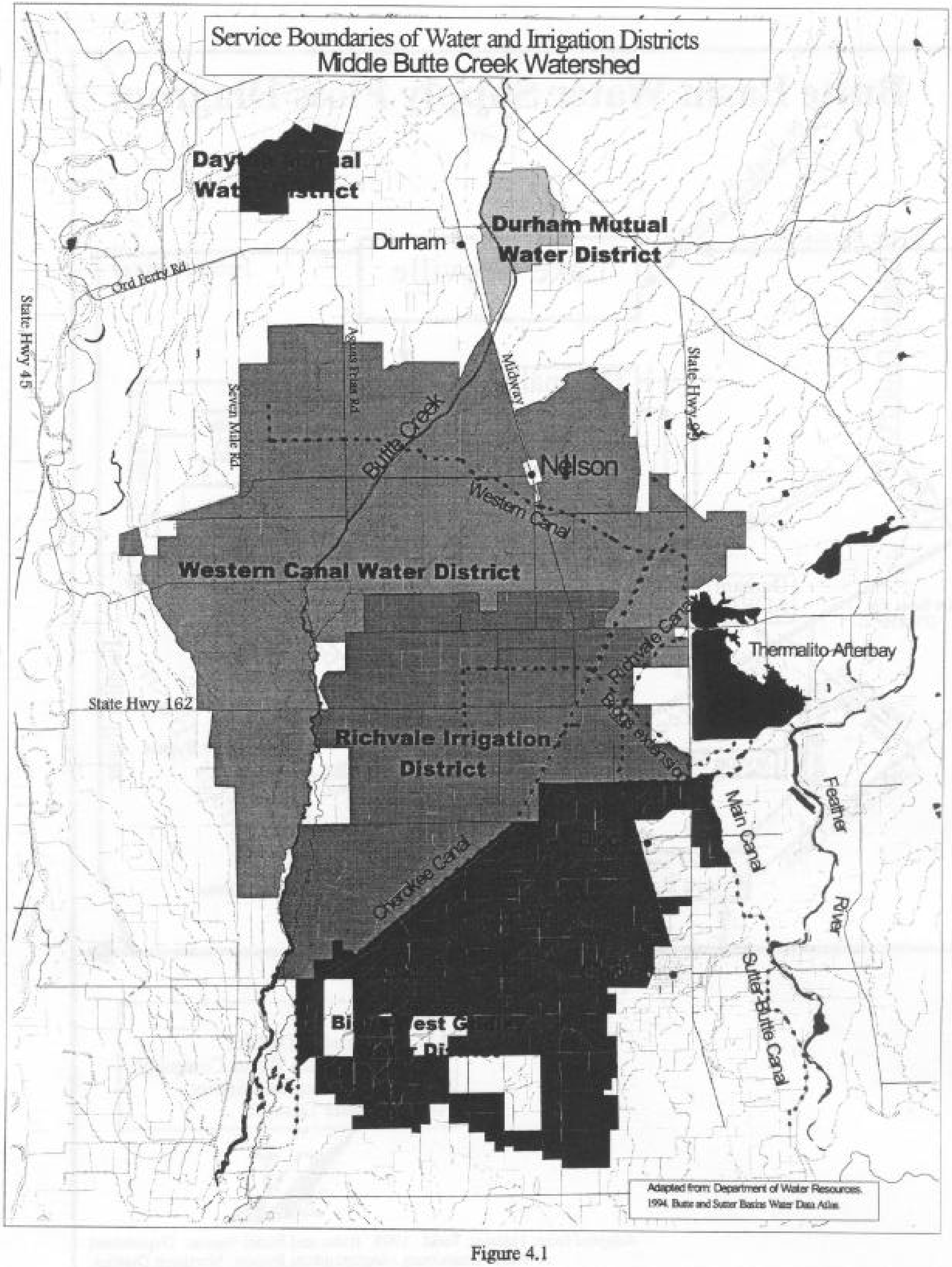
In the first half of the 20th Century many irrigation and water districts were formed to serve agricultural needs as well as growing domestic uses in the Butte Creek Watershed. See Figure 4.1 for current boundaries of service for the water and irrigation districts in the valley section of the watershed. Boundaries not shown include California Water Service, which covers the Chico urban area. Del Oro Water District and Paradise Irrigation District boundaries are also not shown. These two districts cover from Stirling City to Lime Saddle (see Map Appendix - Watershed Base Map); Del Oro includes Paradise Pines District, Magalia District and Lime Saddle District.

A large percentage of the water supply for the water and irrigation districts in the Butte Creek Watershed actually comes from the Feather River. Feather River water is imported into Butte Creek via Hendricks (Toadtown) Canal above Lake DeSabla. Del Oro Water District has a small water right to Feather River water being passed through the Hendricks Canal. The rest of their water supply comes from Lake Oroville, and ground water from two wells in Magalia and five wells in the Paradise Pines area (Pers. com., Ofarreol, 1998). Paradise Irrigation District's water supply comes from Little Butte Creek by way of Paradise and Magalia Reservoirs, as well as one well in town in case of drought. Magalia Reservoir has a current capacity of 796 acre-feet, since the dam was lowered by 25 feet in early 1998 to comply with a Division of Safety of Dams safety requirement. Prior to the lowering of the dam the reservoir had a capacity of 2575 acre-feet. Paradise Reservoir has a current storage of 11,500 acre-feet. There are plans to eventually increase the storage to 16,000 acre-feet but presently the estimated cost of $10 million is beyond the financial resources of the community (Pers. com., Steve Felte, 1997). Of the imported Feather River water, Dayton Mutual Water Company has a right to 3.3 cfs, in addition they have a water right of 16 cfs of Butte Creek water via two pumping stations on Edgar Slough. Durham Mutual also diverts directly off of Butte Creek, utilizing a water right of 44.7 cfs (Hillaire, 1993).

The three major water suppliers for the Butte Basin area within the Butte Creek Watershed are Western Canal Water District (WCWD), Biggs-West Gridley Water District, and Richvale Irrigation District. All three of these districts receive their water from the Thermalito Afterbay. Western Canal and Richvale Canal outlets are combined into one structure. Biggs-West Gridley receives water through the Main Canal which is fed from the Sutter-Butte Canal outlet (see Map Appendix, Hydrology Map). Western Canal has a flow capacity of 1200 cfs and delivers an average of 226,500 acre-feet per year. Richvale Canal has a flow capacity of 500 cfs and deliveries an average of 80,700 acre-feet per year. Richvale Canal supplies water to the eastern portion of Richvale Irrigation District while the western side is served through the Main Canal via the Biggs Extension Canal, providing an average of 52,700 acre-feet per year. The Biggs-West Gridley Water District is supplied by the Main Canal via Belding Lateral, which brings an average of 133,000 acre-feet per year (DWR, 1994). WCWD also has a small water right to Butte Creek water. From April 1 to June 15 they have a right of 33 to 99 cfs, depending on the specific flow for a given year. Western has not diverted water off Butte Creek for the last year due to the fact their new siphon project is being installed. Starting next year they will receive their Butte Creek water through Gorrill Ranch's ditch. To keep things in perspective Butte Creek has an annual average discharge, measured at the Chico gauging station below Honeyrun Covered Bridge, of 289,700 acre-feet per year of which 111,200 acre-feet are used for irrigation (Hillaire, 1993). For the Butte Basin water supply flow diagram showing which canals deliver water from which sources to which water and irrigation districts see Figure 4.2.

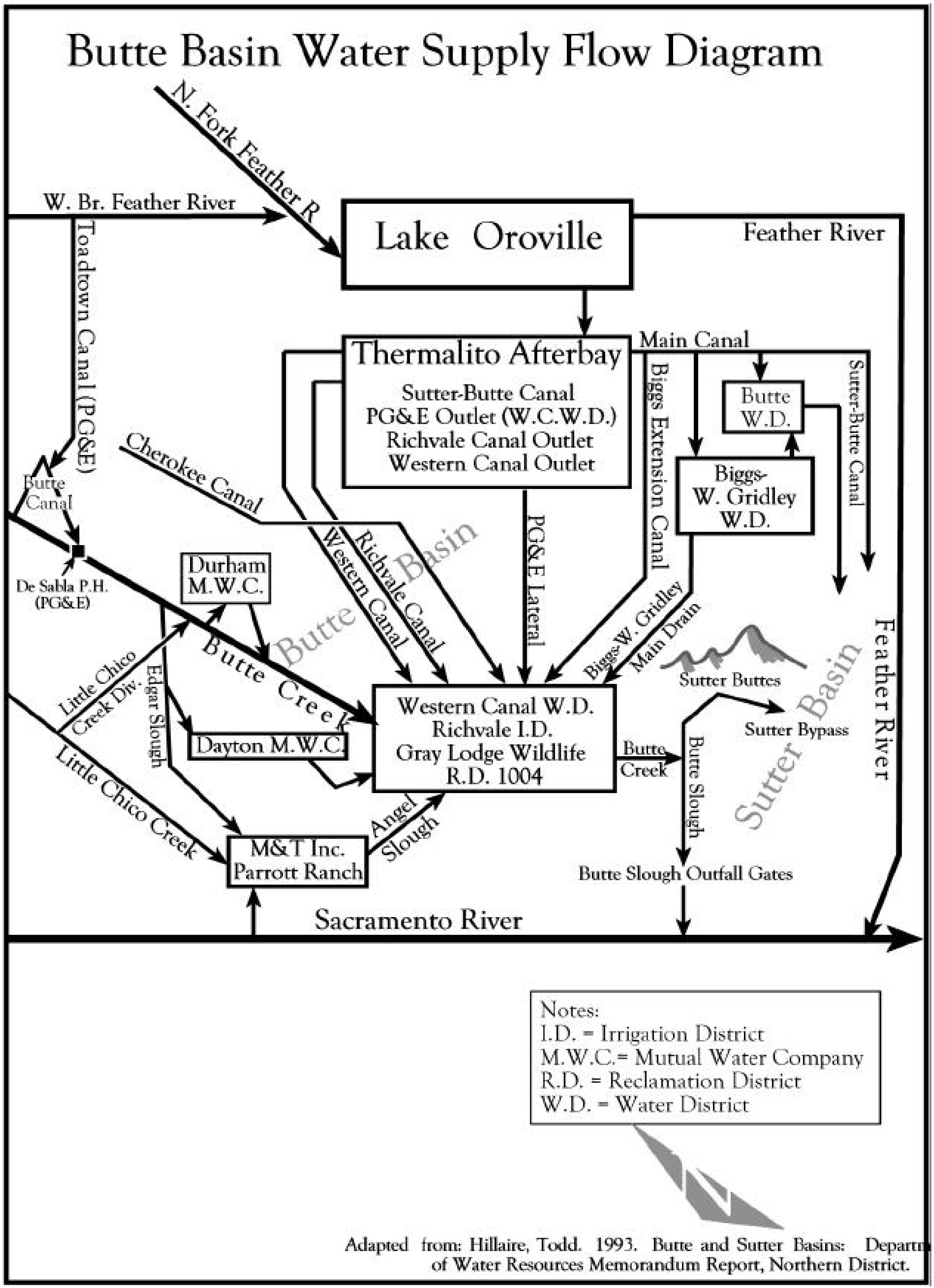
Butte Creek is the water supply source for many other ranches and individuals and the information on those diversions and water rights can be found in the Department of Water Resources Butte and Sutter Basins Water Data Atlas. Also further information is available from Todd Hillaire's DWR report on Butte and Sutter Basins.

Table 4.1 shows the information available for the irrigation and water districts active today that influence the Butte Creek Watershed.



Service Boundaries of Water and Irrigation Districts
Middle Butte Creek Watershed
Durham
Durham Mutual Water District
Ord Ferry Rd
State Hwy 45
Seven Mile Rd.
Aguas Frias Rd
Butte Creek
Midway
Nelson
Western Canal
Western Canal Water District
Richvale Canal
Thermalito Afterbay
State Hwy 162
Richvale Irrigation District
Biggs extension
Main Canal
Feather River
Cherokee Canal
Sutter-Butte Canal
Adapted from: Department of Water Resources. 1994. Butte and Sutter Basins Water Data Atlas.

Figure 4.1



Butte Basin Water Supply Flow Diagram
N. Fork Feather R
W. Br. Feather River
Lake Oroville
Feather River
Toadtown Canal (PG&E)
Thermalito Afterbay
Sutter-Butte Canal
PG&E Outlet (W.C.W.D.)
Richvale Canal Outlet
Western Canal Outlet
Main Canal
Biggs Extension Canal
Butte W.D.
Sutter-Butte Canal
Biggs-W. Gridley W.D.
Cherokee Canal
Butte Canal
De Sabla P.H. (PG&E)
Durham M.W.C.
Western Canal
Richvale Canal
Butte Basin
PG&E Lateral
Biggs-W. Gridley Main Drain
Sutter Buttes
Sutter Basin
Feather River
Little Chico Creek Div.
Edgar Slough
Butte Creek
Western Canal W.D.
Richvale I.D.
Gray Lodge Wildlife
R.D. 1004
Dayton M.W.C.
Butte Creek
Butte Slough
Sutter Bypass
Little Chico Creek
M&T Inc. Parrott Ranch
Angel Slough
Butte Slough Outfall Gates
Sacramento River
Notes:
I.D. = Irrigation District
M.W.C.= Mutual Water Company
R.D. = Reclamation District
W.D. = Water District
Adapted from: Hillaire, Todd. 1993. Butte and Sutter Basins: Departm
of Water Resources Memorandum Report, Northern District.

Table 4.1
Available Information for Water and Irrigation Districts

Name	Year Formed	Water Supply Source	Area Irrigated	People Provided	Misc. Facts	Water Rights
Paradise Irrigation District	1916	Little Butte Creek/Magalia Reservoir and Paradise Reservoir	300 acres	26,000	One well in town in case of drought	
Western Canal Water District	Origins in 1915 under Great Western Power Company, became a water district in 1986	Lake Almanor/Feather River via Thermalito Afterbay and Butte Creek	60,000 acres		System purchased from PG&E in 1986 and became a water district	145,000 ac/ft per year off Lake Almanor 150,000 ac/ft off Feather River 33 to 99 cfs/yr off Butte Creek
Richvale Irrigation District	1930	Lake Oroville via Thermalito Afterbay	26-27,000 acres		Small water right to Cherokee Canal during drought	149,850 ac/ft per year
Biggs-West Gridley Water District	1942	Lake Oroville via Thermalito Afterbay	27-29,000 acres			160,000 ac/ft per year
Durham Mutual Water Company	1918	Butte Creek	2,400 acre boundary			44.7 cfs
Del Oro Water District	1968	Lake Oroville, Hendricks Canal, 2 wells in Magalia, 5 wells in Paradise Pines		6,000 service connections	Originally started to serve Paradise Pines, Currently serves from Stirling City to Lime Saddle excluding area served by Paradise Irrigation District	
Durham Irrigation District		Ground water via 3 wells and one other shared with Durham School District		1500	Only one meter for all wells, pulling approximately 350 ac/ft/yr	
Dayton Mutual Water District		Butte Creek via Edgar Slough			1990 second pump on Edgar Slough installed	19.3 cfs
California Water Service	1926	Ground water via 67 wells		20,000 service connections	Serves Chico urban area	

Groundwater

The groundwater systems for the Butte Creek Watershed can be divided into two primary sections, the upper watershed and the lower watershed, and into two analyses, the physical description of the aquifer, and an overview of groundwater quality. Groundwater management consists of various private and public entities. The County of Butte has groundwater regulations that are currently being implemented.

Geographical Perspective

The West Butte subbasin is bounded on the west and south by the Sacramento River, on the north by Big Chico Creek, on the northeast by the Chico Monocline, and on the east by Butte Creek. The East Butte subbasin is bounded on the west and northwest by Butte Creek, on the northeast by the Cascade Ranges, on the southeast by the Feather River, and on the south by Sutter Buttes.

Hydrogeologic Description

The West Butte aquifer system is comprised of deposits of Late Tertiary to Quaternary age. The West Butte Late Tertiary deposits consist of poorly sorted fluvial deposits of the Tehama Formation and volcanic deposits of the Tuscan Formation. The Tehama Formation consists of locally cememted silt, sand, gravel, and clay of fluviatile deposited from the coast ranges. The Tuscan Formation consists of volcanic gravel and tuff-breccia, fine to coarse-grained volcanic sandstone, conglomerate and tuff, tuffaceous silt and clay predominantly derived from andesitic and basaltic source rocks. Tertiary deposits begin at the surface along the east subbasin boundary and range to approximately 100 feet near the Sacramento River. Maximum thickness of Tertiary age deposits is about 2,500 feet near the western edge of the subbasin. Wells in this zone range from about 150 to 600 feet deep and draw groundwater from the multiple layers of moderate to high permeability. These Tertiary Deposits are the primary source of groundwater for most irrigation and municipal wells in the West Butte Basin.

The West Butte Quaternary deposits consist of the younger alluvium (alluvial fan, flood basin deposits, and recent stream gravel deposits), and older alluvium (Pleistocene alluvial fan and terrace deposits of the Riverbank and Modesto Formations). Quaternary deposits of the Modesto and Riverbank consist of poorly indurated, very coarse-grained gravel and cobbles, with medium to coarse-grained sand, and occasional silt deposited during the Pleistocene period. The Quaternary age deposits begin at ground surface and range in thickness from 0 to about 90 feet. Permeability of the flood basin deposits and finer grained older alluvium is generally low, while permeability of the alluvial fan and recent stream gravel deposits is moderate to high. These deposits are the primary water source for many domestic wells, which range in depth from about 50 to 200 feet.

The East Butte aquifer system is comprised of fluvial and volcanic continental deposits of the Late Tertiary to Quaternary age. The composition of the East Butte Basin subbasin Quaternary alluvial deposits are similar to those of the West Butte subbasin but range in thickness from ground surface to approximately 50 feet. Permeability of these units range from low (flood basin deposits and finer grained older alluvium) to high, with alluvial fan and recent stream gravel deposits yielding large quantities (200 to 3000 gal/min) of water from shallow wells. The East Butte subbasin characteristically has a perennial zone of shallow, or perched groundwater because of agricultural practices (rice farming and flood irrigation with imported surface water). This shallow groundwater zone consists of Quaternary deposits and is a source of water for many domestic wells ranging in depth from approximately 50 to 200 feet.

Late Tertiary deposits consist of the volcanic deposits of the Tuscan Formation and the interbedded alluvial sand, gravel, and silt deposits of the Laguna formation. Tertiary deposits begin at a depth ranging from the surface along the east subbasin boundary. Maximum thickness of the Tertiary age deposits is about 2,000 feet. Tuscan Formation consists of volcanic gravel, tuff breccia, fine to coarse-grained volcanic sandstone, conglomerate and tuff, tuffaceous silt and clay predominantly derived from andesitic and basaltic rocks. The Tuscan Formation is found interingered with the Tehama Formation along the Sacramento River to a thickness of 1,000 feet. Permeability of the Tuscan Formation ranges form moderate to high. The Laguna Formation consists of interbedded alluvial sand, gravel, and silt deposits which are moderately consolidated and poorly to well cemented. Permeability of the Laguna Formation is generally low, except in scattered gravels in the upper portion. Wells drawing from these Tertiary deposits range from about 150 to 700 feet deep and provide the primary source of groundwater for most irrigation and municipal wells in the East Butte subbasin.

Groundwater Levels

The Groundwater Monitoring Stations Map, shows the location of the monitoring wells in the Upper Butte Creek Basin (see Map Appendix). There are a total of 32 monitoring wells, three of which are monitored monthly and twenty-nine monitored semi-annually.

A table entitled *Groundwater Level Monitoring Wells in the Upper Butte Creek Watershed* (see Appendix H), provides information concerning the 32 wells within the basin. Each well can be located within a 40 acre tract as shown in the accompanying explanation of the numbering system (see also Appendix H). The wells are monitored monthly or semi-annually for groundwater levels. The semi-annual measurements were made in the spring and fall. Most of the water level measurements were begun in the late 1940s or early 1950s and continue to the present. Water levels were measured using an electric sounder or a steel tape. All water level measurements should be accurate to the nearest 1/10th of a foot. Long -term well hydrographs are shown on the Groundwater Monitoring Stations Map from the beginning of the measurement period through April of 1992 (DWR, 1993). More recent data can be obtained at the Red Bluff Office of the DWR or from the internet address: [http://well.water.ca.gov/exterra/DBQUERY.html]. Solid circles (dots) on the hydrographs depict actual measured values while a hollow circle enclosing a smaller dot indicates the measurement is questionable. Discontinuities or breaks in a hydrograph represent missing measurements.

The groundwater level monitoring table provides additional information for each well, describing what the well is used for, the type of groundwater body the well draws water from, the geologic units containing the ground water and the degree of certainty associated with the ground water body classification.

Groundwater levels tend to fluctuate annually responding to the amount of pumping, recharge from precipitation, stream percolation, infiltration of applied irrigation water, and subsurface inflow and outflow. Examination of the DWR hydrographs reveals spring to fall changes along with long terms changes resulting from climatic fluctuations or increased or decreased groundwater extraction over several seasons or years. Precipitation, applied water, local creeks, and the Thermalito Afterbay recharge groundwater in the Upper Butte Creek basin.

The 32 hydrographs within the Upper Butte Basin generally show:

- Most groundwater levels within the basin have not changed significantly since the 1950s.
- Three wells - 27, 28, and 30 - north and northwest of Durham show significant long-term water level declines.
- Groundwater levels declines in most wells were associated with the 1976-77 and 1986-92 droughts.
- Nearly all groundwater levels recovered from the 1976-77 drought to pre-drought levels during the wet years of the early 1980s.
- Seasonal fluctuations (spring to fall change) is about 10 to 20 feet in the northern portions of the basin and approximately 5 feet in the southerly portions of the basin.

Groundwater Management

The majority of the West Butte subbasin groundwater is managed by private wells and the users associated with the Butte Basin Water Users Association. There are various water agencies of public and private interests that include Buzztail Community service district, Durham ID, City of Chico, RD 1004, and Western Canal WD (public) with private management including Dayton Mutual Water Company, Del Oro Water Company, Durham Mutual Water Company and California Water Service. California Water Service has jurisdiction over 67 wells with 20,000 service connections to serve the Chico urban area (Pers. com., Bonastich, 1998). Durham Irrigation District also utilizes ground water via three wells and one which it shares with Durham School District (Pers. com., Morrison, 1998). In addition to these two users there are many private users of ground water for both domestic and irrigation use. Table 4.2 shows the number of irrigation and domestic wells, by township, in the Butte Basin section of the watershed.

TABLE 4.2
Well Density by Township

	R1W		R1E		R2E		R3E	
	Irrig.	Dom.	Irrig.	Dom.	Irrig.	Dom.	Irrig.	Dom.
T22N	------	------	274	1375	*19*	*279*	13	316
T21N	49	12	**361**	**574**	**190**	**564**	28	152
T20N	*18*	*2*	**92**	**37**	**104**	**51**	17	20
T19N	*129*	*61*	**30**	**13**	**40**	**76**	26	75
T18N	*94*	*48*	**30**	**13**	**66**	**201**	129	258
T17N	*56*	*20*	*15*	*3*	70	251	------	------

Legend:

Irrig.= Irrigation wells
Dom.= Domestic wells
Bold numbers = Townships area completely within watershed
Italicized numbers = Townships area at least 50% within watershed
Standard numbers = Townships area less than 50% within watershed

The maximum depth of irrigation wells ranged from 300 ft. to 845 ft.
The maximum depth of domestic wells ranged from 198 ft. to 860 ft.

The minimum depth of irrigation wells ranged from 35 ft. to 123 ft.
The minimum depth of domestic wells ranged from 18 ft. to 200 ft.

The mean depth of irrigation wells ranged from 129 ft. to 473 ft.
The mean depth of domestic wells ranged from 81 ft. to 269 ft.

Note: This data and a corresponding map are available on page 22 of the Butte and Sutter Basins Water Data Atlas.

East Butte subasin groundwater is managed similar to West Butte subbasin groundwater. The management entities include. Biggs West Gridley WD, Butte WD, Durham ID, City of Biggs, City of Gridley, Oroville Wyandotte ID, and Western Canal WD. Private management entities are North Burbank Public Utility District. Water projects in East Butte subbasin include Lake Oroville Reservoir, Thermalito Afterbay, Cherokee Canal, Western Canal, and Richvale Canal.

Regulatory Considerations and Measure G

Butte County's Measure G was voted in by the public in November 1996, adopted in December 1996 and codified in the Butte County Code as Chapter 33. The purpose of Measure G is based on findings that groundwater provides the people of Butte County water for agricultural, domestic, municipal and other purposes, and must be reasonably and beneficially used and conserved for the benefit of overlying land by avoiding extractions which harm the Butte Basin aquifer. Through measure G, the County of Butte seeks to foster prudent water management practices to avoid significant environmental, social, and economic impacts. Chapter 33 provides that a nine-member commission be appointed by the Butte County Board of Supervisors. The purpose of Chapter 33 of the Butte County Code is to protect the groundwater resources by requiring the commission and the public to review permit applications for groundwater extraction for use outside of the county. As of August 1, 1998 the County of Butte is working on modifications of measure G that would redefine some aspects of the ordinance and adding a subsection on the intent of the legislation. The modifications were not certified at the time this report was written.

Chapter 5

Water Quality

Introduction

Overall water quality in Butte Creek is considered to be good to excellent in the upper portions of the watershed, and degrades in quality lower in the system. Water quality can vary seasonally, corresponding to precipitation and diversions. It can also vary year to year depending on drought or wet conditions. Large storm events have a great influence on things, increasing turbidity and mobilizing pollutants and salts. Low flows can reduce water quality by concentrating contaminants. The following sections outline desired conditions, illustrate current and historical monitoring, and highlight data gaps regarding various water quality parameters.

Water Quality Goals

The Department of Water Resources (DWR) has compiled a list "Water Quality Goals," listed in Appendix I, that can be used to compare the range of levels that are described later in this chapter.

Sources of Water Quality Monitoring Information

The California Department of Water Resources (DWR) Northern District in Red Bluff coordinates the most comprehensive monitoring of surface water quality. Information was provided from older, pre-computer data stored on microfiche as well as newer information that was downloaded from their computer system. The *Draft Butte Basin Report* was provided to assist in "...efforts in developing management plans for Butte Creek." It contains synthesized data and documents from DWR, the Department of Pesticide Regulations (DPR), the Central Valley Regional Water Quality Control Board (CVRWQCB), the California Department of Food and Agriculture (CDFA), the California Department of Fish and Game (CCDFG), the Department of Health Services (DHS), and Pacific Gas and Electric (PG&E). The appendices contain the raw data for many physical parameters, as well as graphical displays of certain parameters over time.

PG&E has completed three studies on water temperatures in the reach from the Centerville Diversion Dam down to the Centerville Powerhouse. The two efforts resulted in monitoring of Butte Creek summer water temperatures in the area from LCDD to the Centerville Powerhouse for the summers of 1986, 1987, and 1989 (PG&E and SWRCB, 1988) (Kimmerer and Carpenter, 1989) (PG&E's Technical and Ecological Services, January 1990).

Water Quality Monitoring

Table 5.1 shows the parameters being monitored by DWR in the Butte Creek Watershed. Stations are numbered, and these numbers correspond to the Surface Water Quality Monitoring Map (see Map Appendix). The following is an explanation of the abbreviations and codes used in the matrix of Table 5.1, and the sources for the data in the figure:

MIN Refers to minerals with compounds principally of dissolved cations (positively charged ions) and dissolved inorganic material in the water. Other constituents are included in the mineral classification as a convenience. This file contains:

Hardness, calcium, magnesium, sodium, potassium, lab alkalinity (bicarbonate, carbonate, and pH), sulfate chloride, nitrate, fluoride, boron, turbidity, total dissolved solids (TDS), specific conductance, and silica.

NUT Refers to nutrients and other factors that are essential to plant growth in water. This file contains:

Field carbon dioxide, field alkalinity, turbidity, lab alkalinity (bicarbonate, carbonate, and pH), specific conductance, nitrite, nitrate, ammonia, organic nitrogen, Kjeldahl nitrogen, dissolved orthophosphate, dissolved acid hydrolyzable phosphate, dissolved total phosphorus, and total phosphorus.

ME Refers to minor elements, which are the alkali metals, alkaline earths, and metallic and nonmetallic elements that occur in minor amounts in water. This file contains:

Arsenic, barium, cadmium (total and hexavalent), copper, iron, lead, manganese, mercury, selenium, silver, and zinc.

These constituents may be determined for either total (unfiltered) or dissolved (filtered) conditions.

SME Refers to supplemental minor elements, which are alkali metals, alkaline earths, and metallic and nonmetallic elements that occur less frequently than minor elements. This file contains:

Aluminum, antimony, beryllium, bismuth, cobalt, gallium, germanium, lithium, molybdenum, nickel, strontium, titanium, and vanadium.

These constituents may be determined for either total (unfiltered) or dissolved (filtered) conditions.

MISC Refers to miscellaneous constituents, which are measures of various chemical and biological activities in water that are not associated with minerals or minor elements or that are not logical measurements of plant growth in water. This file contains:

Field residual chlorine, methylene blue active substances, oil and grease, cyanide, phenols, settleable solids by weight, chemical oxygen demand, tannin and lignin, biochemical oxygen demand, suspended solids, volatile suspended solids, color, total and dissolved organic carbon, iodide, sulfites, total and dissolved sulfides, and odor at 60°C.

PEST Refers to pesticides, which are substances intended to prevent, destroy, repel, or otherwise control objectionable insects, rodents, plants, weeds, or other undesirable forms of life. At present there are 10,000 pesticides registered for use in California. Those which can be identified either individually or by chemical groupings will be reflected in this file.

PHYS Refers to certain physical parameters monitored more recently by DWR. The include constituents from other categories. This file contains:

Temperature (F. and C.), dissolved oxygen, pH (field and lab), electrical conductivity (field and lab), alkalinity, turbidity, total dissolved solids, total suspended solids, total organic carbon, air temperature at sample site in degrees F.

Map No. Refers to DWR's map codes. Each USGS 7.5' quadrangle has a code number set up by DWR for locating monitoring stations.

Quantity If a water quality monitoring station is at a location with a stage or flow recording device, the "Quantity" box is marked with an "X".

Areal Code This is a five-digit alpha-numeric identifier for basins, units, areas, and subareas of the hydrologic areal designation system. The first digit, a letter, identifies the basin; the second and third digits, numbers, identifies the unit; the fourth digit, a letter, identifies the area; the fifth digit, a number identifies the subarea.

County Code Identifies which county the station is in. Corresponds to the state's numbering system.

Elevation The elevation of the station given in feet.

Remarks This section gives added information on station location, period of record, or some other note regarding the station.

Begin, End The beginning year that sampling began, the year it ended, and the number of times samples were taken during that time period.

Analysis of Historic Monitoring and Water Quality Data

The surface and ground water near unlined, surface water conveyance facilities and streams changes considerably during the year. During the winter, when most of the flow is runoff, the surface water and newly infiltrated ground water is cooler and fresher (contains fewer dissolved solids). The opposite is true when lower, summer base flow conditions exist. Several potential water quality problems are indicated, including high temperatures in surface waters, nutrient compounds primarily of nitrogen and phosphorous, and agricultural biocides. (see Issues and Concerns #2) It should be noted that analyses performed during low base-flow represent essentially ground water or a mixture of ground water and surface water. Low base-flow months include July, August, September, and October.

The time series for individual chemical measurements varies from 1 to 46 years. Six stations have a time series greater than 30 years, so, some historical comparisons are possible. Most of the mineral analyses were conducted at Butte Slough and the Butte Creek near Chico gauge. The waters are predominantly calcium bicarbonate Ca(HCO3) 2 types. Nutrient analyses are primarily in the upper end of the basin above the domestic water supply reservoirs and at Butte Slough. Most of the minor elements and pesticides were analyzed at Butte Slough. The supplemental minor elements were also analyzed at this station. Because many chemical substances were analyzed at the lower end of the basin, it is not possible to trace their exact source location. This is recognized as a data gap.

Some stations have taken enough measurements over a period of years that it may be possible to see chemical change over the period of record. During the growing season, the chemical aspects of the middle and lower portions of the basin are complicated by surface water imports for agriculture from Thermalito Afterbay. In some years, portions of the surface water may be sold and the loss made up by pumping ground water. Chemical differences between the West Branch of the Feather River, Butte Creek, Little Butte Creek, the Thermalito Afterbay, and ground water also need investigation. One fortunate bit of information gathered was that when the water was sampled for chemical testing, the temperature was recorded which represents a discrete point measurement in time.

The temperature report prepared for PG&E by BioSystems Analysis, Inc. evaluated the effectiveness of the flows agreed upon by CDFG to protect holding and spawning spring run chinook salmon and to develop a practical operation model to achieve the temperature objectives with minimum releases. The study examined stream temperatures at several locations during the summers of 1986 and 1987, and ultimately the study puts forth an operating plan that was developed using regression analysis of the data collected during the two summers. The plan sets releases based on a desired goal of exceeding 20°C (67.97 °F) at Pool 4 (a holding pool 1.2 miles above the Helltown Bridge) 50% of the time. Dissolved oxygen and the positive effects increased flows have on dissolved oxygen are not addressed (Kimmerer, W. and J. Carpenter, 1989).

Table 5.1
Water Quality Monitoring Stations

Map #	Name	MIN Begin	MIN End	MIN #	NUT Begin	NUT End	NUT #	ME Begin	ME End	ME #	SME Begin	SME End	SME #	MISC Begin	MISC End	MISC #	PEST Begin	PEST End	PEST #	TEMP Begin	TEMP End	TEMP #	PHYS Begin	PHYS End	PHYS #
1	Butte C A Butte Mdws	9/2/77	9/2/77	1																					
2	L Butte C NR Toad Town (Hupp/Coutelenc Rd)				1972	See note	4																		
3	Mosquito C AB Paradise Res				1972	See note	4																		
4	L Butte C AB Magalia Res				1972	See note	4																		
5	Paradise ID Treatment Plt Bl Magalia Res				1972	See note	4																		
6	L Butte C AT Magalia	9/1/77	9/1/77	1																					
7	Butte C at Pool 4																			5/86	10/86	1			
7	Butte C AT Pool 4																			5/87	10/87	1			
7	Butte C AT Pool 4																			5/89	11/89	1			
7	Butte C AT Pool 4																			9/95	present	2			
8	Butte C AB Centerville PH																			5/89	11/89	1			
8	Butte C AB Centerville PH																			1991	present	6			
9	Butte C BL Centerville PH																			1991	present	6			
10	Butte C NR Chico	1952	1996	333	1959	1996	29	1959	1996	25	1959	1961	6							9/95	present	2	1994	1997	15
10	Butte C NR Chico	1953	1979																	1962	1979	17			
11	Butte C AT Skyway NR Chico	7/20/55	7/20/55	1																					
12	Butte C A Hwy 99E Nr Chico	1973	1986	9																					
13	Butte C A Gorrill Dam																			1991	present	6			
14	Cherokee CA NR Nelson	1970	1974	4*																1970	1974	*4			
15	Butte C BL Western CA																			1991	present	6			
16	Above Little Dry C																			1991	present	6			
17	Rd 833 Dr NR Gridley	1956	?																						
18	Cherokee Canal Bl Main Dr	1991																							
19	Butte Slu A Outfall GTS	1959	1989	77	1960	1989	40	1988	1989	5				1960	1961	18							1988	1989	50
20	Butte Slu NR Meridian	1971	1996	247	1971	1996	130	1971	1996	25	1988	1989	5	1975	1982	84	1972	1977	5	1991	present	6	1991	1997	34
21	Lwr Centerville Diversion Dam																			5/86	9/86	1			
21	Lwr Centerville Diversion Dam																			5/87	10/87	1			
21	Lwr Centerville Diversion Dam																			5/89	11/89	1			
22	Helltown Bridge																			5/89	11/89	1			
23	Top of Centerville Penstock																			5/89	11/89	1			

SOURCES: Babcock, Curt. Department of Water Resources, Red Bluff, Water Quality and Biology. Computer data from recent monitoring. Department of Water Resources. Bulletin 230-81. December 1981. pp 174-174.

The 1990 PG&E report contains the findings of monitoring done after consultation with CDFG and other agencies used the temperature-based operating scheme to determine minimum flow releases from LCDD during summer 1989. Monitoring was conducted from May 22 to November 3, 1989 in order to determine the success of the temperature-based operating scheme at maintaining water temperatures in accordance with the temperature objectives outlined in the original 1983 CDFG Agreement. The study concluded that, based on a limited number of opportunities to implement the temperature-based plan during the summer of 1989, flow reductions based on the maximum daily water temperature at LCDD produced temperatures in Pool 4 in accordance with the rule-based operating plan. It should be noted again that this approach bases minimum releases for the holding spring run chinook in Butte Creek on water temperature alone, and does not evaluate dissolved oxygen or increased holding areas due to increased stream flows (PG&E's Technical and Ecological Services, January 1990).

Current Sampling Methods

DWR uses sampling devices made of chemical resistant materials that will not alter the chemical nature of the water sample. When dissolved constituents are being analyzed, samples are filtered through 0.45 µm polycarbonate membranes using a commercial stainless steel filter pump. Minerals and some nutrient samples are filtered to eliminate particulate matter, while minor element samples are all unfiltered. These constituents are analyzed by Bryte Laboratory or other contract laboratories.

DWR also takes field measurements that include conductivity, pH, temperature, and dissolved oxygen. Conductivity is again measured in the DWR Northern District laboratory along with alkalinity, and turbidity. Temperature and conductivity are measured with a multiparameter instrument. A colorimeter comparator is used for pH measurement and dissolved oxygen is measured using a modified Winkler titration method.

Continuous water temperatures were recorded using Omnidata International Datapod Model 112 thermographs. Five minute recording intervals were used, and the mean, maximum, and minimum temperatures were recorded daily on a Data Storage Module (DSM). Every two months the DSM is removed and replaced with a fresh unit, allowing the other to be downloaded for further analysis. Optical temperature loggers from the Onset Computer Corporation were used to replace the Omnidata Datapods for installations at thermograph sites beginning in September 1995.

Monitored Water Quality Parameters

The water quality parameters of temperature, minerals, dissolved oxygen, turbidity, pH, nutrients, minor elements, and pesticides, and the locations of where they are monitored are discussed below.

Water Temperature

Water temperature issues for Butte Creek are related mostly to the health of the anadromous fishery. Consequently, most data collected has been in the areas used by anadromous salmonids for holding and spawning, although the lower end of the system, a critical first area for migrating fish to pass through, has been monitored as well.

DWR has been monitoring water temperature at a variety of sites since 1990. These sites and their various parameters are contained within Table 5.1. The following sections discuss water temperatures at these stations. For purposes of comparison, the reader is referred to the fisheries chapter to obtain temperature requirements for various anadromous salmonids (see Table 6.3).

PG&E's monitoring of water temperatures was undertaken with the idea that data collected was to be used to establish an operations plan for minimum releases from LCDD or to validate that plan, as described above in the "Analysis of Historic Monitoring and Water Quality Data" section. The information from the two PG&E

reports describes water temperatures in Pool 4, and above and below Centerville Powerhouse as exceeding 70°F at certain times during the three summers evaluated. The complexity of the data of such extensive studies is beyond the scope of this report. Copies of both reports are available for review and duplication, with one report including raw data on stream temperatures for the summer of 1989.

Temperature issues in the upper portions of the creek (located above the valley section) revolve around imports and diversions for hydroelectric power generation and the relation to salmon holding and spawning requirements. Any problems in this area are compounded downstream where warmer, agricultural drain water, and a lack of streamside vegetation allows direct solar incidence to raise water temperatures.

The following discussions relate to DWR temperature monitoring stations, with the temperature data taken from the *DWR Draft Butte Basin report*. Stations can be located on the Water Quality Monitoring Map, located in the Map Appendix.

Butte Creek at Pool 4

Located 1.2 miles above the Helltown Bridge, this data recorder was placed in 1995 to evaluate the effects of reduced flows through the section of creek from the lower Centerville Diversion Dam (LCDD) to Centerville Powerhouse. In 1995, on only nine days did minimum water temperatures exceed 60°F during September (the first month of operation). The monthly maximum was 65.9°F. In June of 1996, daily minimum water temperatures rose above 60°F only four times. During July and August, 1996, minimum water temperatures exceeded 60°F in all but one day, with maximum temperatures of 73.3°F and 72.4°F respectively.

Butte Creek Above Centerville

This station was installed in August of 1990 to evaluate the presumably highest water temperatures found in the "low-flow" section that runs between the lower Centerville Diversion Dam (LCDD) and the Centerville Powerhouse. As the water diverted at the LCDD is returned just downstream of this station at the Centerville Powerhouse, this station represents the water temperature for the lower end of the low-flow section. In August and September of 1990, daily minimum water temperatures exceeded 60°F in all 54 days of record, with monthly maximums of 82.4°F and 73.4°F respectively. Minimum daily temperatures above 60°F persisted through October 16.

In June of 1991, all but 12 daily minimum water temperatures exceeded 60°F. For July and August minimum temperatures fell below 60°F only once, with a maximum temperature of 79.7°F recorded in July. In 1992, minimum daily temperatures above 60°F began May 22, and except for nine days, remained above 60°F until September 15.

In 1993, minimum daily temperatures above 60°F didn't begin until began June 14, but during July and August minimum daily temperatures remained above 60°F every day. In 1994, minimum daily temperatures above 60°F resulted in 76 of the 91 days of the period June through August. The maximum recorded water temperature (75.2°F) for 1994 was recorded in July. Thermographs were removed in October of 1994 when the initial temperature study was terminated, yet monitoring began again in September 1995. In 1996, maximum daily temperatures reached 60°F for the first time on May 12. Maximum water temperature did not reach 70°F in June, with only six days of minimum daily temperatures above 60°F.

Salmon holding in this reach must face high maximum daily temperatures. During July and August of the study period (1990 to 1996) maximum temperatures exceeded 70°F in 231 of 333 days (69%).

Butte Creek Below Centerville

This thermograph was installed to assess the thermal effects of the inflow of water from the Centerville Powerhouse, with this water coming from the lower and upper Centerville Canals. Generally, these water temperatures were cooler than those of station located above the Centerville Powerhouse.

While little data exists for 1990, maximum water temperatures in 1991 reached 60°F on June 2. July and August of this year show all but one day surpassing minimum daily temperatures of 60°F. 1991, a drought year, showed the warmest September temperatures of the study period (1990 to 1996) with 24 of the 29 days of the data exceeding 60°F for minimum daily temperatures.

Over half the days sampled in June 1992 (12 of 21) surpassed the 60°F minimum temperature. July and August had the warmest temperatures for 1992, with August 16th's water temperature of 77.0°F being the highest of the year.

In 1993, the 60°F minimum water temperature was surpassed on June 14. From July through August, only 46 of 62 days monitored had daily minimum temperatures over 60°F, fewest of any on record for that period.

Minimum temperatures continued to be below 60°F until June 11, 1994. The lowest minimum temperatures for July and August 1994 were 62.6°F and 59.9°F respectively. Maximum water temperature for the year was 75.2°F during the month of July. The thermograph was removed in October of 1994. It was replaced in September of 1995, yielding readings of 68.4°F (maximum) and 54.1°F (minimum) for that month. Minimum daily temperatures were below 60°F until June 7, 1996. During July and August of the same year, all daily minimum temperatures were over 60° F. September, however, was the coolest one on record with only one day of minimum daily temperatures above 60°F and 19 maximum daily temperatures above 60°F.

Butte Creek Near Chico

This site, located near the USGS "Butte Creek near Chico" gauging station was installed in 1995 to replace the thermograph at the Parrott-Phelan Diversion Dam. Data shows that this station is generally warmer, May through October, than the upstream station "Butte Creek below Centerville." From May through October of 1995, maximum water temperatures surpassed 70°F only three days in July and seven in August. No daily minimums were above 70°F in 1995 or 1996. Maximum daily water temperatures of 78.3°F and 76.5°F were recorded for July and August 1996, respectively, compared to 70.7°F for both months in 1995.

Butte Creek At Parrott-Phelan Diversion Dam

Parrott-Phelan Diversion Dam is located in the lower portion of Butte Creek Canyon, near the mouth of the canyon. Here, riparian vegetation acting as a canopy over the stream begins to diminish as the creek channel has a broad cross-sectional shape and vegetation is often quite far from the stream. Direct solar exposure and slow moving water (due to a lower gradient) combine to raise water temperatures. June records from 1991 and 1992 show no minimum daily temperatures above 70°F, with maximum temperatures of 72.5°F and 78.8°F respectively. Highest temperatures recorded during 1990 data collection were 80.6°F on both August 8 and 9. July 30, 1991 marked the highest recorded temperature for the study, 81.5°F.

Butte Creek Below Gorrill Dam

This location was added to assess the combined effects of agricultural diversions at Parrott-Phelan, Durham Mutual, Adams, and Gorrill Diversion Dams. Water temperatures are greatly affected by the quantities of water diversions, bypass spills, and the timing of irrigation.

For August of 1990, all 24 days recorded exceeded 70° F for daily minimum water temperatures and a high water temperature of 90.5°F was recorded. In 1991, a high water temperature of 91.4°F was recorded in July. No minimum temperatures were below 70° F from June 30 through October 7, 1991. May of 1992 saw a high water temperature of 87.8° F, and included 14 of 31 days with minimum temperatures above 70° F. No temperature data exists for July and August 1992 or 1993 below Gorrill Dam. Sketchy data through 1994 shows May having cooler temperatures than in 1992, with a maximum of 77.9° F and a minimum of 56.3° F, with no data for June of 1994. The 40 days of record in July and August reveal that of those 40 days, 28 daily temperatures never fell below 70° F, while only six minimum daily temperatures in September exceeded 70° F.

The thermograph was reinstalled in September of 1995, with a maximum of 81.4° F and minimum of 61.8° F. Minimum daily temperatures for 1996 exceeded 70° F on June 8. With only two days of data for July, the maximum high temperature was 91.9° F.

Butte Creek Below Western Canal

The Western Canal, until the summer of 1997, crossed Butte Creek, in the process, mixing its waters with that of the creek and spilling water through the dams. Historically, water temperatures below the Western Canal crossing were cooler than that of Butte Creek below Gorrill Dam. For example, during 1990, 3.7% (two of 54 days) of the temperatures recorded below Western Canal exceeded a minimum temperature of 70° F compared to 90% (26 of 29 days) for that period for the station below Gorrill Dam, three miles upstream. Now, with the siphon under the creek, influences from spills to the creek will be limited to water deliveries to the Butte Sink hunting clubs (see discussion in the Hydrology, Geology, and Basin Morphology chapter), taking place mostly in the fall. While at first it may appear that without the Western Canal waters the creek will be warmer, it should be kept in mind that the Western Canal dams backed up water behind them for over two miles, allowing the water to slow and warm significantly. The results of the siphon project on water temperatures in the creek will be seen in the coming years.

In the 152 days monitored at Gorrill Dam from May to September (1991), 107 (or 70%) exceeded 70° F for daily minimum water temperatures. Below Western Canal, 18% (28 of 152) exceeded this level. In 1992, temperatures were quite similar to those in 1991. In 1993, no minimum daily temperatures exceeded 70° F. In the 18 days of record in May 1994 (the only data collected here for the year) a maximum temperature of 68.9° F was recorded. In 1995, another data logger was installed in September and it recorded a maximum temperature below Western Canal on July 6, 1996 of 76.7° F.

Butte Creek At Little Dry Creek Preserve

Butte Creek, as it flows through the Upper Butte Basin Wildlife Area-Little Dry Creek Unit is the site of temperature monitoring attempting to establish a control to look at the influences of the Cherokee Canal, and also monitor Butte Creek temperatures in the area below the Western Canal thermograph. The highest maximum temperature in the four year study at the Little Dry Creek Unit was 92.3° F was recorded July 4, 1991. Records from July and August 1992 show maximum temperatures above 70° F every day with minimum temperatures exceeding 70° F 28 of 62 days. Until June 15, 1993, all minimum temperatures were below 70° F. Minimum temperatures exceeded 70° F every day in July, and 15 days in August, with no data collection in September and October, 1993. During 1994, all of the days except one in July and August had minimum daily temperatures that exceeded 70° F. The recorder was removed in October of 1994 and reinstated in September of 1995. Minimum daily temperatures exceeded 70° F in June of 1996. For July and August of that year, 92% (56 of 61 days recorded) of the days had minimum temperatures that exceeded 70° F. 85° F was reached for a high in July, and 83.7° F for August.

Butte Slough Near Meridian

This station was installed to assess the thermal influences of the Butte Sink, Cherokee Canal, water imports from the Sacramento River (via R.D 1004, and others), and to set a control above the bifurcation into the east and west borrow pits of the Sutter Bypass. Higher flow at his station have been correlated with lower water temperatures.

In 1991, 87 of 101 days recorded from June through September had minimum temperatures that exceeded 70° F. This low-flow year had seven days in October with water temperatures exceeding 70° F. The following May (1992), 22 of 31 days had minimum temperatures that surpassed 70° F. During the period June through August, only three days had minimum temperatures that were below 70° F. No data was collected again until May of 1994. During the time from June through August, 1994, the daily minimum temperatures never fell below 70° F, and a maximum temperature of 94.1°F was recorded on July 13. September of 1994 had 23 of 26 days' minimum temperature above 70° F. The minimum temperature then did not go above 70°F all winter until May 19, 1995 due to increased flows from an above average winter. The maximum temperatures during June of 1995 reached 98.6°F. From July until September, except for five days, minimum temperatures never dropped below 70°F. In 1996, from June until September 5, minimum temperatures remained above 70° F. Even in October, minimum temperatures exceeded 70°F on ten of 30 days, with a maximum of 77.9° F.

Minerals

Mineral quality of the water in the upper reaches of Butte Creek appears to be excellent. PG&E and the SWRCB found low mineral concentrations, with conductivity ranging from 47 to 113 µmhos/cm near Centerville in 1974, 1975, 1982 and 1984. From 1952 to 1996, when sampled, the "Butte Creek near Chico" gauge site showed conductivity in the range of 63 to 137 µmhos/cm. The waters found in these upper sampling stations are calcium or calcium-magnesium bicarbonate in nature, and are excellent for all beneficial uses. A 1979 CSU, Chico master's thesis examines the hydrogeochemistry of Butte Creek above the Parrott-Phelan Diversion Dam (Okie Dam), and is a good reference document. (Granskog, 1979)

As waters flow through the valley portion of Butte Creek's hydrologic system, mineral conditions can deteriorate somewhat. Total dissolved solids (TDS) are variable depending on season and agricultural practices. Generally the lowest conductivity has occurred during the irrigation season when substantial quantities of high quality water from the Sacramento and Feather Rivers have been imported into the Butte Basin, and dilute mineral concentrations. Drought years and winter months have shown to be times of highest conductivity. Since 1959, conductivity in Butte Slough has ranged from 102 µmhos/cm at Ward's Landing (Butte Slough Outfall Gates) to 1,070 µmhos/cm near Meridian. While mineral quality declines lower in the system, it is still quite suitable for the primary beneficial uses of irrigated agriculture and flooding for wetlands and waterfowl habitat.

To summarize, mineral quality in the upper reaches of Butte Creek is excellent, but deteriorates in lower reaches and in the Sutter Bypass (not a part of this study area). Conductivity is often three times greater in the Bypass than at the Butte Creek near Chico gauge. The likely source of this increased mineral concentration in the lower basin is agricultural drainage. While the highest concentrations of minerals occurs in the upper portions of Butte Creek during the summer low flow period, lower in the system, the highest concentrations are found during the winter and periods of high flow. Higher winter concentrations in the lower creek area is probably due to the leaching of salts from agricultural lands that built up over the previous irrigation season. Mineral concentrations in the lower system are seldom at levels detrimental to beneficial use, and levels detrimental to agriculture generally correspond to the non-irrigation season.

Dissolved Oxygen

The *1994 Central Valley Regional Water Quality Control Board Plan* states "the monthly median of the mean daily dissolved oxygen (DO) concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent of saturation." The EPA, in their 1986 *Quality Criteria for Water*, state that dissolved oxygen should be, at a minimum, 8.0 mg/L to protect the early life stages of cold water aquatic life. The minimum DO levels for warm water species were set at 5.0 and 3.0 mg/L for early life stages and other life stages, respectively (CVRWQCB, 1994; EPA, 1996).

Butte Creek, in the upper reaches above the "Butte Creek near Chico" gauge, has relatively high dissolved oxygen concentrations that approach saturation. This is largely due to moderate water temperatures, a high stream gradient, and a low organic load. Between 1974 and 1984, DO concentrations of 7.0 to 11.2 mg/L were recorded near Centerville by PG&E and SWRCB, as reported in the DeSabla-Centerville Hydroelectric Project Draft EIR. DWR monitored levels ranging from 9.1 to 13.1 mg/L between December 1990 and October 1992.

Moving downstream to the "Butte Creek near Chico" gauge, a historic record from March 1967 to November 1990 has been kept by DWR. Values for that period ranged from 8.7 to 14.7 mg/L. The most recent period of monitoring at this site is from August 1994 through November 1996, and values ranged from 9.0 to 12.7 mg/L.

All DO readings at the "Butte Creek near Chico" gauge exceed the EPA requirements for cold and warm water species.

Monthly grab samples taken from December 1990 to October 1992 at the following locations displayed the trend of higher concentrations in spring, corresponding to low water temperatures and higher flows, and lower concentrations during the summer, with lower flow and higher water temperatures: Gorrill Dam, 8.0 to 13.1 mg/L; below Western Canal 8.3 to 12.6 mg/L, and 7.5 to 12.9 mg/L above Little Dry Creek. According to the *Draft Butte Basin Report*, the water from the Western Canal has a higher DO concentration, causing levels below Western Canal on Butte Creek to be higher than at Butte Creek below Gorrill Dam.

Lower in the system, the only long-term historic records come the Butte Slough area. Here in the lower system, water temperatures are higher, stream gradients are very low, and organic loads are high. Unpublished DWR records from 1971 to 1991 for the Butte Slough near Meridian station show DO concentrations ranging from 4.6 to 12.2 mg/L. DWR records (1959 to 1973) at Butte Slough at Outfall Gates (Ward's Landing) give a range of 4.9 to 11.9 mg/L. Highest values occur in the spring, corresponding to high flows and lower water temperatures. The lower concentrations have usually occurred in August when discharge was low and water temperatures were high. Although these locations are out of the study area, it is important to take a system-wide view relative to species of concern and note that many of these concentrations do not meet EPA standards for protection of early life stage development of cold water species. Spring run adult salmon may be migrating and smolts may be emigrating through the Butte Slough area during May and June. In terms of inter-species competition between anadromous salmonids and other species, DO concentrations have seldom fallen below levels that are adverse to warm water species.

Seasonal patterns of dissolved oxygen concentrations in Butte Creek are predictable, with the highest levels occurring in the winter and lowest levels occurring in summer and fall. Biological activity in water can affect DO levels as well. Diurnal patterns, corresponding to photosynthetic production of oxygen during the day, and respiration at night decreasing oxygen levels are also present. DO levels in Butte Slough (and also the Sutter Bypass below) as well as agricultural drain returns are often quite low and below saturation levels. Spring run salmon smolts and migrating adults find less than desirable dissolved oxygen concentrations that probably negatively affect escapement and migration.

Turbidity

The CVRWQCB has set standards for increases in turbidity that are attributable to controllable water quality standards. Turbidity is measured using a device that measures how much light is scattered when directed at a water sample. The units are reported in Nephelometric Turbidity Units (NTUs). The CVRWQCB has broken their regulations down into categories, with varying restrictions based on the waterways natural turbidity. Butte Creek seems to fall into two categories for natural turbidity: the 0-5 NTU and 5-50 NTU. Butte Creek has ranged from <1 to 14 NTUs from 1974 through 1992, as monitored near Centerville by DWR and the agencies responsible for the *DeSabla-Centerville Hydroelectric Project Draft EIR*. The "Butte Creek near Chico" monitoring station has recorded a low value of 0 NTU and a high value of 70 NTU since 1952. The CVRWQCB objective for 0-5 NTU states that the maximum allowable increase is 1.0 NTU. As the creek also show signs of being in the 5-50 NTU natural turbidity category, which allows for a 20% maximum increase, it should be evaluated through this criteria as well. The highest levels correspond to the wetter portion of the year, when runoff and associated erosion are highest.

What makes analysis of this data difficult is the fact that the range of levels is just that, a range. Specific readings are not tied to storm events or physical disturbances to the creek. For example, canyon residents have reported the creek being extremely turbid following hydroelectric canal failures or maintenance. These occurrences apparently have not been recorded by a turbidimeter or nephelometer as no information was available. Readings have been taken only when field sampling for other parameters has occurred. Residents have taken physical samples for future analysis, but often these incidents occur during the night. Real-time turbidity monitoring will be installed at the "Butte Creek near Chico" gauge by DWR and the USGS in the fall/winter of 1998 to better monitor these conditions. This station will be able to provide the existing flow information along with a measure of turbidity. This can be used to monitor turbidity as a cue for outmigrating juvenile fish as well as to understand the role of the upper watershed as a contributor to sediment in the stream. Sediment is a component of turbidty and its effect on spawning gravel and loss of pool volume is a concern. The road survey scheduled to begin in the Fall of 1998 will begin the process of identifying potential sources (see Issues and Concerns chapter, # 5). This information will ultimately assist in formulating a sediment budget.

Lower in the creek, turbidity is attributed to agricultural drainage or the more highly erodible soils. DWR has recorded values in the Sutter Bypass from 5 to 600 NTU. Since 1959, values for Butte Slough have ranged from 1 to 288 NTU. Upstream in the study area, monitoring was done by DWR from December 1990 to April 1992. The four stations had the following values: at Gorrill Dam (0.25 to 9.4 NTU), Western Canal (1.4 to 17 NTU), Butte Creek below Western Canal (0.5 to 15 NTU) and Butte Creek above Little Dry Creek (0.8 to 39 NTU).

pH

DWR uses the same data sources for pH as they do for dissolved oxygen. Domestic water supplies require pH to fall within 5.0 to 9.0 so as to not be corrosive or adversely affect treatment processes. The EPA seeks to keep pH between 6.5 and 9.0 for protection of freshwater aquatic life. The CVRWQCB criteria is for pH to fall between 6.5 to 8.5.

Levels for pH at Centerville range from 7.1 to 7.9 for the years 1974 through 1984 as measured by PG&E and SWRCB. (PG&E and SWRCB, 1988) DWR records back to 1952 show a range between 7.1 to 8.4. Butte Slough, Sutter Bypass and Sacramento Slough values have ranged from 6.9 to 8.5. Unpublished DWR data for agricultural drains shows a range from 6.6. to 8.6.

The general trend is for pH to increase from the upper portions of Butte Creek to Butte Slough and the Sutter Bypass. Winter values are closer to neutral when increased rainfall increases discharge. Agricultural returns and summer/fall low flows tend to increase levels. Diurnal patterns in pH are related to biological activity, with dark cycle respiration producing CO_2. This subsequently goes on to form carbonic acid, lowering the pH. During the day, photosynthesis uses the CO_2, reducing the amount of carbonic acid, and increasing pH. According to all current data available, pH levels have not exceeded objectives set by the CVRWQCB.

Nutrients

Generally, nutrient concentrations are quite low in the upper portions of Butte Creek, and increase downstream. Little Butte Creek, with its large urban area influence from the town of Paradise, which has no sewage treatment plant, has levels usually elevated from that of a Butte Creek station of comparable elevation. For example, Little Butte Creek, on February 18, 1992, had a reading of 0.44 mg/L of N as dissolved nitrate plus nitrite. For the same parameter, Butte Creek near Centerville registered 0.02 mg/L as N, and downstream of the Little Butte Creek station, with mixing from Butte Creek, the "Butte Creek near Chico" station recorded 0.06 mg/L for nitrates plus nitrites. This large difference may be attributed to urban runoff into the Paradise and Magalia Reservoirs, Middle Butte Creek, and Honey Run Creek, and subsequent transport downstream.

The station at Butte Creek near Centerville had relatively good nutrient concentrations. Dissolved orthophosphates were below detectable levels, total phosphorous ranging from less than 0.01 to 0.03 mg/L as P, and total ammonia plus organic nitrogen ranging from less than 0.01 to 0.02 mg/L as N, during monitoring from December, 1990 through August, 1992. Downstream at Gorrill Dam, (in May, 1992) ammonia plus organic nitrogen was 0.2 mg/L as N below the dam, but increased to 0.5 mg/L downstream of the Western Canal crossing. Water in the Western Canal measured 0.8 mg/L at this time. Western Canal, Little Dry Creek, Cherokee Canal and the numerous other unnamed agricultural drains contribute to rising nutrient concentrations in Butte Creek. An example comes from Cherokee Canal below the (R.D. 833) Main Drain where ammonia plus organic nitrogen measured 0.4 to 1.5 mg/L as N, and 0.01 to 0.57 mg/L as N for dissolved nitrates plus nitrite for the period December 1990 through October 1992.

A large amount of data exists for the station at Butte Slough near Meridian, ranging from 1971 through 1991. The nutrient concentrations in this lower area of the system vary with season and agricultural practices. Nitrate has varied from 0.0 to 0.32 mg/L as N with nitrite plus nitrate ranging from 0.01 to 0.29mg/L as N. A range of 0.1 to 1.2 mg/L was recorded for ammonia plus organic nitrogen, a high value that is six times greater than at the Butte Creek near Chico station. Total phosphorus reached maximum levels at 0.30 mg/L as P, thirty times the Butte Creek near Chico reading.

Minor Elements

DWR monitoring efforts for minor elements are limited to mostly the lower watershed. PG&E and the SWRCB reports did, however, mention that during the time from 1975 through 1984, water coming through the Hendricks/ Toadtown Canal had no detectable copper, iron levels ranged from less than 0.02 to 0.07 mg/L, manganese ranged from less than 0.01 to 0.05 mg/L, and zinc was measured from 0.01 to 0.05 mg/L. (PG&E and SWRCB, 1988). The Granskog's thesis report examined the hydrogeochemistry of Butte Creek above the Parrott-Phelan Diversion Dam (Okie Dam), and fills a spatial data gap that exists in the DWR monitoring (Granskog, 1979).

At Butte Creek near Chico, DWR at various (but inconsistent) times from 1959 through 1988 monitored for aluminum, copper, iron, manganese, and zinc. The monitoring at Butte Creek near Centerville (from February 1991 through September 1992) found traces of zinc and manganese, but arsenic, mercury, cadmium, chromium, copper, lead, selenium, aluminum, and nickel were all below detection limits. DWR improved laboratory techniques, and in October 1994 and January 1995, concentrations of cadmium of 0.002 mg/l were detected at hardnesses of 51 mg/L and 27 mg/L respectively. Table 5.3 shows the chronic and acute exposure criteria for protection of aquatic life as set by the EPA. They are as follows:

Table 5.3
Chronic and Acute Exposure to Cadmium

When hardness of:	Chronic and Acute exposure of:
50 mg/L of $CaCO_3$	0.00066 and 0.0018 mg/L
1000 mg/L of $CaCO_3$	0.0011 and 0.0039 mg/L
200 mg/L of $CaCO_3$	0.0020 and 0.086 mg/L

Source: EPA, 1986

The creek violated this standard for protection of aquatic life. In October of 1994, concentrations of lead were recorded (at a hardness of 27 mg/l $CaCO_3$) of 0.003 mg/L. This parameter too exceeded limits set to protect aquatic life in the creek when referenced to the standards set by the EPA, as seen in Table 5.4:

Table 5.4
Chronic and Acute Exposure to Lead

When hardness of:	Chronic exposure
50 mg/L of $CaCO_3$	0.0013 mg/L
1000 mg/L of $CaCO_3$	0.0032 mg/L
200 mg/L of $CaCO_3$	0.0077 mg/L

Source: EPA, 1986

Lead concentrations at Butte Slough near Meridian, taken on May 23, 1995, show levels of 0.005 mg/L at 74 mg/L $CaCO_3$, indicating that lead may be a hazard to aquatic life in the lower system and the Sutter Bypass.

Aluminum levels above the US EPA National Ambient Water Quality Criteria was detected at all water quality monitoring stations except Butte Creek near Centerville. This criteria calls for a maximum concentration of 0.087 mg/L over a four day average, with a maximum concentration for one-hour of 0.750 mg/L (CVRWQCB 1995). It is noted that aluminum is lethal to trout at 5.0 mg/L for as little as a five-minute exposure. (McKee and Wolfe, 1971) With continuous exposure, concentrations of 0.5 mg/L were lethal to other fishes. At the station below Western Canal, aluminum was recorded at levels below detection limits up to 2.0 mg/L during the time from February 1991 through February 1992. During the same time period, Cherokee Canal below Main Drain ranged from 2.0 to 5.0 mg/L, and Butte Creek at Butte Slough recorded levels from 3.8 to 5.0 mg/L. No aluminum concentration data exists for stations between Centerville and the station below Western Canal. Arsenic, cadmium, mercury, selenium, nickel, and chromium were not detected at Western Canal at Butte Creek when sampled from February 1991 through September 1993. Iron, however, exceeded the 1.0 mg/L EPA standard for chronic exposure to freshwater aquatic life in Butte Creek at Western Canal in May of 1991 with a reading of 1.2 mg/L Fe. Downstream at the Cherokee Canal below Main Drain arsenic levels (0.003 to 0.020 mg/L) exceeded water quality objectives set by the CVRWQCB (0.01 mg/L), and increased levels downstream at Butte Creek at Butte Slough to 0.012.

Pesticides

Due to large fish kills in many of the agricultural drains to the Sacramento River in the 1980s attributed to rice herbicides such as molinate and thiobencarb (which also caused taste problems in the City of Sacramento's drinking water), the Butte Basin has been monitored primarily for rice biocides. Subsequent investigations found levels of insecticides such as carbofuran, malathion, and methyl parathion that were potentially hazardous to aquatic organisms.

The bulk of the monitoring has been in the lower part of the system, much of it outside the scope of the study area (ie. Sutter Bypass, Reclamation Slough, Sacramento Slough, etc.). Due to the DPR regulations developing best management practices (BMPs), the CVRWQCB formulating regulations, and having CDFG monitor, the amount of rice biocides detected has reduced greatly. For example, in 1982, 464 kg of Molinate was estimated to have passed Sacramento in the Sacramento River. In 1995, that amount dropped to 83.7 kg.

While the rice biocide management programs have been quite effective at reducing the quantities found in the Sacramento River, legacy problems still most likely exist. DDT use was banned in 1972, and toxaphene use was prohibited in 1984. Even though DDT was still above National Academy of Sciences (NAS) guidelines to protect predators, in 1980, and toxaphene was just banned (and was also above NAS guidelines), monitoring for these compounds ended in 1984. These compounds are highly persistent in the environment, and although it is assumed that the concentrations are on a downward trend, there is no way to know if there are still hazardous concentrations.

Groundwater Quality

The Groundwater Quality Stations Map shows the locations of 56 ground water quality measuring stations (see Map Appendix). USGS conducted the water quality measurements. Table 5.5 provides additional information regarding location, and when the chemical measurements were taken. Table 5.6 is a matrix for all the wells showing which chemical parameters were measured.

Most of the measurements were done only once in 1975 or 1976. Eight stations were sampled more than once. Those stations and their sample dates are listed below. Table 5.6 shows that most samples involve a standard mineral analysis and some heavy metal analysis.

Below are the sampling times for the eight wells having repetitive sampling periods:

Station Number 7 (ID # 392448121424501):

September 3, 1970	May 20, 1974 (2:10 pm)	May 19, 1977
June 24, 1971	May 28, 1975	May 19, 1977 (9:15 am)
August 21, 1972	May 28, 1975 (8:30 am)	June 9, 1978
June 14, 1973	June 17, 1976	June 22, 1979
June 14, 1973 (11:55 am)	June 17, 1976 (12:15 pm)	June 11, 1980
May 20, 1974	September 1, 1976	

Station Number 28 (ID# 393657121512701):

June 7, 1978	June 22, 1979	July 1, 1981

Station Number 32 (ID# 393728121485101):

August 31, 1970	June 15, 1973	October 7, 1975
June 24,1971	May 22, 1974	June 15, 1976
August 15, 1972	May 27, 1975	May 17, 1977

Station Number 33 (ID# 393811121563801):

January 29, 1957	August 7, 1963	August 31, 1970
September 15,1958	September 25, 1964	June 24, 1971
August 27, 1959	August 3, 1965	August 15, 1972
August 17, 1960	August 8, 1967	June 15, 1973
September 7, 1961	June 27, 1968	May 22, 1974
August 14, 1962	August 25, 1969	

Station Number 35 (ID# 393921121515601):

August 16, 1972	June 15, 1973	June 15, 1976	May 17, 1977

Station Number 36 (ID# 393934121455001):

August 31, 1970	August 16, 1972	May 22, 1974	June 16, 1976
June 30, 1971	June 15, 1973	May 27, 1975	

Station Number 45 (ID# 394124121372201)

September 2, 1970	August 18, 1972	May 21, 1974	June 16, 1976
June 219, 1971	June 15, 1973	May 29, 1975	

Station Number 46 (ID# 394126121550001):

August 31, 1970	August 16, 1972	May 28, 1974	June 15, 1976
June 20, 1971	June 15, 1973	May 27, 1975	May 17, 1977

Groundwater quality in the East and West Butte subbasins is generally good for domestic and agricultural use (USGS, 1979; DWR, 1992). The groundwater is generally magnesium and calcium bicarbonate in nature. Some areas have waters that are sodium bicarbonate in type. These areas often have elevated concentrations of sodium, chloride, sulfate, and total dissolved solids that could limit future agricultural use on sensitive crops.

Nutrients

Nitrogen and phosphorus levels are usually somewhat higher in groundwater than in surface water (USGS, unpublished DWR, 1992). USGS (1979) found six wells in or near the Butte and Sutter Basins that exceeded the nitrate criteria of 10 mg/l as N. Concentrations ranged from 11 to 18 mg/l and were from shallow wells indicating that higher concentrations could have been from surface contamination. Thirteen of 63 wells monitored in Butte County have at sometime exceeded the nitrate criteria (DWR unpublished). Of the 13 wells, two are within the Butte subbasins and have nitrates. DWR sampled 62 wells in the Chico area in May and November 1984 (DWR 1984). Nine of the wells were in the West Butte subbasin. Three of those wells had nitrates exceeding EPA Primary Drinking Water Standards for nitrates of 45 mg/l as NO3 (49. 66, and 71 mg/l as NO3).

Minor Elements

Minor Element data are limited. The most complete records are from wells owned by the California Water Service Company for domestic use by Chico area residents. The most recent and comprehensive collection of minor elements was conducted during the summer of 1989. This evaluation of wells in Butte County included wells in the Butte Basin. Negligible amounts of toxic trace elements have been detected in the groundwaters of the Butte and Sutter basins (USGS, 1979). Iron and manganese occur at concentrations greater than secondary drinking water standards (0.3 mg/l and 0.05 mg/l, respectively, DHS 1977) in some wells. USGS (1979) found two wells exceeding the standard for iron with concentrations as high as 1.2 mg/l, but averaging 0.003 mg/l. Historic records show a range of iron concentrations 0.0 to 1.5 mg/l (DWR, Unpublished). Recent analysis show iron concentrations range from non-detectable to 0.23 mg/l (DWR, 1992).

Manganese values exceeded secondary drinking water standards more often than iron. USGS (1979) found 22 wells above the 0.05 mg/l limit. Concentrations reached 2.3 mg/l and averaged 0.11 mg/l. Historic records show a range of 0.0 to 2.3 mg/l for manganese (DWR unpublished) while the 1989 study found manganese concentrations from non-detectable 0.16 mg/l (DWR, 1992).

Arsenic, chromium, barium, copper, selenium, and zinc have also been detected in groundwater from the Butte subbasins, but not at levels detrimental to beneficial use (BBWUA, 1997 Draft).

Pesticides

The department of Food and Agriculture established a well inventory data base for agricultural pesticide residues in California well water during 1985 (DFA, 1985). The data base includes information from 1975 to the present and is updated annually in a published report (DFA, 1985, 1986, 1987, 1988b, 1989b, 1990, DPR 1991, 1992a, 1993, 1994a, 1995a, and 1997).

The groundwater of Butte Basin has been tested periodically for pesticides from 1988 to the present. Atrazine, bentazon, DDE, and 1,1,2,2,-tetrachloroethane were the chemicals detected. Atrazine was found in two of seven wells sampled during 1988 (DFA, 1989b) but was not detected in any of the 44 wells sampled by the DWR in 1989. (DWR, 1992) Similarly, DDE was detected in two of three wells in 1988 (DFA, 1988b) but was not detected in the 1989 study (DWR, 1992). Bentazon was the only compound to show relatively widespread contamination , being detected in eight of twelve wells during 1988 and 1989 (DFA, 1989a and 1989b). The use of benatzon on rice was discontinued because management practices could not be developed to prevent movement into groundwater.

Data Gaps

Through the Watershed Advisory Committee(WAC) process, comments were received regarding various locations and operations that certain individuals felt could be compromising the water quality of Butte Creek and its tributaries. For example, Paradise, a town of over 30,000 people, all on septic systems, may have an influence on nutrient loading in Middle and Little Butte, Honey Run Creek and other drainages below the town. Mine tailings are highly permeable and require engineered septic systems. Many older homes have septic systems in areas where topography, soils, and geology speed effluent directly into subsurface flow and ultimately into the creek. The two major subdivisions on the lower portion of the Skyway discharge their sewage effluent into County service area leach fields in Butte Creek Canyon. This area has been identified by

Table 5.5
Ground Water Quality Stations   Upper Butte Creek Watershed

WELL	ID #	Latitude	Longitude	Begin	End	Site	#Obs	#Ana
1	CA391728121473501	N39:17:28	W121:47:35	09/11/76	09/11/76	GW	20	1
2	CA392200121413201	N39:22:00	W121:41:32	09/01/76	09/01/76	GW	20	1
3	CA392200121482901	N39:22:00	W121:48:29	09/30/75	09/30/75	GW	31	1
4	CA392202121441001	N39:22:02	W121:44:10	09/01/76	09/01/76	GW	31	1
5	CA392207121452401	N39:22:07	W121:45:24	09/01/76	09/01/76	GW	20	1
6	CA392341121425501	N39:23:41	W121:42:55	09/01/76	09/01/76	GW	20	1
7*	CA392448121424501	N39:24:48	W121:42:45	09/03/70	06/11/80	GW	221	18
8	CA392508121471201	N39:25:08	W121:47:12	09/11/76	09/11/76	GW	31	1
9	CA392512121504301	N39:25:12	W121:50:43	09/30/75	09/30/75	GW	31	1
10	CA392513121485901	N39:25:13	W121:48:59	09/30/75	09/30/75	GW	20	1
11	CA392513121510701	N39:25:13	W121:51:07	09/30/75	09/30/75	GW	20	1
12	CA392617121481201	N39:26:17	W121:48:12	09/30/75	09/30/75	GW	31	1
13	CA392818121443401	N39:28:18	W121:44:34			GW	31	1
14	CA392934121471701	N39:29:34	W121:47:17	09/08/76	09/08/76	GW	20	1
15	CA392937121443601	N39:29:37	W121:44:36	09/08/76	09/08/76	GW	20	1
16	CA393127121411701	N39:31:27	W121:41:17	09/07/76	09/07/76	GW	20	1
17	CA393135121405801	N39:31:35	W121:40:58	09/07/76	09/07/76	GW	31	1
18	CA393257121401001	N39:32:57	W121:40:10	09/09/76	09/09/76	GW	20	1
19	CA393257121424001	N39:32:57	W121:42:40	09/08/76	09/08/76	GW	47	1
20	CA393306121455001	N39:33:06	W121:45:50	09/08/76	09/08/76	GW	20	1
21	CA393307121410801	N39:33:07	W121:41:08	09/08/76	09/08/76	GW	31	1
22	CA393322121384301	N39:33:22	W121:38:43	09/08/76	09/08/76	GW	31	1
23	CA393425121424001	N39:34:25	W121:42:40	09/08/76	09/08/76	GW	20	1
24	CA393533121364801	N39:35:33	W121:36:48	09/08/76	09/08/76	GW	20	1
25	CA393539121443901	N39:35:39	W121:44:39	09/08/76	09/08/76	GW	31	1
26	CA393608121415701	N39:36:08	W121:41:57	09/08/76	09/08/76	GW	20	1
27	CA393633121400501	N39:36:33	W121:40:05	09/08/76	09/08/76	GW	31	1
28*	CA393657121512701	N39:36:57	W121:51:27	06/07/78	07/01/81	GW	20	3
29*	CA393717121454301	N39:37:17	W121:45:43	08/16/72	06/16/76	GW	32	4
30	CA393722121445001	N39:37:22	W121:44:50	09/08/76	09/08/76	GW	31	1
31	CA393723121464001	N39:37:23	W121:46:40	09/08/76	09/08/76	GW	20	1
32*	CA393728121485101	N39:37:28	W121:48:51	08/31/70	05/17/77	GW	122	9
33*	CA393811121563801	N39:38:11	W121:56:38	01/29/57	05/17/77	GW	312	20
34	CA393856121481601	N39:38:56	W121:48:16	10/07/75	10/07/75	GW	31	1
35*	CA393924121515601	N39:39:24	W121:51:56	08/16/72	05/17/77	GW	40	4
36*	CA393934121455001	N39:39:34	W121:45:50	08/31/70	06/16/76	GW	78	7
37	CA393935121482501	N39:39:35	W121:48:25	10/07/75	10/07/75	GW	31	1
38	CA393945121513601	N39:39:45	W121:51:36	10/07/75	10/07/75	GW	20	1
39	CA393950121474101	N39:39:50	W121:47:41	09/09/76	09/09/76	GW	31	1
40	CA394011121510501	N39:40:11	W121:51:05	10/07/75	10/07/75	GW	20	1
41	CA394015121454301	N39:40:15	W121:45:43	09/09/76	09/09/76	GW	31	1
42	CA394050121471601	N39:40:50	W121:47:16	09/09/76	09/09/76	GW	20	1
43	CA394051121432501	N39:40:51	W121:43:25	09/09/76	09/09/76	GW	20	1
44	CA394059121513301	N39:40:59	W121:51:33	10/07/75	10/07/75	GW	31	1
45*	CA394124121372201	N39:41:24	W121:37:22	09/02/70	06/16/76	GW	53	7
46*	CA394126121530001	N39:41:26	W121:53:00	08/31/70	05/17/77	GW	89	8
47	CA394145121540501	N39:41:45	W121:54:05	10/07/75	10/07/75	GW	31	1
48	CA394157121485701	N39:41:57	W121:48:57	10/07/75	10/07/75	GW	31	1
49	CA394203121480501	N39:42:03	W121:48:05	09/09/76	09/09/76	GW	20	1
50	CA394212121455101	N39:42:12	W121:45:51	09/09/76	09/09/76	GW	31	1
51	CA394214121504801	N39:42:14	W121:50:48	10/07/75	10/07/75	GW	20	1
52	CA394218121484401	N39:42:18	W121:48:44	10/07/75	10/07/75	GW	20	1
53	CA394242121474001	N39:42:42	W121:47:40	09/09/76	09/09/76	GW	47	1
54	CA394244121482401	N39:42:44	W121:48:24	10/09/75	10/09/75	GW	20	1
55	CA394308121520001	N39:43:08	W121:52:00	10/09/75	10/09/75	GW	20	1
56	CA394334121494901	N39:43:34	W121:49:49	10/09/75	10/09/75	GW	46	1

(Source: USGS)

Table 5.6
Tests for Trace Elements

Test #	Test Name	GRP 1	GRP 2	WELL 29	WELL 35	WELL 19 & 53	WELL 45	WELL 36	WELL 46	WELL 37	WELL 7	WELL 33
10	Temperature	X	X	X	X	X	X	X	X	X	X	
27	Agency Col Spl										X	
28	Agency Anl Spl			X	X		X	X	X	X	X	X
95	Spec. Conduct.	X	X	X	X	X	X	X	X	X	X	X
400	pH	X	X	X	X		X	X	X	X	X	X
405	Carb. Dioxide	X	X	X	X		X	X	X	X	X	X
410	Alkalinity	X	X	X	X		X	X	X	X	X	X
440	Bicarbonate	X	X	X	X		X	X	X	X	X	X
445	Carbonate	X	X	X	X		X	X	X	X	X	X
608	Nitrogen (Amm)					X					X	
630	Nitogen (N)	X	X	X		X				X	X	
660	Phosphate		X	X		X				X	X	
671	Phosphorus		X	X		X				X	X	
681	Organic Carb.					X					X	
900	Total Hardness	X	X	X	X	X	X	X	X	X	X	X
902	Noncarb. Hard.	X	X	X	X	X	X	X	X	X	X	X
915	Calcium	X	X	X	X	X	X	X	X	X	X	X
925	Magnesium	X	X	X	X	X	X	X	X	X	X	X
930	Sodium	X	X	X	X	X	X	X	X	X	X	X
931	Na Ab. Ratio	X	X	X	X	X	X	X	X	X	X	X
932	Sodium %		X	X	X	X	X	X	X	X	X	X
935	Potassium		X	X	X	X	X	X	X	X	X	X
940	Chloride	X	X	X	X	X	X	X	X	X	X	X
945	Sulfate	X	X	X	X	X	X	X	X	X	X	X
950	Flouride		X	X		X				X	X	X
955	Silica		X	X		X				X	X	X
1000	Arsenic		X	X		X				X	X	X
1020	Boron	X	X	X	X	X	X		X	X	X	X
1025	Cadmium					X					X	
1030	Chromium					X				X	X	X
1035	Cobalt					X					X	
1040	Copper					X					X	X
1046	Iron		X	X		X				X	X	
1045	Total Iron											X
1049	Lead					X					X	X
1056	Manganese		X	X		X				X	X	X
1060	Molybdenum					X					X	
1065	Nickel					X					X	
1080	Strontium					X					X	
1085	Vanadium					X					X	
1090	Zinc					X					X	X
1106	Aluminum		X	X		X				X	X	X
1130	Lithium					X					X	
1145	Selenium					X					X	
70300	Sld Evap. Resd.	X	X	X		X				X	X	
70301	Sld. Sum Const.		X	X	X	X	X	X	X	X	X	X
70303	Dissolved Sld.	X	X	X		X				X	X	
71846	Nitrogen (NH4)					X					X	
71850	Nitrogen (NO3)	X	X	X	X	X	X	X	X	X	X	X
71890	Mercury					X					X	

Group 1: 1, 2, 5, 6, 10, 11, 14, 15, 16, 18, 20, 23, 24, 26, 28, 31, 38, 40, 42, 43, 49, 51, 52, 54, 55
Group 2: 3, 4, 8, 9, 12, 13, 17, 21, 22, 25, 27, 30, 34, 37, 39, 41, 44, 47, 48, 50, 56
(Source: USGS)

DWR as an area for groundwater recharge. In Durham, all residences and commercial buildings are on septic systems (see Issues and Concerns #6).

There is currently a moratorium on septic systems in Nelson due poor soil conditions and high groundwater, making leach systems difficult. In Richvale, there is a city sewer system that ultimately deposits wastewater into evaporation ponds. These recently expanded ponds evidently handled the extensive precipitation of 1997-98. The City of Biggs also has a city sewer, but has experienced problems with water infiltration into their system, especially during high precipitation events. This has caused the system to exceed capacity. The Chico Mobile Country Club, located off Dayton Rd., has a wastewater treatment plant utilizing an aerated package plant with the effluent discharged into percolation ponds.

The Neal Road Landfill is monitored by Butte County Public Works, and as the landfill and area around it drain into Hamlin Slough, it has the potential to affect water quality in Butte Creek. The landfill is permitted by Public Works, with a staff person from Butte County Environmental Health, the local enforcement agency, doing monthly site reviews. Any water that has come into contact with garbage is funneled into a evaporation pond with a required two foot freeboard. Water that comes onto the site but does not come into contact with garbage (ie. inflow from upslope or any non-garbage surface water flow) is tested during at least three storm events during the winter as part of compliance with the landfill's storm water pollution prevention plan. This past winter, the evaporation ponds exceeded freeboard, but did not overtop as personnel pumped this effluent into trucks for proper disposal elsewhere. Groundwater is tested quarterly at test wells on the perimeter of the site. The landfill is currently left with 20 years' of capacity, and the County has solicited proposals to facilitate a materials recovery facility (MRF). The MRF is a center where any recyclable or reusable materials are recovered for such uses and the much reduced remaining materials are then disposed of in the landfill. Such efforts may extend the life of the landfill.

The contributions to surface and groundwater contamination of the various sewage and waste disposal systems is monitored, but not as frequently or timely as needed. Their contribution to groundwater recharge is a concern (see Issues and Concerns #6). Funding for further studies and monitoring is limited, however this data gap is one that should be addressed.

Because many chemical substances were analyzed at the lower end of the basin, it is not possible to trace their exact source location. In order to determine the source of many chemical parameters associated with agriculture, more stations and analyses would be required in the middle and lower basin if source identification and reduction is a goal. Agricultural return flows throughout the middle and lower basin should also be chemically monitored for the same reason. CVRWQCB realizes that there is a need for continuous, broad spectrum analysis of biocides in the Butte (and Sutter) basins, but due to funding constraints, one has not yet been implemented. This lack of data in a spatial context is recognized to be a data gap.

Some surface water quality stations have taken enough measurements over a period of years that it may be possible to see chemical change over the period of record. This data should be plotted and analyzed in detail with attention to the direction of long-term trends so that efforts to reduce pollution can be planned and monitored.

Chemical differences between the West Branch of the Feather River, Butte Creek, Little Butte Creek, the Thermalito Afterbay, and ground water also need investigation. One fortunate bit of information gathered was that when the water was sampled for chemical testing, its temperature was recorded which represents a discrete point measurement in time. This could be used to make inferences, albeit only one point in time, on stream temperatures in places where no other data exists.

Further analysis of flow issues related to water temperatures, dissolved oxygen, and holding areas for spring run chinook seems merited, especially relative to the uncertainty of future operations of the DeSabla-Centerville Project with the current deregulation of the California power industry (see Issues and Concerns #2).

The CVRWQCB objective for turbidity, 0-5 NTU, states that the maximum allowable increase is 1.0 NTU or 20%. In some cases, it would appear that Butte Creek violates this standard. As the creek also show signs of being in the 5-50 NTU natural turbidity category, which allows for a 20% maximum increase, it should be evaluated through this criteria as well. Even when evaluated in this category, it appears that the creek violates the standards.

Further examination for aluminum (i.e., increased sampling stations) may be warranted as the concentrations in the lower system appear to be at levels that could harm resident and anadromous fish, and currently, data suggests only that the problem is "upstream."

Future Monitoring of Water Quality Parameters

The best time to look for nutrients (especially compounds of nitrogen and phosphorous) in Butte Creek would be in the summer and fall when nutrient concentrations would be high due to low base flow conditions. A more extensive water quality sampling program may be able to provide information regarding the influence of residential septic systems and agricultural drains on the creek. A good place to sample, and ultimately look at the influences of Paradise's lack of sewage treatment, would be just above the confluence of Little Butte Creek and Butte Creek, on each of these streams. Additional sampling locations on Butte Creek should include the area between the Helltown Bridge and the Skyway Bridge. Sampling points should be selected immediately upstream (for control) and downstream of the larger subdivisions and analyzed for nitrogen and phosphorous. Due to the widespread use of caffeinated beverages by Americans, wherever domestic sewage is suspected as a source of nutrient pollution, caffeine should also be measured as a diagnostic test. Sampling for agricultural drain water should be done immediately upstream (for control) and downstream of drainage outfalls.

Chapter 6

Ecology

Plant Communities and Distributions

Due to differences in topographic features, solar exposure, soil moisture, slope, and elevation, the Butte Creek Watershed supports a diverse flora and a mosaic of plant communities. These plant communities generally follow gradients (i.e. elevation, precipitation) and are discussed as following an elevation gradient from the sink to the headwaters.

Valley Communities

There are several distinct communities in the valley sections of Butte Creek as well as many ecotones, or zones of overlap. A general discussion of the region will be followed by specific descriptions of plant communities.

Agricultural Lands

Agricultural lands occur in the lower portion of Butte Creek and the Butte Sink. Agricultural crops include English walnuts, almonds, sunflowers, beans, prunes, rice, and peaches. The reader is referred to the chapter on land use for a more detailed account of agricultural land use.

Wetlands

The Butte Creek Watershed supports a variety of natural wetlands including freshwater marsh, slough, vernal pool, montane wet meadow, and seep. Human created wetlands stemming from irrigation ditches, canals, and reservoirs also occur. Discussion is limited to the natural and major wetland communities that occur within the watershed. Distribution of wetlands differ based upon the wetland type. Freshwater marshes and vernal pools are located in the valley or basin area of the watershed. Wet montane meadows occur in forests in the upper canyon. Riparian forests are found throughout the watershed where an ephemeral or perennial water course flows.

Freshwater Marsh

The freshwater marsh community has been severely reduced from its natural range. The decrease of the community's range is in part due to the recent increased aridity of the California climate. However, this natural process has been dwarfed by the draining of the freshwater marsh for replacement by agriculture lands, by the removal of water for irrigation, and by the diversion or retention of water by dams (Ornduff, 1974).

In the Butte Creek Watershed, freshwater marshes may be found where there is standing or slow-moving shallow water. These areas include the banks of lakes, rivers, creeks, sloughs, and ponds. The most substantial areas are found in the Butte Sink, including Gray Lodge and Sanborn Slough. Three layers of plants can be found in or along the marshes or sloughs: free floating (*Lemna* spp., duckweed), emergent (*Typha* spp., cattail), and partially to fully submerged (*Potamogeton pectinatus,* fennel-leaved pondweed).

Three genera are well represented: cattails (*Typha latifolia* and *T. domingensis*), sedges (*Carex amplifolia* and *C. praegracilis*), and rushes (*Juncus balticus* var *mexicanus and J. oxymeris*). Hard-stemmed tule (*Scirpus acutus*) is often associated with the cattails, sedges, and rushes. Cane (*Phragmites australlis*), and blue vervain (*Verbena hasta*) also are present in small amounts.

Vernal Pools

Vernal pools form associations in a variety of communities including valley grassland, blue oak woodland, and montane forest. Due to their location within these communities, the distribution of vernal pools has suffered the same fate as the communities in which they are found, namely conversion to agriculture and urbanization (Holland and Griggs, 1976).

Vernal pools are shallow depressions with impervious soils that fill with winter rain creating seasonal bodies of water. As the pools dry during spring, many native annual species complete their life cycle presenting a spectacular wildflower display and seed set. Flood inundation due to winter rains and summer desiccation due to scorching summer temperatures makes this a harsh environment. It has been suggested that the high percentage of native, annual, and endemic species located in vernal pools is due to the severe and fluctuating seasonal conditions (Zedler, 1990).

There are different kinds of vernal pools in the Butte Creek Watershed including mudflow at Parrot Ranch (Jokerst, 1990), basalt flow on Table Mountain (Jokerst, 1983), and alluvial hardpan in the Richvale pools. The Richvale pools comprise the largest known aggregation of vernal pools and are the most well documented pools in the watershed (Sanders, 1981, Schlising and Sanders, 1982, Schlising and Sanders, 1983). Each of the 120 pools is unique varying in size, depth, and species composition.

Two state listed vernal pool species found in the watershed are the rare orcuttgrass (*Orcuttia pilosa*) and the endangered Green's tuctoria (*Tuctoria greenei*). Fremont's gold fields (*Lasthenia fremontii*), Fremont's tidytips (*Layia fremontii*), Douglas' microseris (*Microseris douglasii*), white meadowfoam (*Limnanthes alba*), popcorn-flowers (*Plagiobothrys* spp.), *Downingia* spp., and *Navarretia* spp. are common associates.

Riparian Communities

Riparian forests can be found at all elevations throughout the watershed wherever perennial or ephemeral watercourse flow. There are several types of riparian communities within the Butte Creek Watershed: gravel and sand bars, willow scrub, cottonwood forest, white alder forest, and valley oak woodland. The forests are capable of mixing with and forming next to one another. The distribution of each of these series has been reduced by anthropomorphic disturbances of flood control, agriculture, and urbanization. The various types are listed.

Gravel and Sand Bars

Gravel and or sand bars form as a result of the inherent flood dynamics of a riparian system. Flood waters scour the banks gathering debris and sediment from one site and depositing them at another site. It is in these disturbed sites where early succession may begin. Native early succession or pioneering species whose seedlings may be found growing on sand and gravel bars include Fremont's cottonwood (*Populus fremontii*), a variety of willow (*Salix*) species, and many native herbs. However, these newly created openings provide a opportunity for a variety of non-native species to become established as well.

Willow Riparian Scrub

Willow scrub may form dense thickets generally along sandy creek banks in the watershed. The composition of willow species may differ throughout the watershed due to elevation differences. A representative sample of willow scrub is located in the Canyon Unit of the Butte Creek Canyon Ecological Reserve (Oswald, 1990). Willows may also form an understory in areas dominated by tree species, as is the case at the site of the Forks of Butte Hydroelectric Project (Larson and Associates, 1985). Here, arroyo willow (*Salix lasiolepis*) and other willow species form an understory in a white alder forest. Sandbar willow (*S. exigua*) and Gooding's black willow (*S. gooddingii*) are more commonly found on the valley floor where as red, yellow, and arroyo willows (*S. laevigata*, *S. lucida* ssp. *lasiandra*, and *S. lasiolepis*) can reach into the coniferous forest (Oswald, 1994).

Cottonwood Riparian Forest

The cottonwood riparian forest occurs as remnant populations on the valley floor to elevations of 3700 ft. where alluvial soils occur in low-gradient areas (Oswald, 1994). The Butte Creek Canyon Ecological Reserve supports this native plant community (Oswald, 1990). Additional species that grow in conjunction with cottonwood and its perennial water source include: box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*). Button willow *(Cephalanthus occidentalis*) and a variety of willows may comprise the understory. Since cottonwoods are found at sites where slopes are gradual and plains are broad, the cottonwood forest can be correspondingly broad (Ornduff, 1974).

White Alder Riparian Forest

The white alder (*Alnus rhombifolia*) riparian forest is found mainly along swiftly flowing and well aerated sections of waterways, and may be found from the valley floor into the reaches of the coniferous forest to an elevation of 4000 ft. (Oswald, 1994). The white alder forms a beneficial symbiotic relationship with nitrogen fixing bacteria. This relationship results in nutritionally "conditioned" soil for the associate plant species. A representative forest is present near the Forks of Butte Hydroelectric Project (Larson and Associates, 1985). Associates include: bigleaf maple (*Acer macrophyllum*), western sycamore (*Platanus racemosa*), and miner dogwood (*Cornus sessilis*).

Valley Oak Riparian Forest/Woodland

Valley oaks (*Quercus lobata*) generally do not occur immediately along the banks of rivers and streams. Instead, they stand atop terraces overlooking the floodplain as they do along Honey Run Road (Greystone, 1993) or they stand on the alluvial aggregation setback from the main watercourse. Additional valley oak forests can be seen in the Virgin Valley Unit of the Butte Creek Canyon Ecological Reserve (Oswald, 1990).

Associates of the valley oak riparian forest include: common elderberry (*Sambucus mexicana*), California wild grape (*Vitis californica*), poison oak (*Toxicodendron diversilobum*), and western sycamore.

The valley oak may extend its range out of the riparian forest and into the surrounding grassland or woodland communities, thus integrating with grassland or woodland species and creating a valley oak woodland. In woodlands where blue oak is present, valley oaks may hybridize with the blue oak. Associate species of the woodland are those species discussed below in the woodland section.

Grassland (Valley and Annual Non-native Grasslands)

Historically, valley grassland occupied large expanses of the central valley floor which includes the lower portion of the Butte Creek watershed. However due to the conversion of this deep and rich soiled grassland to agriculture, this plant community occupies only a small remnant of its former distribution (Ornduff, 1974).

Grasslands can be found at lower elevations in the watershed (Sink and Lower Creek), and they abut the eastern side of agricultural lands and the western side of the Sutter Buttes. Extant occurrences of the valley grassland community, in particular the native perennial bunchgrasses, may occur in the Butte Creek Watershed. It is most probable that bunchgrasses will occur in undisturbed areas and/or in association with non-native annual grasses.

Not only has the distribution of the valley grassland changed, but the composition of species in the remnant occurrences has also changed. Originally, many perennial bunchgrasses, such as purple needlegrass (*Nassella pulchra*), three-awns (*Aristida* spp.), bluegrasses (*Poa* spp.), wild ryes (*Elymus* spp.), and melic grasses (*Melica* spp.) comprised the composition of the valley grassland. Due to human encroachment (agriculture, grazing, urbanization) many exotic and invasive annual grasses occur: brome grasses (*Bromus* spp.), wild oats (*Avena* spp.), medusa head (*Taeniatherum captu-medusae*) or fescue (*Festuca* spp.). Therefore, the native valley grassland has been converted to human constructs as well as to a feral or ruderal annual grassland.

Two sites for which there is a detailed account of species are the Aguas Frias Bridge at Butte Creek 17 miles west of Chico and the Butte Creek Ecological Reserve 2 miles southeast of Chico. The Reserve lists a sizable amount of exotic species and no native bunchgrasses. In fact, the flora surveyed on the preserve is composed of 44.6% non-native species, a percentage much greater than that of Butte County collectively (22%) (Oswald, 1990).

Two listed CNPS species are found on the preserve: California black walnut (*Juglans hindsii*--1B listing) and shield-bracted monkey flower (*Mimulus glaucescens*--4 listing). California hibiscus (*Hibiscus lasiocarpus*), a listed sensitive species, occurs in sloughs and ditches a few miles northwest of the Aguas Frias Bridge. Narrow-leaved goosefoot (*Chenopodium desiccatum*) has not been previously found or listed in Butte County, but is reported in the management plan, and autumnal water starwart (*Callitriche hermaphroditica*) is found at only one other location in Butte County (Oswald, 1990).

Foothill and Montane Communities

Blue Oak Woodland

If an ascending easterly transect is drawn from the sink to higher elevations, the next plant community encountered is the blue oak woodland. The grassland gently transitions into this community which begins at an elevation as low as 300 feet (Ornduff, 1974) and may continue until 1600 feet (Oswald, 1994). Many of the grassland species form the majority of the ground cover in this community. However, the salient feature of the blue oak woodland is the tree species, blue oak (*Quercus douglasii)* and gray pine (*Pinus sabiniana*), which speckle the hillsides.

Although reduced from its historic distribution, considerable stands of blue oak woodland remain and are found in the Butte Creek Watershed. Although the species composition of the dominant vegetation has not changed, the ability of the blue oak to successfully reproduce mature stands is questionable (Griffen, 1971), therefore, the species character and abundance of the blue oak woodland may change as well. Several factors may play a role preventing acorns to mature: grazing and trampling by livestock, competition with exotic species especially annual grasses, and an increase of acorn harboring animals due to the decrease of their predators. In effect, this may change the future composition of the woodland by eliminating the blue oak because certain critical life stages of the plant are hindered.

Associated species include redbud (*Cercis occidentalis*), California buckeye (*Aesculus californicas*), various forbs, and the aforementioned native and non-native species discussed in the grassland community section. When adjacent to riparian habitat, valley oaks (*Quercus lobata*) may occur as an associate. Black oak (*Quercus kelloggi*) may be associated with the woodland in moister and higher-walled sites (Oswald, 1994). Chaparral species (see below) may form associates in more xeric or drier sites. A sample of this community can be seen in the lower foothills along Honey Run Road.

Foothill Chaparral

Foothill chaparral occurs in scattered sites adjacent to the foothill woodland and is found at an elevation between 400 to 5000 feet. It occurs on ridges and upper slopes where it is restricted to poor, shallow, and/or serpentine soils (Sawyer and Keeler-Wolf, 1995). The foothill chaparral community generally lacks trees and herbs, and is characterized by evergreen and sclerophyllous (hard-leaved) shrubs that may grow to 10 feet in height (Ornduff, 1974). Other identifying features of chaparral plants are small leaves, which have a low surface to volume ratio, and leaves that have a thick and waxy cuticle. These leaf features help the plants survive in a harsh environment where soils are low in important nutrients and low in water holding capacity.

Chaparral is a fire adapted community where fire plays two major roles. First, fire is important in replenishing plants dependent on periodic fires to establish germination. Second, fire recycles nutrients (i.e. rain leeching nutrients from charred wood) in this nutrient limited environment.

Associated species include: whiteleaf, common, and greenleaf manzanitas *(Arctostaphylos viscida*, *A. manzanita*, and *A. patula* respectively), chamise (*Adenostoma fasciculatum*), wedgeleaf ceanothus or buckbrush (*Ceanothus cuneatus*), tobacco brush (*C. velutinus*), mountain whitethorn (*C. cordulatus*) ocean spray (*Holodiscus discolor*) scrub oak (*Quercus berberdifolia*), and Fremont's silk tassel (*Garrya fremontii*)(Sawyer and Keeler-Wolfe, 1995). Community representatives are found near the sites of the DeSabla, Centerville, and Forks of Butte hydroelectric projects.

Montane Chaparral

Similar to the foothill chaparral community, the montane chaparral community also occurs on shallow and/or serpentine soils located along ridges and upper slopes, is fire adapted, and has members of the same genera present. However, the elevation where montane chaparral occurs is greater (2000 to 9000 feet), and therefore generally interrupts the montane forest community. The Butte Creek House Ecological Reserve is located near sites that support montane chaparral (Oswald, 1990).

Species composition between the chaparral communities differ. Species found in the montane chaparral include: greenleaf and pinemat manzanitas (*Arctostaphylos patula* and *A. nevadensis* respectively), bitter cherry (*Prunus emarginata*), and bush chinquapin (*Chrysolepis sempervirens*). Many of these species can overlap their distribution into the surrounding communities.

Montane Forest

Ponderosa Pine - Mixed Conifer Series

The landscape of the mixed ponderosa pine forest which occurs on well drained soils of all aspects has taken on a different appearance. Historically, this forest was less densely populated by ponderosa pines, but these pines had enormous girths. The landscape resembled a park-like setting where trees grew spaciously apart from one another, and the understory growth was negligible. However, due to the practices of fire suppression, logging, and/or grazing, the ponderosa pine forest has taken on a different appearance and identity. Present day appearance differs because dominant pine trees have much lesser girth and grow more densely together. In addition, a well developed and layered understory is prominent in this series (Zack, 1997). An identity change may occur because white fir, whose elevation range (3800 to 7400 feet) in part overlaps with that of the ponderosa pine (800 to 5800 feet), may become an invasive and dominant species under the aforementioned practices. This series is found at the DeSabla Centerville Hydroelectric System site (Larson and Associates, 1985) (see Issues and Concerns chapter, # 3).

Ponderosa pine can either be the sole, dominant, or a codominant species. Associated species include: douglas *fir (Pseudotsuga menziesii*), incense cedar (*Calocedrus decurrens*), and sugar pine (*Pinus lambertiana*) in the upper canopy; black oak (*Quercus kelloggii*) and canyon live oak (*Quercus chrysolepis*) in the lower canopy;

and *Ceanothus spp*. forms a shrub layer. When an herbaceous layer is present one may find Bolander's bedstraw (*Galium bolanderi*) and California brome (*Bromus carinatus*) (Sawyer and Keeler-Wolf, 1995).

Ponderosa Pine - Douglas Fir Mixed Series

In areas where granitic, schistic, or ultramafic derived soils occur, the ponderosa pine may form codominance with the douglas fir (Sawyer and Keeler-Wolf, 1995). Associate canopy species are the same as in the previously described series, therefore, differentiation between the series may be difficult.

Mixed Fir Series

The red and white fir mixed series of the montane forest boarder the upper distribution of the ponderosa pine mixed series, have a sympatic elevation distribution with one another, but differ in substrate preference (Sawyer and Keeler-Wolf, 1995). The dominant species of each series and its associates may integrate with the neighboring series, therefore, making discrete zonation unintelligible. For example, white fir (*Abies concolor*) may become an associate species in the red fir series, and jeffrey pine, sugar pine, and lodgepole pine (*Pinus jeffreyi*, *P. lambertiana*, and *P. contorta* ssp. *murrayana* respectively) overlap distribution into all three series.

The white fir mixed series may have a greater present day distribution due to its invasion into the ponderosa pine forest under current logging, grazing, and fire suppression practices (see Issues and Concerns chapter, # 3).

Coniferous Forest (Non-Mixed)

Ascending in elevation and out of the montane forest, large stands of single species dominance are encountered. The Butte Creek Watershed has three species that compose these dominant stands.

White Fir Series

This series is similar to the mixed fir series except that white fir (*Abies concolor*) is the sole or dominant tree. The stand occurs on upland slopes that have well drained soils and the range can extend up to an elevation of 7400 ft. (Sawyer and Keeler-Wolf, 1995).

Layers of the canopy may range from continuous to sparse. Associated species in each layer may include: jeffrey and ponderosa pines, sierran/bush chinquipin *(Chrysolepis sempervirens*), and pacific dogwood (*Cornus nuttallii*). Understory shrubs and herbs may include: mahala carpet (*Ceanothus prostratus*), Hooker's fairybells (*Disporum hookeri*), kellogia (*Kellogia galiodes* in dry sites), and pallid mountain monardella (*Monardella odoratissima*) (Oswald, 1994).

Red Fir Series

The red fir (*Abies magnifica*) may dominate at elevations around 6000 to 7400 feet where deep and moist soils occur (Oswald, 1994). A characteristic stand is found on northeast facing slopes near the Butte Creek House Ecological Reserve (BCHER, 1993). Associates include jeffrey and sugar pines, white fir, sierran/bush chinquipin in the canopy, and creeping snowberry (*Symphoricarpos mollis*) and bracken fern *(Pteridium aquilinum*) as ground cover.

Lodgepole Pine Series

Lodgepole pine can occur over a large elevation range and often occurs as an associate in the montane forest series. However, at higher elevations in the Butte Creek watershed, lodgepole pine can become the dominant or sole species in a stand. Lodgepole pine commonly grows on the edges of meadows, streams, and lakes (Oswald, 1994). A representative area of lodgepole pine occurs near the meadow in the Butte Creek House Ecological Reserve. According to Sawyer and Keeler-Wolf (1995), it can also grow in well drained soils on all slopes at sub-alpine elevation.

Associated species in more mesic or wetter sites include quaking aspen (*Populus tremuloides*) and red fir. In drier sites western white pine (*Pinus monticola*) and jeffrey pine may occur.

Wet Montane Meadow (wetland)

This herbaceous plant community occurs at higher elevations in the watershed. A wet meadow occurs near the headwaters of Butte Creek and is surrounded by a ridge system which extends to 7000 feet. The meadow contains riparian elements and is surrounded by coniferous forest (Butte Creek Ecological Reserve, 1993). The Butte Creek House meadow supports two species of special concern, Plumas County Penstemon *(Penstemon neotericus*) and Great Basin Brome (*Bromus polyanthus*). In addition, there are many species associated with this meadow that are of interest because they are know only from the reserve and are markedly lacking in other areas of the county with similar habitat (CDFG, 1993; Oswald, 1994). The species of interest are meadow arnica (*Arnica chamissonis*), dwarf thistle (*Cirsium foliosum* [CDFG, 1993]); *C. scariosum* [Oswald, 1994]), western hawksbeard (*Crepis occidentalis*), mountain butterweed or alpine meadow ragwort (*Senecio cymbalarioides*), vernal water starwort (*Callitriche verna*), Nuttall's monolepis (*Monolepis nuttalliana*), and short-flowered monkey flower *(Mimulus breviflorus*). Many other monkey flowers are also found along the meadow: Common or seep, Brewer's, musk, and primrose (*M. guttatus*, *M. breweri*, M. *moschatus*, *and M. primuloides* respectively). Additional meadows occur in the watershed. Notably a series of wet meadows stipples the upper watershed from Butte meadows to Jonesville (Oswald, 1994).

Sensitive Botanical Resources

Special Status Plant Categories

A plant is considered a special status species when it is protected by the California State and/or Federal Endangered Species Acts. The scientific community along with government agencies play a role in promoting the status of rare species by providing data and information which has the plant considered or qualified for a protected status.

Special Status Plant Categories include:

- Plants that are listed or are proposed for listing as either threatened or endangered under the Federal Endangered Species Act (50 CFR 17.12). Species proposed for listing can be found in various notices in the Federal Register.
- Plants that are listed or proposed for listing by California either as threatened or endangered under the California Endangered Species Act (14 CCR 670.5).
- Plants that meet the definition of rare or endangered in the California Environmental Quality Act (CEQA) guidelines (Section 15380).
- Plants that are in the California Native Plant Society's *Inventory of rare and endangered vascular plants of California* (Skinner and Pavlik, 1994) as either rare, threatened, and endangered (lists 1B and 2), plants where additional information is needed to determine their status (list 3), or plants of limited distribution (list 4).
- Plants protected under the California Native Plant Protection Act (California Fish and Game Code, Section 1900).

Special-Status Species in the Butte Creek Watershed

A review of literature, the *Natural Diversity Data Base*, *and CNPS's Inventory of Rare and Endangered Plants* was conducted to determine known or suspected occurrences of rare, endangered, and threatened species in the watershed. CNPS's inventory was reviewed to ascertain special-status species (federal, state, or CNPS listed) present in Butte county. The search resulted in a finding of 36 known or potentially occurring species (see Appendix J). The status of the species listed and a key to the abbreviations used is included in Appendix J.

Appendix J lists species' habitat in Butte County (Oswald, 1994), as well as, the county distribution of the species within the state of California (Skinner and Pavlik, 1994). Additional states where the species occur are also listed in Appendix J. Site specific information was gathered from Oswald (1994) and the Natural Diversity Data Base (1996). Quadrant codes listed for the special-status plants in the CNPS's Inventory are also noted. A listing of a plant in a quadrant which the watershed occupies does not necessarily mean the plant is in the watershed since the watershed may not fall entirely in certain quadrants. It does however indicate that a suitable environment for the species is either in or near the watershed.

The watershed spans 27 quadrangles, and special-status plants occur in 24 of the quadrangles. The quadrangles with the greatest numbers of special-status plants are Hamlin Canyon (576B), Paradise East (592D), and Cohasset (592B) with 7, 6, and 5 plants respectively.

Of the 36 special-status species, 21 occur at specific documented sites within the watershed. Some species, such as *Atriplex minuscula*, occur at a single site location, while other species, *Hibiscus lasiocarpus*, occur more commonly throughout the watershed. An additional 13 species are listed as occurring in the quadrangles that cover the watershed. Only two of the species listed, *Navarretia heteranda* and *N. subuligera*, do not fall within site specific locations or within the watershed quadrants. However, a suitable environment for these two species exists in the watershed, therefore, they do have the potential to occur within the watershed.

The freshwater marsh and vernal pool communities support a fair number of special-status species. In particular, 4 species, *Atriplex cordulata*, *A. depressa*, *A. miniscula*, and *Eleocharis parvula* are found in freshwater marshes at Gray Lodge. Five species *Chamaesyce hooveri*, *Limnanthes floccosa*, *Orcuttia pilosa*, *Navarettia heteranda*, and *Tuctoria greenei* may be found in vernal pools.

Invasive Exotic Plants

Invasive exotic plants (weeds) are those that have been introduced by humans to a site which is generally disturbed and where the plant does not occur natively (Baker, 1985). These introduced invasive plants are often able to proliferate profusely in a new environment because the controls that keep them limited in their native environment are lacking.

Invasive exotics have the ability to change community structure (species composition) as well as community function, i.e. nutrient cycling (Vitousek, 1986). In fact, some invasive species are capable of supplanting an array of species, thus creating a monospecific stand and decreasing biodiversity. If these monospecific stands do not replace the functional role of the displaced species (i.e. food source, nesting habitat, shade), habitat will be lost as well.

Areas that are most susceptible to invasion are those that are disturbed due to either natural or anthropomorphic disturbances (Orians, 1986). These disturbances create ecologically open habitats where invasive species can easily gather a foothold (Mooney et al., 1986). The habitat in the Butte Creek watershed which is most susceptible to invasive species is the riparian community. The invaluable riparian habitat has high habitat value for fisheries (erosion control, water temperature moderator, basis of food chain) and wildlife (nesting sites, breeding sites, prey refuge, etc.). However, this habitat is dually hindered by disturbance. The community experiences natural disturbance annually when winter high waters scour the banks, knocking down trees and removing vegetation. The second source of disturbance is anthropomorphic (construction, urbanization) and not limited to a specific time of year.

Considering the substantial impact invasive exotic species can have on native communities, the issue of invasive species control is not one to be taken lightly. Many federal (EPA, BLM, USDOT), state (CalTrans, Dept. of Food and Agriculture.), and local (regional parks, municipal water districts) agencies have active weed eradication protocols or programs. A list of noxious weeds recognized by the California Department of Food and Agriculture was combined with a weed list produced by the California Exotic Pest Plant Council (CalEPPC, 1997). Several of those weeds occur in the Butte Creek watershed and include: tree of heaven

(*Ailanthus altissima*), giant reed (*Arundo donax*), black mustard (*Brassica nigra*), whitetop (*Cardaria pubescens*) yellow star thistle (*Centaurea solstitialis*), Canadian thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), field bindweed (*Convolvulus arvensis*), edible fig (*Ficus carica*), black locust (*Robinia pseudoacacia*), himalayaberry (*Rubus discolor*), johnson grass (*Sorghum halepense*), and medusahead (*Taeniatherum caput-medusae*). Appendix K lists weeds, noxious or otherwise, that are known to occur in the Butte Creek Watershed.

Management Concerns

Many of the communities discussed in this report are affected by invasive species. In fact, a survey of management plans revealed that control of exotic species is a high management priority. Exotic species management often takes priority because it is coupled with other management practices or goals important in a given community. For example, grazing, especially in grasslands, is a management concern, and the timing and duration of a grazing episode may influence (increase or decrease) the amount of exotic species. Therefore, exotic species removal is problematic due to the inherent tenacity of the plant and the combined effects which may occur based on other management practices.

In contrast to exotic species removal, rare and endangered species need to be managed to ensure their conservation. Nowhere is this more apparent than in the vernal pool community. Vernal pools support a variety of plants whose fates are questionable. Concern for vernal pool species generally occurs when creating or restoring the pools for mitigation. Often newly created pool success is rated by physical characteristics: hydrology, species richness, vegetation cover, or target species. Rarely is the new pool measured to determine if the pool fulfills its functional or ecological roles: food chain support, raptor foraging site, amphibian breeding site, and endemic habitat (Ferren Jr. and Gevirtz, 1990). Monitoring must be long-term in order to ascertain that the pool is self-sustaining for all the roles it plays.

Riparian ecosystems provide the greatest opportunity to protect large areas of valuable habitat for many threatened and endangered species. CALFED has identified the Shaded Riverine Aquatic (SRA) as a primary habitat for the restoration of the Bay-Delta ecosystem and that of the tributaries. The benefits of riparian vegetation and management as a buffer system is critical to this restoration.

Benefits of Riparian Vegetation

Riparian vegetation provides a number of important ecosystem functions. It can support terrestrial and aquatic habitat. It can help to buffer the destructive potential of floodwaters. It can also help to control nonpoint source pollution.

Native plant species along a stream often provide diversity to the environment, promoting habitat for terrestrial wildlife. The extent of this benefit is dependent on the type of vegetation, the width of the band of vegetation parallel to the stream and the degree to which it forms a corridor with contiguous habitat areas. Riparian vegetation has been shown to be critical for the quality of the aquatic ecosystem as well. The shading of streams by vegetation reduces water temperature fluctuations that occur from solar warming (Beschta and Taylor, 1988; Brazier and Brown, 1973). Organic material falling from streamside vegetation, particularly from native plant species, is an important source of food for aquatic organisms (Meehan et al., 1987; Newbold et al., 1980).

Apart from providing food material (see Fisheries chapter), large woody debris has a particularly important role in protecting the aquatic environment. It provides habitat for a diversity of macroinvertebrates at densities much higher than on the stream bottom (Benke et al., 1984; Rhodes and Hubert, 1991; Sweeney, 1992). It acts to increase channel roughness, diversifying the stream environment, and supporting the development of debris jams, riffles, and pools. These structures provide fish habitat and slow down the movement of the organic matter that provides the food sources for resident aquatic populations. Gregory et al. (1987) pointed out that organic matter cannot serve as a nutritional resource for aquatic biota until it is retained within the stream channel. The presence of large woody debris in streams also reduces the bank erosion and channel straightening from the scouring of unimpeded stream flow (Oliver and Hinckley, 1987) and the destruction of aquatic habitat from the scouring effect that can occur during storm events (Dolloff et al., 1994).

However, to effectively enhance stability of the aquatic environment, woody debris must be of substantial size. Debris of large diameter is slower to decompose. In wide channels, where short pieces of material may be floated away, stability is improved by woody debris that is sufficiently long so that much of its weight is supported by ground outside the channel and so that the debris can lodge against standing trees (Swanson et al., 1984).

Removal of timber along streams has a long-term influence on the stream. Levels of allochthonous organic inputs are reduced for one or two decades, or longer at high elevations. However the quality of organic inputs may be changed for as long as 100 years after harvest of mature trees. Studies have shown that streamside trees do not provide substantial recruitment of large woody debris until they are 50-80 years old. Removal of timber along streams also may shift the composition of woody inputs from relatively decay resistant coniferous material to more rapidly decomposed deciduous material (Gregory et al., 1987). Even selective cutting of old growth along streams can significantly degrade the aquatic ecosystem by reducing inputs of large woody debris (Bisson et al., 1987).

The benefit of nonpoint-source pollution control is due to several effects of riparian vegetation. It can provide a physical barrier to the contamination of surface waters by pesticide sprays. It also provides a physical barrier to the movement of surface water, sediment, and sediment-borne chemicals running off upland fields. The vegetation can take up potential pollutants such as nitrogen and phosphorus through its roots and sequester them in the standing biomass. It also provides an abundance of organic matter in its litter that provides a substrate for microbial transformations.

Management of Riparian Buffer Systems

Compared to no riparian vegetation at all, even a narrow buffer of vegetation between surface water and intensive upland uses can have a positive effect on controlling water quality. Guidelines are available for the effective restoration and management of riparian areas. The U.S. Dept. of Agriculture-Forest Service with assistance from several other agencies produced a booklet specifying a three-zone buffer system representing increasing levels of management away from the stream (Welsch, 1991).

Zone 1 is permanent, undisturbed woody vegetation immediately adjacent to the stream bank that helps protect the aquatic ecosystem. Zone 2 is recommended as a managed forest strip that can be harvested periodically to provide income opportunities and maintain rapid rates of vegetation growth. Zone 3 is a strip of herbaceous vegetation that helps to spread out water flow from the upland area, and it can provide a useful area next to a field for maneuvering equipment and avoiding interference from the trees in Zone 2.

Riparian vegetation does not function in isolation from the upland area above it. For the reduction of pollutants reaching the stream, it is best to do as much as possible to reduce pollutants within the field. High levels of pollutants reaching riparian vegetation in concentrated flow may overwhelm the ability of a buffer to mitigate the pollution load.

Although farmers often begrudge taking land out of production, riparian buffer systems can provide alternative income opportunities. The growth of vegetation can allow for the sale of hunting rights and pulpwood in the short term and timber in the long term.

Land Use and Opportunities for Water Quality Enhancement in the Lower Watershed

The most intensive residential areas in the watershed are around Paradise, Butte Creek Canyon, south Chico, and Durham (see Map Appendix; Land Use). Much of this area is unsewered. Educational programs regarding the value of riparian vegetation should be promoted. People should be encouraged to maintain wide forested buffer areas near the creeks so as to minimize the influx of surface and subsurface pollutants and to protect stream habitat.

A large area on the east side of the watershed is rangeland. While well-managed rangeland is certainly not incompatible with healthy streams, overgrazing and excessive occupation of streamside areas by animals can seriously degrade stream quality. By causing soil compaction and loss of vegetation cover, overgrazing can aggravate erosion and subsequently increase sedimentation into streams. While riparian vegetation is important for protecting stream bank stability, the trampling caused by unrestricted access to the stream by grazing animals can destroy the stream banks, increasing erosion and impeding the emergence of riparian vegetation.

South of Chico and around Durham is a large area of orchards, largely sprinkler irrigated. Irrigation water is used conservatively, with apparently little surface or subsurface water loss. However, there is very little riparian vegetation in this area, and the orchards are mostly kept clean cultivated between the fruit and nut trees. During the winter rainy season, the presence of cover crops between orchard rows and riparian vegetation along the stream channels would greatly reduce pollution into the creek.

West and south of Durham, rice production dominates land use through much of the lower watershed (see Map Appendix; Land Use). Direct return flow of irrigation water into drainage channels circumvents some potential that riparian vegetation would have for mitigating contamination by water-borne chemicals. However, the practice of maintaining water in the fields for a period of time after the application of pesticides helps to reduce potential pollutants before the water leaves the fields (see discussion on "Pesticides" in Water Quality). What nitrates are not taken up by the rice plants, are probably rapidly denitrified in the process.

Farmers are understandably reluctant to try alternatives that would interfere with production practices. Weeds, consumption of the crops by blackbirds, and tunneling by rodents are problems that could be aggravated by allowance for increased vegetation around fields. It would seem that the growth of hedgerows on the berms (checks) between rice fields would offer an opportunity for enhancing the ecological diversity of the area for wildlife habitat. Where roads separate fields, the berms are wide enough so shrubs could be planted along the sides with less possibility for undermining by rodents.

Tailwater ponds and sloughs also offer logical possibilities for enhancing habitat and for cleaning pollutants from the water. Trees, shrubs, and marsh would allow pollutants to be sequestered in standing vegetation or to be degraded by microorganisms in the organic debris. Support for farmers to attempt this kind of habitat enhancement might be provided by mitigation opportunities. Observations of areas in the basin where wildlife habitat has been promoted have indicated an increase in raptor populations which help control rodent populations. More study is needed for methods of effectively maintaining non-crop vegetation without increasing pest problems.

The California Department of Fish and Game acquisition of the Howard Slough Unit has allowed the creation of over 4200 acres of wildlife refuge. Much of this area will be kept permanently or seasonally flooded with water draining from about 6000 to 7000 acres of rice fields. About 80 percent of this water is from the Western Canal Water District. This is a large scale example of a kind of vegetated filter strip that may serve to enhance water quality.

The concept of a large-scale vegetated filter strip is perhaps also a useful way of considering the kind of function provided by the marshlands in the Butte Sink at the south end of the watershed. Acting as a huge filter for much of the water from the upper reaches of the watershed, they may provide an important function in controlling the water quality of Butte Creek before it enters the Sacramento River.

Wildlife In The Butte Creek Watershed

The information gathered from the literature and consultations with agency personnel and experts have been used in this report to describe the historical and existing conditions of wildlife habitat and wildlife occurrences in the Butte Creek Watershed.

The condition of the wildlife populations in the Butte Creek Watershed can only be as good as the conditions of the associated habitat. To obtain a baseline for wildlife populations, wildlife values of the past are first reported. Because the watershed has diverse habitats the watershed has been divided into four sections: Butte Meadows Basin, Canyon Section, Valley Section, and Butte Basin. Each section discusses the importance of the plant communities to the wildlife populations found there. For the most part, only listed species or species of special concern are discussed. For more in depth listing of species, individual species distribution, and threats - see the table entitled "Special Status Wildlife Known or With the Potential to Occur in the Butte Creek Watershed, Butte County, California" in Appendix L.

Wildlife Values of Past Riparian and Fresh-Water Marsh Habitats

Prior felling of riparian trees in the valley section beginning in the 1860's (Thompson, 1961), has jeopardized or completely wiped out heron rookeries and riparian forest. Grazing, farming practices, levees, and diversion dams have significantly reduced the fresh-water marshlands and vernal pools which previously supported native wildlife, many of which are now extirpated, endangered, threatened or species of special concern (Holtgrieve et al., 1996).

Historical riparian forests along lower Butte Creek provided habitat for a variety of migratory and resident birds and mammals. Wider bands of historical riparian forest supported the Bald Eagle, Cooper's Hawk, Least Bell's vireo, Common yellow-throat, Long-eared owl, Purple martin, Swainson's Hawk, Warbling vireo, Western yellow-billed cuckoos, Willow flycatchers, Yellow-breasted chat, and Yellow warbler. These species formerly nested along Butte Creek and it's tributaries but now only the Swainson's hawk, Western yellow-billed cuckoo, and Yellow-breasted chat nest in scattered, isolated locations in the Lower Butte Creek watershed (CDFG, 1965).

Historical marshes in the lower Butte Creek watershed and the Butte Basin provided a rich habitat for a variety of migratory and resident birds, amphibians, and mammals. Hundreds of thousands of acres of historical freshwater marsh supported the Black tern, California black rail, Fulvous whistling duck, Great Blue heron, Great egret, Short-eared owl, Tricolored blackbird, Western least bittern, Western snowy plover, and Yellow rail. These species formerly nested in the fresh-water marshes of the Valley Section and Butte Basin but now only the Black tern, California black rail, Great Blue heron, Great egret, Tricolored blackbird nest in scattered, isolated locations in the valley and Butte Basin (CDFG, 1965).

The Llano Seco Rancho contains the largest Blue Heron Rookery for which data is known. The rookery was discovered in June 1937. A thousand nests were situated in the tops of tall cottonwood trees. At that time 400 pairs of Great Egrets, 200 pairs of Great Blue Herons, 150 pairs of Double-crested Cormorants, and 80 pairs of Black-crowned Night Herons was tallied. The herony at Llano Seco Rancho was impacted by logging operations in 1975. West of Gridley a Great Blue heron and Great egret rookery that held 600 nests was completely destroyed in the early 1950's due to tree removal (Sands, 1980). New growth riparian habitat on Rancho Llano Seco that was dominated by Elderberry and Poison Oak was logged in the early 1970's and burned in 1984; thereby, threatening the known habitat of the Tricolored Blackbird.

Wildlife Values of Past Butte Creek Canyon and Butte Meadow Basin Habitats

Prior to hydraulic mining in the early part of this century (last dredging for gold reported to be 1930), Butte Creek was in a natural state which included large stands of riparian forests that provided valuable wildlife habitat. Historical coniferous mixed forest of the Butte Meadow Basin provided habitat for a variety of migratory and resident birds, mammals, amphibians and reptiles. Increased human population in the canyon, increased recreational use of the upper watershed, timber harvest plans, and clearcutting have reduced or disturbed the habitat of the resident species.

The quiet streams and associated marshes, pools and ponds of the upper watershed provided habitat for the California red-legged frog, Cascades frog, Foothill yellow-legged frog, Mountain yellow-legged frog, and the Mountain beaver. Since the turn of the century the montane meadows of upper Butte Creek have been grazed by sheep and cattle. The livestock caused destructive impacts on riparian vegetation and amphibious habitat (Animal Species of Special Concern CDFG). The amphibious species formerly laid their eggs in the clear streams, pools, ponds and marshes of the upper watershed but the populations are now very small or localized in areas where they are now heavily invaded by exotic frogs and fishes.

Historical old-growth coniferous forest of the Butte Meadow basin provided nesting trees, snags, tree cavities and forest canopy closure for the California spotted owl, Great gray owl, Northern goshawk, Yellow warbler, and the Pacific fisher. The avian species formerly nested in the mature coniferous forest but now only the California spotted owl, Northern goshawk and the Yellow warbler nest in scattered and isolated locations of oak-conifer and mixed conifer forest. The Pacific fisher was virtually eliminated through trapping before 1940. It's elimination created a natural unbalance of porcupines as the Pacific fisher is the only predator that hunts porcupines (Mathews, 1998).

Current Status of Special Status Wildlife Populations

Butte Meadows Basin

The mixed conifer forest of the Butte Meadows basin supports over three hundred animal species. The upper tributaries of Colby, Willow, Jones and Bolt Creek connect with Butte Creek in the Butte Meadows Basin. These tributaries, with their associated meadows, wet swales, and seasonal ponds, provide critical breeding habitat for amphibians such as the California red-legged frog (*Rana aurora draytonii*), Cascades frog (*Rana cascadae*), Foothill yellow-legged frog (*Rana boylei*), and Mountain yellow-legged frog (*Rana muscosa*). Cattle grazing still occurs in the wet montane meadow areas of the Butte Meadow Basin. Some areas, where a creek flows through the meadows, have been fenced off from cattle to create a riparian buffer zone between the creek and meadows. As these riparian strips become naturally vegetated they will provide protective cover for wildlife attracted to the available surface water.

Avian species of special status known to occur in the mixed conifer forest of the upper Butte Creek Watershed include California spotted owl (*Strix occidentalis occidentalis*), Cooper's Hawk (*Accipter cooperi*), Great Gray Owl (*Strix nebulosa*), Merlin (*Falco columbarius*), Northern goshawk (*Accipiter gentilis*), Osprey (*Pandion haliaetus*), Purple martin (*Proque subis*), Sharp-shinned hawk (*Accipiter striatus*), Vaux's swift (*Chaetura vauxi*), and Yellow Warbler (*Dendroica petechia*). For more information see Appendix L.

The abundance of water in the upper Butte Creek Watershed enhances the value of the Douglas fir mixed conifer forest for wildlife. The composite mosaic of streams, Douglas fir mixed conifer forest, Ponderosa pine mixed conifer series, chaparral, meadow and oak woodland in the upper watershed enhances the wildlife habitat through its wide variety of habitats and ecotones.

The wildlife value of the mixed conifer forest varies with the degree of canopy cover, density, and the diversity of understory plant species present. The highest wildlife diversity and abundance occurs where the vegetation is highly stratified; the stratification offers a greater variety of niches for wildlife species. The intergrade between Douglas fir mixed conifer forest or pine mixed conifer with scrub communities creates a mosaic that is highly stratified and of high value to wildlife.

Significant habitat features include the presence of cavity bearing trees. Mature forests bear natural cavities that are vital resources for cavity-nesting birds and small animals. Mature forests typically contain snags which are valuable resources for woodpeckers as they prefer dead trees and limbs for excavation of roost and nest sites. Woodpeckers carve out a new domicile each year making their former homes available to secondary cavity-nesting species such as chickadees and wrens.

Great horned owls and Western screech owls nest in mixed conifer forest and prey on rodents that are active at night. Species of special status that are diurnal raptors in this habitat include the Golden Eagle (*Aquila chrysaetos*), Cooper's Hawk (*Accipiter cooperii*), Northern Goshawk (*Accipiter gentilis*), and Sharp-shinned Hawk (*Accipiter straitus*). These raptors feed primarily on small mammals or other birds, while golden eagles may take larger prey. The Snowshoe hare (*Lepus americanus tahoensis*), is a crucial staple in winter diet of several predators, including the Sierra red fox (*Vulpes mulpes necator*), great horned owls, bobcats and Pacific fishers (*Martes pennanti pacifica*).

Another significant feature of the mixed conifer forest is the abundance of fallen woody debris. The woody debris adds structural complexity to the forest habitat, and is important as cover, nesting, roosting, and foraging substrate for wildlife. Downed wood helps moderate arid conditions and creates micro-climates suitable for amphibians and reptiles. The downed woody debris provides suitable breeding and cover sites for several amphibious species such as the Ensatina Salamander (*Ensatina eschscholtzi*). Aquatic breeding species such as the Sierra newt (*Taricha torosa sierrae*), typically spend their terrestrial existence in rodent burrows but may also take refuge under woody debris in adjacent forests. A high diversity of reptiles is due to the abundant prey and cover by understory vegetation and fallen woody debris. Representative species that prefer the moist, wooded drainage bottoms include garter snakes, Common Kingsnakes (*Lampropeltis getulus*), and Ringneck Snakes (*Diadophis punctatus*).

Representative mammal species that utilize both the Douglas fir mixed conifer forest or Ponderosa pine mixed conifer forest habitats include the Virginia Opossum (*Didelphis virginiana*), Deer Mouse (*Peromyscus maniculatus*), Western Gray Squirrel *(Sciurus griscus*), Bobcat (*Lynx rufus*), Gray Fox (*Urocyon cinereoargenteus*), Striped Skunk (*Mephitis mephitis*), Mountain Lion (*Felis concolor*), Black Bear (*Ursus americanus*), and many bat species.

White fir forest provides excellent habitat for snag and cavity dwelling species. It also provides foraging habitat for insect-gleaning birds such as Western Tanager (*Piranga ludonciana*), Chestnut-backed Chickadee (*Parus rufescens*), Mountain Chickadee (*Parus gambeli*), Golden-crowned Kinglet (*Regulus satrapa*), and Yellow warbler (*Dendroica petechia),* a State species of special concern.

Red fir forest habitats are significant to many species of special concern including; Northern Goshawk (*Accipiter gentilis*), Great Gray Owl (*Strix nebulosa*), Sierra Nevada Red Fox (*Vulpes v. necator*), and Marten (*Martes americana*). The Red fir habitat is also associated as habitat for the Wolverine (*Gulo luscus*).

Wildlife species in Butte Meadows Basin suffer stress from logging practices, pesticide use, road construction, livestock grazing and off-road vehicles -- particularly in meadows, riparian areas, streams and lakes (CDFG, 1993). Predation by, and competition with, the exotic bull frog threatens the Cascades frog, California red-legged frog, the Foothill yellow-legged frog and the Mountain yellow-legged frog. Human recreation in the area also causes stress as some species, such as the Western pond turtles are sensitive to human presence (CDFG, 1993). Avian species are threatened by direct and indirect human disturbances at nest sites. Forested nesting areas of the Great gray owl have been destroyed by logging. Meadow foraging areas for this State endangered species have been lost to, or damaged by, reservoirs, grazing, roads, and buildings. Numerous avian species, such as the Merlin, Northern goshawk and Northern harrier, are still being impacted by DDT, along with other threats including: exposure to toxic substances, hunting (sometimes illegal), trapping, fishing and collision (CDFG, 1993).

Canyon Section

The canyon section of the Butte Creek Watershed is a mix of Early Successional Riparian Gravel and Sand Bars, Mixed Riparian Forest, Cottonwood Riparian Forest, White Alder Riparian Forest, Riparian Scrub, Blue

Oak-Foothill Pine Woodlands, Valley Oak Woodland, Willow Scrub and Mixed Conifer Forest communities. These communities provide a complex mosaic of habitat and ecotones.

Riparian communities offer some of the highest level of wildlife species diversity and abundance in California. The factors that contribute to the high wildlife value include the abundance of plant growth, the presence of surface water, and the variety of niches provided by the high structural complexity of the habitat. Riparian habitat is used by wildlife for food, water, nesting, thermal cover, escape cover, migration, and dispersal corridors.

Mature Valley Oak mixed with cottonwood occurs in the lower canyon adjacent to or overlapping with the riparian corridor. This habitat is particularly valuable to wildlife due to the close proximity of water and the dense undergrowth of willow, wild grape, blackberry and elderberry. The dense understory is habitat for such species as the Ash-throated Flycatcher (*Myiarchus cinerascens*), swallows, Bushtits (*Psaltriparus minimus*), Osprey (*Pandion haliaetus*), American Goldfinch (*Carduelis tristis*), and Black Phoebe (*Sayornis nigricans*).

Streamside pools and low-flow shallows provide breeding habitat for Sierra Newts (*Taricha torosa sierrae*), and Pacific Treefrogs *(Hyla regilla)*. Other amphibian species such as the California Slender Salamander (*Batrachoseps attenuatus*), utilize moist, terrestrial habitats underneath fallen logs and woodland debris for breeding and refuge. Common reptile species that utilize aquatic habitat for foraging or escape cover include the Western Aquatic Garter Snake (*Thamnophis counchi*), Western Terrestrial Garter Snake (*Thamnophis elegans*), and Western Skink (*Eumeces skiltonianus*).

The deciduous trees found along the riparian corridor attract insects in abundance which create areas especially suitable for neo-tropical migrants who feed on numerous insects to replenish their migratory fat reserves. Examples of neo-tropical migrants include such species as Wilson's Warbler (*Wilsonia pusilla*), Warbling Vireo (*Vireo gilvus*), and American Redstart (*Setophaga ruticilla).* Residents that are more abundant in riparian habitats than in adjacent forests include the Winter Wren (*Troglodytes troglodytes*), Song Sparrow (*Melospiza melodia*), and Swainson's Thrush (*Catharus ustulatus*). The nearshore areas of the creek are utilized by American Dipper (*Cinclus mexicanus*), Belted Kingfisher (*Ceryle alcyon*), herons and other waterfowl. Red-shouldered Hawks (*Buteo lineatus*), utilize riparian trees for nesting while swifts, swallows and flycatchers can be found hawking their insect prey over water.

Mammals such as skunks, raccoons, opossums, Ringtail (*Bassariscus astutus*), Longtail Weasel (*Mustela frenata*), Gray Fox (*Urocyon cinereoargenteus*), Mountain Lion (*Felis concolor*), and Bobcat (*Lynx rufus*) are likely to drink from the creeks and forage on insects, amphibians and rodents. The riparian habitat provides movement corridors and water sources for Colombian Black-tailed Deer (*Odocoileus hemionus columbianus*), and birds. Bats that are associated with riparian forests include California Myotis (*Myotis californicus*), Fringed Myotis (*Myotis thysanodes*), and Long-eared Myotis (*Myotis evotis*).

Successional riparian river rock beds are dry rock beds in the river channel, deposited by the meandering effect at high water flows. During the summer months these areas frequently contain calm, shallow, backwater pools as the water levels drop and water becomes restricted to the main channel flow. Western Spadefoot Toads (*Scaphiopus hammondi*), and their tadpoles utilize these back water pools. The warmer water temperature associated with calm, shallow water and the presence of algal growth create areas that are good for Pacific tree frog reproduction. Herons, skunks and raccoons forage for stranded fish, tree frogs and tree frog tadpoles in these areas.

Rock bars with sandy patches exposed are often colonized by willows, mulefat, sticky monkey flowers and other flowering plants. Hummingbirds forage from sticky monkey flowers until the next high water event. The hot micro-climate of the rocks combined with deposits of woody debris from the river provides basking habitat for heat seeking reptiles such as Northern Alligator Lizard (*Gerrhonotus coeruleus*), Common Garter Snake (*Thamnophis sirtalis*), and Northwestern Pond Turtles (*Clemmys m. marmorata*).

The Blue Oak-Foothill Pine Woodlands of the Butte Creek Watershed lack an understory of mix of age class which is typical of oak habitats statewide and is thought to be a result of management practices such as flood and fire suppression, and overgrazing which suppress oaks from regenerating (Pavlik, et al., 1991). Oak woodlands are critical habitats for the conservation of many mammal and bird species. Significant habitat features include acorn production and the presence of cavity-bearing trees. As a seasonal food, acorns are important for survival of numerous species of wildlife in the fall and winter. The mammals and birds that are dependent on acorns as a seasonal food source include deer, woodpeckers, Black Bears (*Ursus americanus*), Western Gray Squirrels *(Sciurus griscus*), Wild Turkeys (*Meleagris gallopayo*), Northern Flickers (*Colaptes auratus*), Scrub Jays (*Aphelocoma coerulecscens*), Band-tailed Doves (*Columba fasciata*), and California Quails (*Callipepla californica*). Scrub jays, Western gray squirrels and California Ground Squirrels (*Citellus beechevi*), bury acorns which are more likely to germinate because they root better and are less likely to be eaten by other species.

Cavity-nesting birds and small mammals depend on the natural cavities associated with mature oak trees. Mature oak trees often have broken limbs that contain some degree of decay which birds and mammals can then excavate for nest and roost sites. These cavities receive high levels of use by woodpeckers and secondary cavity-nesting birds such as owls, Tree Swallow (*Tachvcineta bicolor*), Violet-green Swallow (*Tachvcineta thalassins),* and Purple Martin (*Progne subis*), a state and federal species of special concern.

The insects associated with oaks are preyed upon by several avian species such as Bushtits, Kinglets (*Regulus* spp.) and warblers. California Towhee (*Piplio crissalis*), and sparrows forage for insects on the ground under the oaks.

Wildlife species in the Canyon section suffer stress from human presence, harassment and disturbance which have caused loss of habitat by the human population expansion into nesting and feeding areas. Illegal shooting and reproductive failures due to food chain contamination by pesticides also cause the loss of wildlife in this section. The most sensitive species in this section are the Northwestern Pond Turtles, American Peregrine Falcon, American White Pelican and the Greater Sandhill Crane (CDFG, 1965).

Valley Section

In the valley section of the Butte Creek Watershed there are only a few fragmented sections of remaining mixed and Valley Oak riparian forest. Southeast of Chico where Butte Creek crosses Highway 99 is the “Virgin Valley Riparian Area” used by California State University, Chico for educational purposes (NDDB, 1995). The mature forest extends up Butte Creek on the mine tailings. Another small fragment of great Valley Oak riparian forest is located approximately three miles south of Durham. This forest is a long, disturbed corridor that is suffering from continued clearing and agricultural conversion threats. South of Biggs is a Valley Oak dominant riparian forest fragment where Swainson’s hawk (*Buteo swainsoni*) are known to nest. Another great valley mixed riparian forest fragment is on Butte Creek west of Richvale and is used for a gun club (NDDB, 1995).

Valley riparian forests support a high diversity of breeding birds; 67 species are known to nest in the forests of the Sacramento Valley. This high diversity seems to depend on foliage volume and foliage height profile. Most birds (84%) nest above ground in woody vegetation with a high percentage (41%) utilizing tree holes or cavities. Hole-nesting species show superior success as compared to open-nesting species both in hatching eggs and fledging young. This is due to the greater security tree holes provide from nest predators, such as squirrels, raccoons and jays. Tree holes are in short supply limiting the density of cavity-nesting birds. The erection of nest boxes and other artificial nesting facilities can increase the riparian forest bird population by 25-fold.

Riparian forests provide nesting and breeding sites for nine species of water birds which forage in surrounding marsh and riverine habitats. The Osprey (*Pandion haliaetus*), is a fish-eating raptor that builds its bulky stick nests in trees near the rivers where they hunt. Two species of waterfowl, Wood Duck and Common Merganser, raise their young in tree-cavities. Riparian forests are of particular importance for the colonial nesting rookeries of the Great Blue Heron (*Ardea herodias*), Great egret (*Casmerodisus albus*), Snowy Egret (*Egretta thula*), Black-crowned Night Heron (*Nycticorax nycticorax*), and Double-crested Cormorant *(Phalacrocorax auritus).*

The State and Federal endangered and threatened species occurring in the valley riparian section of the Butte Creek Watershed are Valley elderberry longhorn beetle (*Desmoecerus californicus dimorphus*), Conservancy fairy shrimp (*Branchinecta conservatio)*, Vernal pool fairy shrimp (*Branchinecta lynchie*), Vernal pool tadpole shrimp (*Lepidurus packardi)*, Greater Sandhill Crane (*Gus canaensis tabida*), Swainson's Hawk (*Buteo swainsoni*), Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), and Willow Flycatcher (*Empidonax traillii*). Only one community of Valley elderberry shrubs, which provide habitat to support valley elderberry longhorn beetles, has been located along Comanche Creek. Species of special concern occurring in the riparian forest fragments of Butte Creek Watershed include the Long-eared owl (*Asio otus*), and Yellow-breasted chat (*Icteria virens*).

The stress on wildlife in this section is the loss of vernal pools and temporary ponds, loss of riparian areas, loss of marshes, loss of woodlands, loss of grasslands, bank disturbance, toxic pesticides, water quality deterioration, illegal killing, and collisions (CDFG, 1994). The loss of riparian area has caused the decrease in the Valley Elderberry longhorn beetle. The status of the Giant Garter snake was caused by the loss of habitat from filling of sloughs and drainage of marshes. This State and Federal threatened snake is also impacted by water quality deterioration, destroyed food sources, snakes collectors, and illegal killing. The State threatened status of the Swainson's Hawk was caused by loss of grassland (foraging) and woodland (nesting) habitats primarily to agricultural and urban land use conversion. Pesticides and rodenticides are additional problems.

Butte Basin

The Central Valley of California is one of the most important waterfowl wintering areas in the Pacific flyway and the Butte Sink is one of the most significant wetlands of the Central Valley. The Butte Sink is very large (about 11,000 acres), and provides a variety of wildlife communities in its riparian forest corridors, and seasonally and permanently flooded wetlands. Since 1914 rice growers have drained water from their fields into the Butte Sink. In 1922 (Kerhoulas), an agreement was made to provide for the perpetual flowage of drainwater from the Western Canal to 7,700 acres of duck clubs, returning the land to marsh habitat and making the land unfarmable. Wildlife species found in the basin include waterfowl guilds, shorebird guilds, and riparian wildlife guilds. Generally, the wildlife populations in the Butte Basin are healthy.

Seasonally flooded wetlands are prevalent through the lower portions of the basin and are extremely important habitat areas for waterfowl, shorebird, an wading bird guilds. The riparian and riverine aquatic habitat is important for aquatic and terrestrial species. Healthy riparian vegetation provides a migration corridor that connects the mainstem Sacramento River with the habitats of the upper Butte Creek Watershed. This corridor is used by terrestrial species, such as birds and mammals.

The freshwater marshes of the Butte Basin are of great value to terrestrial wildlife as the surface water provides water for drinking. The freshwater marshes are excellent breeding areas for the Black tern (*Chlidonias niger*), Marsh wrens (*Cistothorus palustris*), Red-winged Blackbird (*Agelaius phoeniceus*), Western Pond Turtle (*Clemmys marmorata*), and Sierra Newt (*Taricha torosa sierrae*). The freshwater marshes also provide foraging habitat for the Belted Kingfisher (*Ceryle alcyon*), Black-crowned Night Heron (*Nycticorax nycticorax*), Great blue heron (*Ardea herodias*), Great egret (*Casmerodisus albus*), Green-backed Heron (*Butorides striatus*), and the Northern harrier (*Cicus cyaneus*). Federal and State listed species found in the freshwater marshes of Butte Sink include the Giant garter snake (*Thamnophis counchi gigas*), Aleutian Canada Goose (*Branta canadenis leucopareia*), California black rail (*Laterallus jamicenis coturniculus*), and Greater Sandhill Crane (*Grus canaensis tabida*). The Fulvuous whistling duck (*Dendrocygna bicolor*), was once common in the Butte Sink but is now apparently extirpated, the Harlequin duck (*Histrionicus histrionicus*) is most likely no longer breeding in the Sink and is only a rare winter resident, and though the Tricolored blackbird (*Agelatus tricolor*) occurs here, no nesting sites have been observed. Species of special concern still occurring in the Butte Sink marshes are the Western least bittern (*Ixobrychus exilis hesperis*), White-faced ibis (*Plegadis chihi*), and Yellow rail (*Coturnicops noveboracensis*).

Vernal pools in the Butte Sink are habitats for several species of special concern and are of high wildlife value for waterfowl, shore birds, mammals, predatory birds, reptiles and amphibians. The Western spadefoot toad

(*Scaphiopus hammondii*) breeds in the vernal pools, and the only known occurrence of the California tiger salamander (*Ambystoma californiense*) was observed in a vernal pool at Graylodge. The vernal pools are used for watering holes for numerous mammals and as foraging, and nesting areas for various birds. Small rodent populations particularly rely on the presence of vernal pools for seasonal water such as the Deer mouse, Blacktailed hare, and Valley pocket gopher. Migratory waterfowl and shorebirds feed on the invertebrate and amphibian species of the vernal pools.

The riparian forests are valuable because they support a high density and diversity of wildlife species and because they are a diminishing resource. These areas provide potential habitat for Federal and State listed species such as the Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), and Willow flycatcher (*Empidonax traillii*); and species of special concern such as the Yellow-breasted chat (*Icteria virens*). The above species along with the Red-shouldered hawk, and Blue Grosbeak (*Guiraca caerulea*) breed in no other forest habitat.

The preservation of dead trees and snags is an important consideration for the management of riparian forest habitat for bird populations. Most of the tree-hole nesting sites in riparian forests are excavated by woodpeckers such as the Downey Woodpecker (*Picoides pubescens*), in the soft wood of dead, decaying trees and snags. Since woodpeckers carve out a new domicile each year, their former homes are available to other cavity-nesting species.

By late summer, the riparian forests provide the only lush, insect-rich forest habitat in the lowland as the long dry period has seared the surroundings to golden brown. The importance of riparian forests to southward (fall) migrants cannot be underestimated.

Stressors to the habitats and species in the Basin include insufficient flow in the lower portions of most of the streams, and inadequate riparian vegetation. Diversions for flooding State and Federal Refuges, and private duck clubs, cause the insufficient flow of the lower portions of the streams. While the wildlife refuges and hunting clubs dependent on Butte Creek water provide some of the most valuable wildlife and waterfowl habitat in the Sacramento Valley, the timing of water needs sometimes conflicts among duck clubs, agriculture and anadromous fisheries (CALFED, 1997).

The California Tiger Salamander suffers from loss of vernal pools and other seasonal water sources that are required for viable breeding. The status of the Giant garter snake was largely caused by the filling of sloughs and drainage of marshes; they are also affected by destroyed food sources and snake collectors. The loss of inland wetlands by filling and drainage, along with stream channelization, continues to threaten the California Black rail (Flores and Edelman, 1995). Pressures of hunting, DDT, and other toxics cause problems for the Fulvous whistling duck, Great Blue Heron, Great Egret and the Greater Sandhill Crane. The status of the Western Yellow-billed cuckoo was apparently caused by DDT contamination and pesticide use (Gaines and Layman, 1984). This neotropical bird also suffers stress from the loss and degradation of riparian habitat that is vital to reproduction.

Threats by Exotic Species

Brown-headed Cowbirds (*Molothrus ater*), arrived to the valley ~1900, and with the spread of irrigated agriculture they arrived in flocks (Gaines and Layman, 1984). The spread of agriculture has allowed the cowbirds to penetrate into new regions where they have access to host populations that have had little or no ancestral experience through which to develop effective defenses against them. In the breeding season, cowbirds invade riparian forest habitat, where they burden other species with the task of incubating their eggs and raising their young. Since cowbirds reproduce ferociously, not having to feed their young, a single female can lay as many as 50 eggs in a breeding season. The decline of Willow Flycatcher (*Empidonax traillii*), Bell's Vireo (*Vireo bellii*), Warbling Vireo (*Vireo gilvus*), Yellow Warbler (*Dendroica petechia*) and Common Yellowthroat (*Geothlypis trichas*), in the Butte Creek Watershed has been partially attributed to cowbird parasitism. Once a female cowbird lays her eggs in the nests of vireos, warblers, or other susceptible hosts, she takes no further interest in her progeny. The hosts hatch her eggs and raise her young at the expense of some of their own brood. Some researchers point out that cowbirds are not the primary threat to endangered songbirds--humans are (Dunaief, 1995). The least Bell's vireo, for example, has lost 95 percent of its habitat to farms and other human uses. Restoring habitat, most researchers agree, is the only long-term solution to the songbirds' woes. It would help them directly, by giving them breeding space, and indirectly, by taking that space from cowbirds.

Bullfrogs (*Rana catesbeiana*) are an exotic species that exerts differential effects on native amphibians including Foothill yellow-legged frog (*Rana boylii*), Mountain yellow-legged frog (*Rana muscosa*), Red-legged frog (*Rana aurora draytonii*), Cascades frog (*Rana cascadae*), Pacific Treefrog (*Hyla regilla*), and Sierra Newt (*Taricha torosa sierrae*). Bullfrogs prey on adult frogs, tadpoles and eggmasses of the above species in the Butte Meadows Basin and Canyon sections. The competition from large overwintering bullfrog larvae significantly decrease survivorship and growth of native tadpoles. Studies have shown that bullfrog tadpoles have the potential to cause a 48% reduction in survivorship of Foothill yellow-legged frog, and a 24% decline in mass at metamorphosis. The bullfrog has smaller effects on Pacific treefrogs; a 16% reduction in metamorph size and no significant effect on survivorship.

Threatened and Endangered Species

Valley Elderberry Longhorn Beetle (*Desmoecerus californicus dimorpus*). The Valley elderberry longhorn beetle is a Federally threatened species. This beetle is a pithbore on elderberry shrub (*Sambucus* spp.) in riparian habitats. Recent information has demonstrated that the beetle are found only in elderberry stems 1 inch or greater in diameter (CDFG, 1994). Valley elderberry shrubs are sporadically located along riparian habitats in the Valley section and elsewhere.

Conservancy Fairy Shrimp (*Branchinecta conservatio*). The Conservancy Fairy Shrimp was listed as an Federally endangered species along with several other crustaceans in September 1994. Several possible causes of extinction include urban development, agricultural land conversions, and the isolation of individual populations among a small number of vernal pools. Vernal pool habitat was once much more extensive throughout California's Central Valley, probably allowing a much broader distribution of the species. Vernal pools, temporary ponds formed by seasonal rainfall upon small watersheds, provide the sole habitat for the fairy shrimp. A water impermeable layer just below the surface of the ground assures the collection of water during the winter, while the drying effects of Spring cause a complete drydown of the pool by evapotranspiration. The fairy shrimp survives the hot, dry summer by depositing drought resistant "resting eggs" or cysts in the pond soil. The crustaceans represent a food resource for water birds, and birds may possibly disperse the shrimp's cysts on their bodies over their migratory route; the cysts may also be transported within the avian digestive tract. Population densities within individual ephemeral pools may be quite high. Fairy shrimp do not inhabit lakes which may have predatory fish and offer no seasonal dry downs for their reproductive cycle. Occurrence of the Conservancy fairy shrimp has been observed at the lower end of Comanche Creek (Valley section), in a freshwater emergent marsh in a low-lying depression within the streambed caused by the backup of water to due a beaver dam.

Vernal Pool Fairy Shrimp (*Branchinecta lynchie*). The Vernal Pool Fairy Shrimp is a Federally threatened species. In California these crustaceans inhabit ephemeral wetlands, such as vernal pools, mountain meadows, and desert playas with wet/dry cycles. The shrimps hatch and mature during the aquatic phase and deposit dormant cysts that remain in the soil through the dry phase. In some habitats, due to the variable nature of local rainfall patterns, pools at times fill only partially and dry quickly before the shrimp are able to mature and reproduce. Species in such unpredictable environments produce cysts that do not all hatch when first hydrated; a portion remain dormant and hatch in later pool fillings. Occurrence of the Vernal pool fairy shrimp was observed in a freshwater emergent marsh in the Spring of 1996 on Comanche Creek west of Hwy. 99, Valley section.

Vernal Pool Tadpole Shrimp (*Lepidurus packardi*). The Vernal Pool Tadpole Shrimp is a Federally endangered species. This shrimp exclusively inhabits vernal ponds in Northern California, and is present 4 out of 5 months that the ponds are flooded. They are often found in shallow depressions in open, treeless range land that is frequented by livestock and migrating water fowl. The margins of ponds may vary from cobbly hardpan to soft clay mud, with some areas receiving strong wave actions from prevailing winds. Tadpole shrimp are often present in the greatest abundance along wave disturbed shores. They are basically detritivores and their preference may be attributed to the accumulation of pond detritus at those locations. Occurrence in the Butte Creek Watershed was observed in a freshwater emergent marsh in Comanche Creek, west of Hwy. 99, Valley section.

California Red-legged Frog (*Rana aurora draytonii*). The California red-legged frog is a Federally threatened species and a State species of special concern. This species is found in quiet pools along streams, in marshes, and ponds. Red-legged frogs are closely tied to aquatic environments and favor intermittent streams which include some areas with intact emergent or shoreline vegetation, and a lack of non-exotic bullfrogs and non-native fishes. They are generally found on streams having a small drainage area and low gradient. The breeding season for this frog spans from January to April when females deposit 1,000-4,000 eggs on submerged vegetation at or near the surface. Introduced predators are a primary threat to this species. It has also been found that this species is showing declines in populations due to UVB sensitivity, especially on the eggs, which are potentially the most UVB-sensitive stage (Hays et al., 1996). The red-legged frog is a year-round resident of Butte Creek House Ecological Reserve located in the Butte Meadows Basin.

Cascades Frog (*Rana cascadae*). The Cascades frog is a State endangered species that is a year round resident of upper Butte Creek. They are mountain frogs that are closely restricted to water, and frequent small streams, potholes in meadows, ponds and lakes. They are found in the water or among grass, ferns and other low herbaceous growth. They are a rather slow moving frog that will often allow close approach. When frightened they will usually attempt to escape via swimming rather than seeking refuge at the bottom of the stream, pond or lake. The U.S. Forest Service has constructed riparian fencing to protect the Cascades frog on Colby Creek. This population of Cascades frog is the southernmost population in the Cascades. The Rough-skinned newt (*Taricha granulosa*) is a predator of the Cascades frog tadpole.

The Cascades frog is also declining due to UVB radiation. A lab study was made with Cascade frogs where tadpoles were raised to maturity and were supplemented with modest levels of UV light or light filtered to remove UVB wavelengths. Observations revealed severe effects of both UVA and UVB light on tadpoles and metamorphs; this included developmental abnormalities and high mortalities.

Foothill Yellow-legged Frog (*Rana boylei*) The Foothill yellow-legged frog is a Federal threatened species and a State species of special concern. It is found in or near rocky streams in a variety of habitats, including valley foothill hardwood, valley-foothill riparian, coastal scrub, mixed conifer, mixed chaparral, and wet meadows. This species is very closely tied to its aquatic habitat and is rarely found far from perennial or intermittent streams. Foothill yellow-legged frogs are typically found in shallow water of partly shaded streams. Adults seek moving but usually not swiftly flowing water. Pools are used on intermittent streams during the dry season. Breeding takes place from mid-March to early June. The female attaches grape-like clusters of eggs to gravel or rocks in moving water near stream margins. The Foothill yellow-legged frog has been observed at the Butte Creek House Ecological Preserve. The Butte Meadows Basin is a unique area where both the Mountain yellow-legged frog and the Foothill yellow-legged frog can be found.

Giant Garter Snake (*Thamnophis counchi gigas*). The Giant Garter Snake is a Federal and State threatened species. They are aquatic in habit, historically they were found in colonies in tule patches. They are extremely alert and timid. They inhabit irrigation canals that are usually about 15 feet wide, with nearly vertical banks and a current of slightly turbid water several feet deep. The wariness of these snakes is probably correlated with their open habitat. Water is usually shallow in this habitat; rocks and logs are absent both under water and along shores; trees and bushes are absent along the edge of the water, and the snakes are not screened from view from above. Under these conditions they are in constant danger from herons, marsh hawks, and other predatory birds which might drop down upon them or seek them out in the shallow water. The Giant garter snake has been observed in the northern portion of Butte Sink, Little Dry Creek, Upper Butte Basin Wildlife Area, Butte Creek at McPherrin Dam, and at the Rancho Llano Seco.

Aleutian Canada Goose (*Branta canadensis leucopareia*). The Aleutian Canada Goose is a Federally threatened species that was once listed as endangered. A stunning and unexpected recovery in populations of

Canada geese began 30 years ago when there were just a few thousand of them in all of North America. Today, there are more than 1.5 million of Aleutian Canada Geese. These geese hatch anywhere from five to eight young a year. In some areas, state and wildlife officials are trying to reduce numbers by addling (shaking to prevent hatching), eggs, moving goslings to game preserves, or killing adult birds. While resident geese flourish, some migratory populations are shrinking dramatically (Waytiuk, 1996). One Atlantic group of migratory birds now has just 29,000 breeding pairs which is a 27 percent drop from the year before and a dramatic tumble of 75 percent from 1988 numbers. The resident birds do not mix with migratory flocks that stop over twice each year on their way north or south. The two populations, genetically identical, refuse to interbreed. It has something to do with the pair-bonding as Canada geese mostly mate for life, and they choose from their own area. Currently migratory populations are protected from hunters, but the U.S. Fish and Wildlife Service has resorted to issuing kill permits on resident flocks. The Aleutian Canada Goose migrates to the Butte Sink in October and usually migrates south in December.

<u>American Peregrine Falcon</u> (*Falco peregrinus anatum*). The American Peregrine Falcon is a Federal and State endangered species. Peregrine falcons are infrequently found from annual grassland up through high elevation coniferous forest of the Coast Range. They typically require cliffs for nesting and perching, and prefer nearby lakes or rivers. The most common hunting method of Peregrine falcons is a low surprise attack initiated from a high perch; Peregrines can make up to three kills per day. During courtship the males are physically dominated by the females in landed interactions. The males bring prey to make contact easier with their mate. Until fledging size, the possibility of a male reaching the young depends on the female's control; males transfer food to the females in order to give food to the young. During the 1960s and early 1970s populations of Peregrine falcons drastically declined but indications from studies in Baja to Canada suggest that the local populations are recovering (Castellanos, et al., 1997). In Canada the natural productivity was high at 1.0-2.9 young per territorial pair. The high natural productivity and large releases of captive-raised young should continue the recovery of the Peregrine falcon. The American peregrine falcon is infrequently seen throughout the Butte Creek Watershed but is of regular occurrence from September to October.

<u>Bank Swallow</u> (*Riparia riparia*). The Bank swallow is a State threatened species. This swallow prefers to breed in colonies in earthen banks. The extent of protected, earthen banks and potential bank swallow habitat along Lower Butte Creek and its tributaries is not known, but suitable nesting sites for this species could be present. Protecting banks from disturbance could benefit this species.

<u>California Black Rail</u> (*Laterallus jamicenis coturniculus*). The California Black Rail is a State threatened species and an endangered species in Arizona. The use of habitat is not sufficiently well known for effective management. Studies have observed that California black rails select areas close to upland vegetation during the postbreeding season, possibly because broods cannot use areas with water greater than 6 cm deep. Habitat structure is more effective than plant composition in predicting use of habitat. California black rails may not use areas within wetlands where deep water occurs necessitating the minimization of fluctuations in water level in wetlands managed for the rail. Habitat should include not only vegetational cover, but also water depths within wetlands, access to upland vegetation, and overhead coverage by emergent vegetation. A few adults have been observed north of Sutter Buttes and northeast of Sanborn Slough at Butte Creek.

<u>Greater Sandhill Crane</u> (*Grus canaensis tabida*). The Greater Sandhill Crane is a State threatened species. This crane migrates to California wintering areas in October and November. Habitat improvement increases crane nesting success but brood survival can generally decline and recruitment will be low if the habitat is not managed for predator control. The mean clutch size for cranes in California is 1.91 which is generally similar to the mean clutch size in other states. Since 1986, recruitment has declined ranging from 3.4 to 6.5%. Presently, populations are stable or slightly decreasing. Even though other mortality factors are prevalent in Oregon and California, the most important population limitation appears to be low annual recruitment. With high predation on eggs by Common Ravens, raccoons, and coyotes, and losses of young to coyotes, few young fledge. Due to the longevity and deferred breeding age of adult Greater Sandhill Cranes, a decline in breeding pairs may not occur for a number of years. With the attrition of older breeders, pairs can drop abruptly, many years after declining recruitment is first recorded (Littlefield, 1995). This indicates that caution is warranted when an increased mortality factor is introduced into Sandhill crane populations, as it may take a number of years before higher mortality results in a decrease in breeding adults. Greater Sandhill Cranes usually arrive to

the Butte Sink Basin September 10-20. While at the Wild Duck Goose Club a Sandhill crane was observed in the marsh on September 29, 1997.

Great Gray Owl (*Strix nebulosa*). The Great Gray Owl is a State endangered species. The Great Gray owl have likely been stable over the past 10-100+ years, though local populations fluctuate in response to food supply and/or nest-site availability. Breeding Great Gray Owls require pre-existing nest structures in forest stands that are adjacent to open foraging habitat, preferably with hunting perches. Current forestry practices have the potential to affect about 75% of the Great Gray Owls' breeding range. Intensive timber management typically removes large diameter and deformed nest trees, leaning trees used by juveniles for roosting before they can fly, and stands with dense canopy closure used by juveniles and adults for cover and protection. Specific recommended guidelines include restriction of harvest unit size, but within a mosaic of multi-sized units, retention of forest stands with 300 m of known or potential nest trees/sites, provision of hunting perches in cut-over areas, ensuring irregularly shaped harvest units, and maintenance of forested travel corridors between cut-over areas (Duncan, 1997). Great Gray Owls can breed on home ranges up to 800 km apart in successive years. There have been isolated observations of the Great Gray owl in the Butte Meadows and Stirling City regions.

Swainson's Hawk (*Buteo swainsoni*). The Swainson's Hawk is a State threatened species. This hawk prefers a nest in the crown of tall oaks and riparian trees, and forages in nearby grassland and agricultural lands. Swainson's Hawk nest sites have been observed along Butte Creek south of Durham. Ongoing enhancement of riparian habitats in the watershed could benefit Swainson's Hawk.

A study was made of the Swainson's Hawk in Butte Valley from 1984-94. This study monitored the annual occupancy, reproductive performance, and natal dispersal of 567 Swainson's hawks banded as nestlings. The mean annual nest success was 65%, and the annual fledging rate was 1.53 young per nest attempt. The dispersal distances from natal site to subsequent breeding site ranged from 0-18.1 km with a mean of 8.2 km. Another study was conducted along the Sacramento River in 1992 where four adult Swainson's hawks were radiotagged. The mean home range was found to be greater than 4,000 ha and core areas of intensive use by nesting Swainson's hawks ranged from 25.9-82.2 ha. Individual hawks foraged as far as 2.5 km from the nest. A third study mapped 162 observations of Swainson's hawk in five years of surveys. This study found that Swainson's hawks in the Sacramento Valley preferred riparian habitat, grassland, alfalfa stands of greater than two years, and annual field crops. In the Butte Creek Watershed the Swainson's hawk is found throughout the lower watershed west of Hwy. 99.

Western Snowy Plover (*Charadrius alexadrinus nivosus*). The Western Snowy Plover is a State endangered species. Snowy plovers have biparental incubation duties, but only males care for broods. Most females depart immediately after nests hatch. Female site fidelity seems to be affected by the nesting success in the previous year. Females have been known to avoid areas with high densities of nests which may be an anti-predator strategy. Most nest failures are apparently caused by mammalian predators. The Western snowy plover is rare in the Butte Creek Watershed and may not occur annually.

Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) The Western Yellow-billed cuckoo is a U.S. Forest Service Sensitive species and a State endangered species. Riparian forests are the habitat which host this endangered species. They are restricted to broad expanses of cottonwood-willow forest. The wide removal of this essential habitat has caused the decline of this sinuous bird (Gaines and Layman, 1984). Western yellow-billed cuckoos historically nested on Butte Creek along the Butte Glenn County border, Little Butte Creek marsh and Butte Sink. The habitat at Little Butte Creek Marsh is predominately tule-bulrush marsh, with islands of riparian habitat which was in very good condition at a sighting in 1980. There are currently sparse breeding populations in the riparian areas of Butte Creek along the Butte and Glenn County borders, in the Little Butte Creek Marsh, and Butte Sink.

Willow Flycatcher (*Empidonax trailii*). The Willow flycatcher is State endangered species. This flycatcher was considered to be a very common summer resident in the riparian willow habitat of central California, especially along the valley rivers in 1890. Breeding Willow flycatchers have vanished from almost all of their former riparian forest haunts in the valleys of California. Willow flycatchers prefer riparian willow habitat where they can replenish their fat stores, with an average body mass gain of 1.6%/day, as they migrate between their breeding and wintering grounds. The Willow flycatcher is a Spring (April-May), and Fall (August-September), migratory transient of the Butte Creek Watershed. Because of the loss of riparian habitat in the valley the Willow flycatcher now only nests in the upland areas of the watershed (Sands, 1980).

Wolverine (*Gulo gulo luscus*). The Wolverine is a State threatened species that was denied Federal threatened status in April 1995 due to the animals rarity and mysterious nature; Fish and Wildlife claimed that there was not enough information to warrant listing. The fierce and much-feared wolverine once roamed most of North America, but has been driven back to remote areas of the Pacific Northwest and Canada, and very little is known of its location, diet or habits. Habitat destruction and trapping have reduced North America's most touted predator. A few survivors have retreated to make a last stand in remote mountains and far-northern strongholds, but biologists are not even sure where they are; extensive searches have turned up mostly inconclusive flashes of fur and blurred snowprints deep in the woods. Their ranges may be the truest maps of our few remaining wild places.

Wolverines are not little wolves, in fact they are a larger cousin of otters, weasel and skunks. They seem most at home in snowy, hostile places--deep conifer forests, tundra, above-treeline mountain tops, and Arctic ice floes. They are thinly spread and probably slow to reproduce. Wolverines are expert swimmers, diggers, and tree climbers that roam when other animals flee south, or go into hibernation. They are the ultimate scavenger, and they depend on wolves, bears and the rare human hunter to do their kill for them where they can sneak in for leftovers. They kill porcupines and hares and have been observed in the summer eating mushrooms, berries, bird eggs, and wasp larvae.

The last specimen of a California wolverine was taken in 1925, near Yosemite National Park, yet hikers keep reporting wolverine-like creature and tracks in the high Sierra Nevada. Some of the sightings are credible, and since 1991 California scientists and volunteers have used bait and motion-sensing cameras in an attempt to prove the animals presence but have so far not been successful. The wolverine has a range as big as 770 square miles. They give birth in the winter where there is deep isolation and persistent snow. They seem to exist only in areas with remote, undisturbed sites for denning and wide corridors for dispersal. When wild places are disturbed, wolverines are the first to be extinguished. The wolverine may be the best indicator that an ecosystem is intact or not. Once gone, wolverines do not seem to come back from adjoining refuges, whether because of slow reproduction and dispersal or some other, unknown factor. There have been unsubstantiated sightings of the Wolverine in the Humbug Summit-Philbrook area.

Management Concerns

The Butte Creek Watershed contains populations of seven species listed as endangered, 12 species listed as threatened, and 50 species of special concern or those under federal protection. To protect these fragile populations, and to stop the further listing of other species, the protection of intact natural resources is vital, and restoration of degraded resources is necessary.

In the Butte Meadows Basin the Cascades frog (SE), California red-legged frog (FT), Foothill yellow-legged frog (FT), and the Mountain yellow-legged frog all need further protection. The Great gray owl (FS, SE), requires the preservation of meadows for foraging which have been lost or damaged by logging, grazing and roads. This owl requires old growth, coniferous forest that border meadows; a large meadow system for foraging, and old growth forest for nesting. There are other species in this Basin who have basically the same requirements. The California spotted owl (FS, SC), requires late successional forest, including snags that are near water. The Northern goshawk (FS, SC), prefers to nest near water on a north slope of late successional forest and require a mix of different forest age classes and forest structures for foraging and nesting. The Sierra red fox (FS, T), requires Red fir and Lodgepole pine forests that are associated with montane meadows.

In the Canyon section greater protection is needed for the American peregrine falcon (FE, SE) who suffer stress from human presence, harassment and disturbance in nesting and feeding areas as they lay their eggs on bare ground or cliffs. This endangered falcon also suffers from reproductive failures due to food chain contamination by pesticides.

In the Valley section, the lower end of Comanche Creek (west of Hwy. 99, where Comanche Creek crosses the south end of the industrial zone of Chico), is in need of protection. At this site is a fresh water emergent marsh that is important habitat for the Giant Garter snake (FT, ST), Northwestern pond turtle and the Western spadefoot toad. The protection of this site (acquisition or conservation easement) is significant as the status of the Giant Garter snake was caused by the loss of habitat from filling of sloughs and drainage of marshes. In the same area along Comanche Creek are found Valley elderberry shrubs that provide critical habitat for the Valley elderberry longhorn beetle. This riparian habitat also needs protection. This is of importance as the loss of riparian areas (>90%) and Valley elderberry habitat has caused the decrease in the Valley Elderberry longhorn beetle. The Swainson's Hawk (ST), has been observed several times, in the ten year period between 1984 and 1994, on Butte Creek, NE of Durnel Road and about four miles south of Durham. The nest tree is presumed to be a Fremont cottonwood on private land on the south levee of Butte Creek. A Tricolored blackbird (FSC) colony has been observed along Seven-Mile Lane, north Nelson West Road, NE of Butte City. In 1985 about 5000 pairs were observed over several acres of cattails and tules. This is important marsh habitat that should be protected.

In the Butte Basin hunting and human harassment is a significant local problem for the Greater Sandhill Crane (ST) (CDFG, 1993). As more than half of the California population of this crane occur in Butte County, during the fall and early winter, it is significant that crane associated habitat (roost in shallowly flooded marshes, forage in grain fields) be preserved. The habitat within the watershed for the Greater Sandhill Crane is principally west of Hwy. 99 near Durham, to Rancho Llano Seco, and the Nelson area down to Butte Sink. The Western Yellow-billed cuckoo (SE), population has been declining drastically, therefore; it is critical that cuckoo habitat is protected. Within the watershed only one observance (NDDB, 1995), occurred, July 1977, in Butte Sink, east and west of Butte Creek. This neotropical bird also requires riparian habitat reproduction. A continuous riparian corridor (1/4 to 1 mile wide), along Butte Creek is vital in the preservation of this bird and other species, such as the Yellow-breasted chat.

Fisheries And Aquatic Resources

A Brief Historic Perspective

"Historically many small creeks and sloughs were braided throughout the Sacramento Valley floor. Some creeks ended in lower depressed "sinks" (Butte Sink) and did not join the main network of the Sacramento River except during floods. Sedimentation and scouring associated with frequent flooding created mosaics of natural levees, abandoned channels, sinks, lowland swamps, and hummooks over the otherwise relatively flat flood plains. The extent of these flood plains varied from a few hundred meters to several kilometers wide. Riparian forests were formerly present adjacent to rivers and creeks. Sloughs, oxbows, and meander scars were interspersed within riparian forests (Lapham et al., 1909; Keller, 1997; Thompson, 1961; and Katibah, 1984; and Scott and Marquis, 1984; in Heitmeyer et al., 1988).

Clark (1929) stated that there was only a fall-run in Butte Creek, "as the water is very low and warm in the summer." At that time (1928) so much water was being diverted from the stream during most of the summer and fall that the fall-run was stated by Clark to have been "almost destroyed." However, it appears that Clark did not fully recognize that the flow conditions he observed in the summer and fall, while detrimental to the fall-run or to any salmon that might be present in the lower creek, did not preclude the existence of the spring-run.

According to Hanson et al. (1940), Butte Creek reportedly was "a very fine salmon stream in the past" but was no longer suitable for salmon due to extensive mining and hydroelectric development that had occurred in the watershed.

Fry (1961) noted that Butte Creek had a spring-run but "almost no fall-run", setting it apart from most small streams in the north Sacramento Valley which had mainly fall-runs. The many removable dams on the creek blocked or reduced flows late into the fall, and fall-run fish could not surmount them. He reported that the spring-run ranged from <500 to 3,000 fish during the period 1953-1959.

Hallock and Van Woert conducted a study of Butte Creek Diversions for salmon losses. They concluded "that screens are necessary to protect them (adult salmon)" (Hallock and Van Woert, 1959) (see Issues and Concerns chapter, #2).

As late as 1960, the spring-run numbered > 6,700 in Butte Creek, with smaller numbers of fall and late-fall fish (Mahoney, 1962). More recent annual estimates of spring run numbers range from < 10 in 1979 (Reavis, 1981) to > 7,500 in 1995 (Pers. com., Kathy Hill, 1997).

Prior to 1965, Butte Creek supported an average of about 2,500 spring-run Chinook salmon (Flint and Meyer, 1977); however, through 1991, an average of only 349 (14% of 2500) spring-run Chinook salmon have spawned in the creek (Brown, 1993).

Flint and Meyer (1977) also spoke of a late-fall-run which "migrates up Butte Creek in January-February and spawns immediately after arriving at the spawning beds." Flint and Meyer (1977) noted that "the unimpaired reach of Butte Creek above (the Butte Head dam) produced about 2,500 trout per mile." But that the population was "drastically less" in the reach from Butte Head Dam to Forks of Butte. This was due to diversion at Butte Head Dam which, after spring-run off reduced Butte Creek to a series of warm, barely connected pools. Trout production fell off there to about 50 per mile (Flint and Meyer, 1977).

PG&E employees at one time reported salmonids past the site (the Centerville Head Dam) to areas upstream. It is not known if they were salmon or steelhead.

Hydraulic Mining Impacts

The belt of hydraulic mining traversed most of the Sierra Nevada west side drainages to the Sacramento and upper San Joaquin valleys. Between 1850 and 1885, hydraulic mining washed tons of silt, sand, and gravel into the Sacramento River and its tributaries. The mining debris, composed of clay, sand, gravel, and cobbles, washed downstream during high flows (Reynolds et. al., 1993).

The unrestricted use of hydraulic mining in the river drainages along the eastern edge of the Central Valley was extremely damaging to the stability of stream systems and habitat for anadromous fish. Riparian areas were destroyed and sediment and fines washed directly into the creek.

The State Supreme Court in 1884 upheld a suit against the hydraulic mining interest filed on behalf of agricultural interest. That decision was the beginning of the end for hydraulic mining, but extensive damage had already occurred. On Butte Creek, hundreds of acres of stream and floodplain gravel had been hydraulically mined, each area gone over at least once and in some cases 3 times (Colman, 1972). A USGS map from 1951 shows hydraulic tailings in Butte Creek covering 488 acres, probably much less than what originally was evident.

Historic Wetlands

"Each watercourse on the flat Sacramento Valley floor... flowed on an elevated platform, built up by silt the streams deposited in their own beds. As floodwaters periodically overtopped the stream banks and spread out over the Valley floor, natural levees were built up, ... from these more elevated locations paralleling the watercourses, floodwaters flowed down to pond in wide shallow basins lying between the streams. The ponds in these basins created a vast inland sea... which slowly drained into the river channels. In their lowest elevations where the water ponded longest these basins contained immense swamps of tules" (Kelley, 1989)

The extent of wetlands in the Sacramento Valley is not entirely known, but probably exceeded 1,482,000 acres (Heitmeter et al., 1988). Seventy-five percent of these were riparian forests and flooded tule marshes

(Heitmeter et al., 1988). Along the Sacramento and San Joaquin Rivers permanently flooded marshes consisted primarily of cattails, bullrushes and pondweeds. These marshes, ponds and stream channels were generally bordered by stands of riparian woodlands in various successional stages (Reynolds et al., 1993) Most recently, there are an estimated 291,000 acres of seasonal or permanent wetlands in the Central Valley. In addition to this acreage, post harvest flooding of 79,000 acres of rice, corn, and wheat fields provides additional habitat for waterfowl and migratory water birds (Heitmeyer et al., 1988). Additional acreage of seasonally flooded rice fields have been added since 1988. These fields provide an energy source for waterfowl and other animals in the waste grain (344-388 kg/hectare) (Miller and Wylie, 1996). Permanent wetlands with uplands provide moist soil seeds, invertebrates, forage, tubers, and nesting and brood rearing habitats as well (Heitmeter et al., 1988).

Based on gill-net catch data for the Sacramento-San Joaquin rivers, it has been estimated that the peak Chinook salmon runs in the Sacramento River system may have been as large as 800,000 to 1 million fish, with an average run size of about 600,000 fish prior to 1915. By 1960, salmon habitat in the Sacramento-San Joaquin river watersheds had been substantially reduced. The streams had either been dammed, blocking migration, or they had been so severely degraded that they were barely usable by salmon. Speaking of Butte Creek, Clark (1929) stated "the creek was formerly one of the best salmon streams, but because of irrigation dams and low water the run has been almost destroyed."

Stream Habitat Conditions

Riparian Habitat and Large Woody Debris

"The stream and its living creatures are directly and inexorably linked to the adjacent riparian zone, and in reality should all be thought of as part of a larger interacting system or environment that includes both an aquatic instream portion and an adjacent terrestrial riparian portion" (Reynolds et al., 1993).

Riparian vegetation moderates temperature in Butte Creek, shade or lack of it can increase temperature by 11.7º - 18º Farenheit (Reynolds et al., 1993). Vegetation protects stream banks from erosion by reducing velocities and binding soil particles. It increases deposition of silt during floods, enables willows and cottonwoods to reproduce, provides substrate material for aquatic insects, and provides escape and resting cover for fish species (Reynolds et al., 1993).

Riparian areas and forests supply large woody debris such as tree trunks with their rootwads attached or tree branches greater than eight inches in diameter. This wood supplies partially processed food and becomes continually smaller as it travels down Butte Creek's stream system. Woody food is mostly litter, such as leaves, needles, cones, twigs, bark, and wood and provides energy to stream organisms. Large trunks of old trees require special regard because they enter streams infrequently (barring drought kill). Trunks and rootwads are somewhat slow moving and physically shape smaller streams. Large wood is biologically processed and broken down in place, unless it is flushed downstream in a rare debris torrent, such as occurred in some headwater streams in the January 1997 flood event.

Debris moves fastest through the stream system during flood events (such as the 1986 and 1997 storms) and is not completely processed at any one spot. This is true to the extent that the stream has enough in-stream obstacles to slow the water and act as areas of deposition, sieving the incompletely processed organic debris out of the current. Small headwater streams feed organic debris to larger streams and larger streams feed still larger ones in Butte Creek's Watershed.

In small streams that flow through older forests, a large proportion of the basic food for invertebrates is derived from leaves and wood. Wood is 50 to 70 percent of the total organic debris available to microbes and invertebrates in small streams, including very fine particles derived almost exclusively from the massive trunks of trees (Maser and Sedell, 1994).

The greatest forest influence is in first-order streams, but the greatest diversity of both debris inputs from riparian areas and habitats is found in the third to fifth-order segments of Butte Creek, and the segments of Butte Creek with flood plains. The quantity (pieces/mile) and quality of large woody debris in Butte Creek is unknown. Stream surveys can determine quantity and quality. Numerical comparisions can then be made with similar stream types in more pristine areas.

Habitat Value of Pools

Deep pools offer fish a better chance of escaping terrestrial predators. They also allow coexisting species of fish and/or fish of the same species but of different ages to live in layers within the pool. (see Figure 6.1). Pools created by wood dams are often characterized by deep, slow-moving water, low light intensity, and complex cover afforded by root masses deeply undercut banks, and large sunken wood. They have the highest use by juvenile Coho and Chinook near the water's surface, brown trout along the bottom, and steelhead trout more than a year old at the upstream head of the pool.

Good rearing habitat for salmonids consists of pools and riffles (in a 50/50 ratio), adequate cover, and food (mostly macroinvertebrates), water temperatures between 40ºF and 60ºF during the summer, dissolved oxygen at saturation (Reiser and Bjornn, 1979). Butte Creek's pool/riffle ratio is probably much less than 50/50 thus limiting rearing area.

The greater the amount of wood in a stream, the greater the number of pools. Around 80 percent of the pools in some small streams are created by large wood (Sedell, 1988). A lack of pools in Butte Creek can be due in part to a lack of large woody debris. A habitat study is needed to confirm or deny this.

In first through third order streams, single pieces of large wood or accumulations of wood often create a stair-stepped, longitudinal profile (step pools). Such pools consist of debris dams with an upstream depositional area, the woody dam itself, a waterfall and a large plunge pool scoured by falling water. Logs can tie up significant sediment. Above one step pool on a 2nd order tributary of Little Chico Creek a 3 foot diameter log backs up approximately eight feet of sediment.

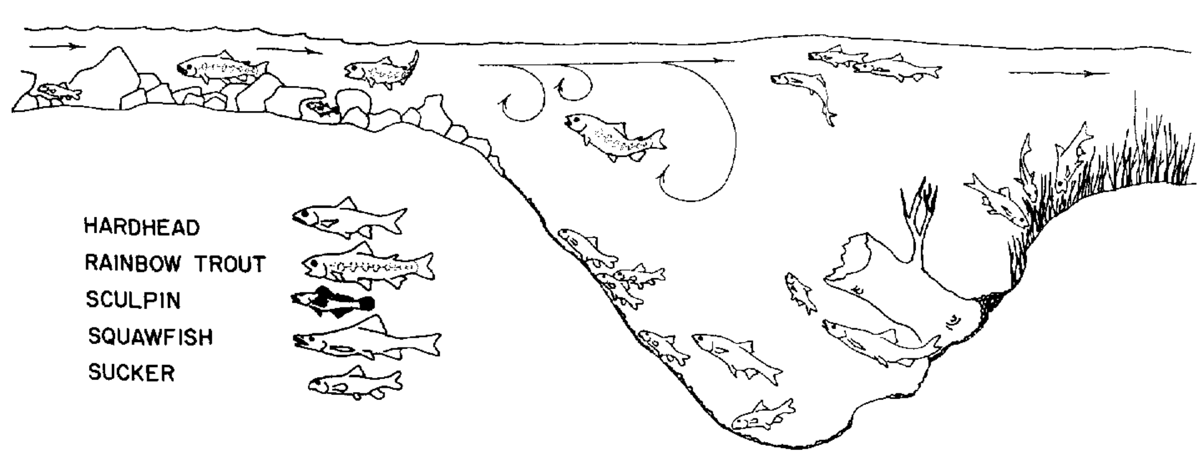


Figure 6.1

How fish species locate themselves in a typical pool.
(From Moyle, 1976)

Pools are inhabited by mayflies, whose nymphal stage feeds on algae, leaves that fall into the water and sink, and fungal mycelia. Also in the pool are immature dragonflies, stoneflies, caddisflies, and wood-eating craneflies. All species prefer pools during the normal winter flow, but the preference level is determined by the quality of a pool. Pool quality is often determined by the abundance of wood. The more wood, the more fish use a pool. During winter floods, the pool-riffle sequence of a stream's stepped profile becomes a continuous, high-velocity torrent in which there is often little protection for trout and salmon from the moving sediments or swift, turbulent waters (see Figure 6.2).

Fishes of Butte Creek

For a complete listing of fish species found in Butte Creek see Table 6.1. For a summary description of fish species found in Butte Creek refer to Appendix M.

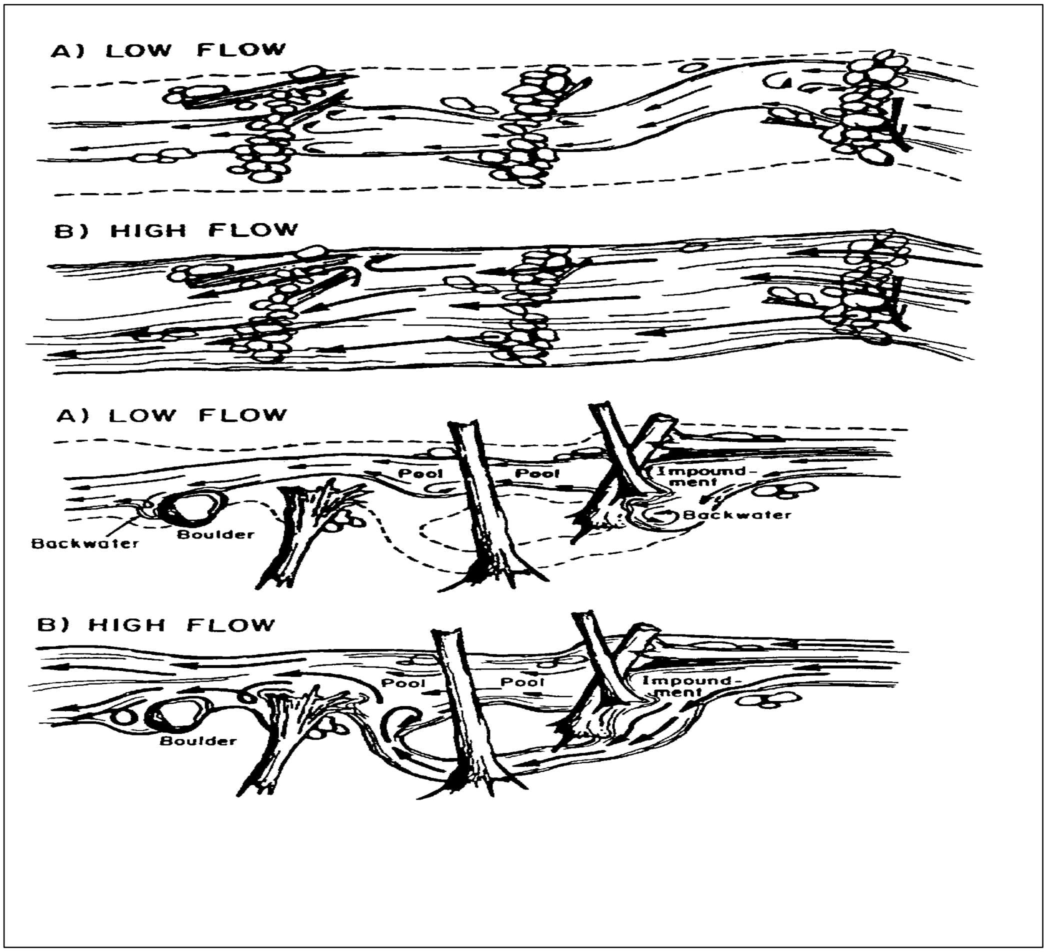


Figure 6.2

During floods, quiet water refuges are provided almost exclusively by anchored wood and standing vegetation in a stream's floodplain.

Table 6.1
The Fishes Of Butte Creek

Common Name	Scientific Name
Pacific lamprey	*Lampetra tridentata*
Pacific brook lamprey	*Lampetra pacifica*
Chinook salmon	*Oncorhynchus tshawytscha*
Rainbow trout	*Oncorhynchus mykiss*
Steelhead rainbow trout	*Oncorhynchus mykiss*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Hitch	*Lavinia exilicauda*
California roach	*Hesperoleucus symmetricus*
Hardhead	*Mylopharodon conocephalus*
Sacramento squawfish	*Ptychocheilus grandis*
Speckled dace	*Rhinichthys osculus*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Carp	*Cyprinus carpio*
Sacramento sucker	*Catostomus occidentalis*
Black bullhead	*Ictalurus melas*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Mosquitofish	*Gambusia affinis*
Threespine stickleback	Gasterosteus aculeatus
Bluegill	*Lepomis macrochirus*
Redear sunfish	*Lepomis microlophus*
Green sunfish	*Lepomis cyanellus*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Largemouth bass	*Micropterus salmoides*
Smallmouth bass	*Micropterus dolomicui*
Spotted bass	*Micropterus punctulatus*
Bigscale logperch	*Percina marcolepida*
Tule perch	*Hystcrocarpus traski*
Prickly sculpin	*Cottus asper*
Riffle sculpin	*Cottus gulosus*

(Moyle, 1976, Brown, 1992b). For descriptions of species see Appendix M.

Wood creates and maintains a physically diverse habitat by (1) anchoring the position of pools along a channel, (2) creating backwaters along a stream's margin, (3) forming secondary channels in valley floors filled with sediments deposited by the stream, and (4) varying channel depth. Thus, fallen trees create new stream habitats (Sedell, 1998).

Aquatic Insects-Fish Food

Butte Creek and it's tributaries contain diverse communities of fish, invertebrates, plankton, amphibians, hydrophytes (water lovers), and vertebrates. The abundance and structure of biological communities found in stream systems are a reflection of past and present conditions and interactions. Butte Creek's floodplain and its aquatic system are intimately connected. Solar energy converted by terrestrial plants through photosynthesis, enters the stream by two paths. Primary Path: direct input of leaf litter and other plant material (especially important in headwater reaches). Secondary Path: Organic material enters the stream by excretion by organisms that consume plant material and deposit of terrestrial organisms into streams. Aquatic organisms and plants are also consumed by terrestrial organisms and vice versa.

The aquatic insect feeding group composition varies from the headwaters to medium sized streams and large rivers due to changes in nutrient availability and utilization. This stream continuum includes the available food resources for the animals inhabiting it, ranging from invertebrates, to fish, birds, and mammals. A critical role is played by streamside vegetation in the control of water temperature, stabilization of water temperature and stream banks, and food production (Reynolds et al., 1993).

Productivity in Butte Creek is determined by the amount of energy and nutrients entering it from the terrestrial system, as well as the amount of energy produced within the stream. The nutrient flow in the stream is highly variable and dependent on the biological and physical qualities, and seasons of Butte Creek. For example, in the fall there are more leaves in the creek for processing by aquatic insects; in the summer there is more sunlight available for algae and diatoms and in the spring there is a greater movement of nutrients through the system due to increased water flows. Changes in annual rainfall, temperatures, etc., also lead to variations in nutrient flow.

A critical factor is the degree to which Butte Creek has access to its flood plain/riparian areas where fines drop out and organic matter can be picked up and deposited. Flood plain interactions are also useful for absorbing stream energy, indeed the complexity of a number of Butte Creek's ecosystem niches are dependent on flood plain access.

Salmon Life Histories

Spring-run Chinook salmon

Spring-run Chinook salmon (*Oncorhynchus tshawytscha*) have an unusual life history pattern in that they migrate into Butte Creek during March - June (CDFG, 1993). They over-summer primarily in pools from the confluence of Little Butte Creek to the Centerville Head Dam, and begin spawning late September to early October. Unlike spring-runs in Deer and Mill Creeks, spring-run in Butte Creek presently spawn in the lower part of the creek at relatively low elevation (less than 1,130 ft) where they are hindered by the "Quartz Bowl", a natural barrier, and blocked by the Centerville Head Dam. Cramer and Demko (1997) state that "the warmer temperatures of Butte Creek during fall and winter at the elevation where spawning occurs would favor survival of a later spawning stock". It is apparent that Butte Creek's spawning and rearing waters are somewhat warmer than Deer or Mill Creek.

Although the spring-run in Butte Creek migrates and spawns at similar times as spring-run in other streams, it seems to be somewhat different in that the fry emerge in December, most of these fry migrate out immediately while others migrate out in the spring (Reynolds et al., 1993). The remaining fraction remains in the stream until the following fall (1 year after they had been spawned) (SNEP, Vol.3). This is in contrast to the pattern seen where spring-run fish spawn as well in colder, higher elevation reaches (i.e., Mill and Deer Creeks). There fry remain in the streams to migrate out starting in January, and as late as March. At higher elevations, under most conditions, fry remain to migrate out in February of the following year as juveniles. Recent evidence also shows that under some conditions Mill and Deer Creek spring-run migrate as fry (Pers. com., Ward, CDFG, 1998).

Studies conducted during 1993-96 provide substantial information on timing and stage of development of salmon out migrants. Rotary screw traps were used to capture spring-run fish near Chico and in lower Butte Creek within Sutter Bypass during the September to June timeframe. Starting in 1995, juveniles have been tagged using coded wire tags to provide information on downstream migration and adult returns (Baracco, 1997).

Spawning takes place during the last week in September to mid-October based on twelve years of record (Hill, 1997). The majority of fish spawn upstream from the Parrott-Phelan Diversion located a few miles west of Chico. Peak spawning density occurs from the upper limit of migration, below Centerville Head Dam and the Quartz Bowl pool (elevation 1,130 ft. at Quartz Bowl) downstream to the Covered Bridge (elevation 400 ft), a distance of about 10 miles. In Butte Creek, there is some spatial and time overlap in spawning of fall and spring-run salmon in some years (Hill, 1997; Cramer and Demko, 1997).

Generally, adequate migration flow exists to the Western Canal Dam; however, during some years there are several areas above Western Canal where the majority of water is diverted, thus causing passage problems. With the new M&T Agreement an additional 40 cfs will be left in the creek so passage problems are reduced (pers.com., Ward, 1998).

Based upon results of the 1993-96 studies, it appears juveniles emigrate from Upper Butte Creek predominantly as fry from mid-December through March. A lesser number of smolts emigrates March - June and yearlings emigrate the following October through January (Baracco, 1996). Substantial numbers of both Butte Creek and non-Butte Creek juveniles were found to use the Sutter Bypass for emigration. Data from juveniles tagged in Butte Creek canyon (at Parrott-Phelan Dam) shows that they can reach the Bypass in less than two weeks. Juveniles grew rapidly. In 1996, tagged fish were recaptured in the Delta as early as April 2, with one recaptured at Chipps Island as late as June 3 (Baracco, 1996).

Spring-Run Chinook Salmon Population

Butte Creek supported a maximum of 6,700 spring-run Chinook salmon up to 1960 (see Table 6.2). As late as the 1960's, a run of over 4,000 adults was reported. Currently, the spring-run numbers has reported fewer than 200 adults. This represents over a 95 percent decline in the past 30 years. CDFG population estimates and PG&E fish surveys indicate that few adult spring-run salmon reach upper Butte Creek, where excellent flow, temperature, and habitat conditions are available. Between 1983 and 1985, DFG attempted to restore the spring-run by planting surplus fry from the Feather River Hatchery. In 1988, 1,300 adult spring-run salmon returned to Butte Creek to spawn, most probably a result of the hatchery release. Estimated spawning success was estimated at about 50 - 60% in Butte Creek in 1989 (Campbell and Moyle, 1992). CDFG calculated a mean run size of 500 fish (1980-1989). Butte Creek recently had the highest return of spawners ever observed at 7,500 in 1995 (Cramer and Demko, 1997).

Table 6.2
Estimates of spawning spring-run Chinook salmon in Butte Creek, 1956-1997.

Year	Number	Year	Number
1956	3,000	1977	100**
1957	2,192	1978	128
1958	1,100	1979	10
1959	500	1980	226
1960	6,700	1981	250
1961	3,100	1982	534
1962	1,750	1983	50
1963	6,100	1984	23
1964	600	1985	254
1965	1,000	1986	1,371
1966	80	1987	14
1967	180	1988	1,300
1968	280	1989	1,300
1969	830	1990	100
1970	285	1991	100
1971	470	1992	730
1972	150	1993	650
1973	300	1994	474
1974	150	1995	7,500
1975	650	1996	1,413
1976	46	1997	635

** 388 spawning adults from Red Bluff Diversion Dam were released (Hoopaugh,1979)
(Information from: Fry, Gerstung and Ward, CDFG)

Fall-Run Chinook Salmon

Adult fall-run chinook salmon enter lower Butte Creek from late September into early October, and often into November. Several barriers exist which impede the adult migration until high flows occur. Spawning generally occurs from October through December. Some spawn in late October but most spawning occurs in mid-November. Most fall-run Chinook salmon spawn in the area predominately below Durham Mutual Dam to the Western Canal siphon (Pers. com., Ward, 1998), although they are known to spawn above Adams Dam during some years. Fall-run fry begin to emigrate in January and February and continue through April to May. However, juveniles are often entrained at diversions (Brown, 1993).

Fall-Run Chinook Salmon Population

CDFG has estimated that fall-run population varies between a few to as many as 1,000 (Brown, 1993; Reynolds et al., 1993).

Late-Fall-Run Chinook

Although little is known about the late-fall-run Chinook, they probably enter Butte Creek from December through February, spawning above Parrott-Phelan Dam during January through March. Few barriers, except during extremely dry years, impede the passage of late-fall-run adult salmon. Fry and smolts are thought to emigrate from April through June (later than Fall-run) and face the same potential losses to diversions as fall-run.

Late-Fall-Run Chinook Population

There are late Fall-run in Butte Creek; however, their numbers are unknown (Reynolds et al., 1993).

Chinook Restoration Potential

Restoration of habitat in Butte Creek would allow the spring-run Chinook population to return to an annual spawning population of about 4,000 fish and fall-run Chinook to about 2,000 fish. In *Restoring Central Valley Streams-A Plan for Action*, CDFG assessed the Butte Creek spring-run Chinook population as having a "high" potential for restoration (Reynolds et al., 1993). The steelhead run would also increase.

Regarding the opening of the reach of Butte Creek above Centerville Head Dam to spring-run, Johnson and Kier (1998) concluded "there is no doubt in the authors mind that Butte Creek Canyon (above Centerville Head Dam) would prove an excellent opportunity for rebuilding the watersheds natural spring-run numbers." Others have raised serious concerns about the number and height of barriers, especially a 35-foot waterfall a third of a mile above the Centerville structure. This proposal is now under discussion as a policy decision.

Steelhead

Steelhead are the anadromous form of rainbow trout, a salmonid native to California. They used to support a major sport fishery. Steelhead trout use the Sacramento River as a migration corridor to and from spawning grounds in Butte Creek. They are present in the Sacramento River year-round, either as juveniles migrating downstream or as adults migrating upstream or downstream.

Steelhead are similar to some Pacific salmon. They are born in fresh water, then emigrate to the ocean where most of their growth occurs, and then return to fresh water to spawn. Steelhead ascend Butte Creek in the late fall and winter (August through March). They spawn in tributaries such as Dry Creek (Brown, 1992b) and in the main stem of Butte Creek above Parrott-Phelan diversion in winter and spring (generally December and April). They prefer to spawn in clean gravel at the pool-riffle transition (McEwan and Jackson, 1993).

Unlike Pacific salmon, steelhead do not always die after spawning. Post-spawning survival rates are generally quite low, and vary considerably between populations. Fish that survive spawning return to the ocean from April to June.

The life history of steelhead differs from that of Pacific salmon in two aspects: juveniles have a longer fresh water rearing requirement (usually from one to three years) and they do not migrate at any set age. Juvenile migration generally occurs during the spring after at least one year of rearing in upstream areas. Some individuals remain in a stream, mature, and even spawn without ever going to sea. Others will migrate to sea as fry. In Scott and Waddell Creeks (Santa Cruz County), the majority of adults returning to spawn spent two years in fresh water and one or two years in the ocean. Other steelhead from these streams spent from one to four years in fresh water and from one to three years in the ocean (Shapovalov and Taft, 1954). "Generally,.in California the most successful steelhead spend from one to two years in fresh water before migrating downstream" (Reynolds et al., 1993).

All steelhead in California are *0nchorynchus mykiss irideus*. CDFG has traditionally grouped steelhead into seasonal runs according to their peak migration period: summer steelhead and winter steelhead. This describes run timing but doesn't reflect stock characteristics or spawning strategies (McEwan and Jackson, 1993). These terms are synonymous with stream-maturing and ocean-maturing steelhead.

There is substantial gene flow between anadromous and resident trout. It is not uncommon in anadromous steelhead for males to mature and then assume a resident life style. Butte Creek, like all stream systems in California, is subject to extreme variations in rainfall which can result in high volume, flash flood runoff, or droughts lasting several years. The lower reaches of streams have in the past become intermittent during the dry season. Juvenile steelhead rearing in the perennial headwaters of these streams during drought times may have no ocean access for several years (McEwan and Jackson, 1993).

The fact that anadromous and resident rainbow trout can form a single interbreeding population in a particular stream has important management implications. Management of native steelhead populations must include measures to protect and restore native resident trout.

Steelhead Trout Population

Steelhead trout populations have greatly declined over much of the species range, including the Sacramento River basin, and the species is under consideration for federal listing as a threatened species. The causes of decline in steelhead trout are the same as those described for spring-run salmon. Presently, the most viable, self-sustaining populations of steelhead are found in Deer and Mill Creeks, but small populations also persist in Big Chico and Antelope Creeks (Reynolds et al., 1993). Steelhead have been reported in Butte Creek principally through reports by DFG wardens of angler catches. Steelhead juveniles were caught in Dry Creek (Brown, 1992b), but no steelhead were caught in studies of salmonid losses in agricultural diversions (Brown, 1992a). The Sutter Bypass is used by juveniles in the vicinity as rearing habitat (Hill, 1997).

No estimate of Steelhead numbers in Butte Creek were found in this review of the available literature.

Habitat Requirements of Salmonids

In the Butte Creek Watershed, there is increasing concern how human activities effect salmonid habitat. The requirements of these unusual fish must be known before we can understand the effects human and natural disturbances have on salmonid's ability to reproduce and sustain themselves and their population. Salmonid needs vary according to life cycle stage and season of the year. Upstream and seaward migration, spawning, incubation of eggs, juvenile rearing, and residence, will be examined.

Upstream Migration of Adults

Adults returning to natal streams must arrive in good health and at the proper time for successful spawning. Detrimental flows, elevated temperatures, turbidity, and water quality can impair or prevent fish from completing their journey. No specific water quality problems were identified in this review of the literature.

Temperature

Some salmon have completed migration in water temperatures from 37º - 75º F (see Table 6.3). During migration, steelhead prefer temperatures from 46º - 60º F (Reiser and Bjjorn, 1973; McEwan and Jackson, 1993).

Table 6.3
Optimum Temperatures for Anadramous Salmonids

	Optimum (°F)	Range (°F)
Chinook Salmon		
Spawning	42-60	37-73
Eggs	42-56	38-63
Fry	42-65	36-75
Juvenile	53-64	32-75
Steelhead		
Spawning	46-52	39-61
Eggs	50	--
Fry	55-60	55-72.5
Juvenile	44-52	43-63

Source: US Bureau of Reclamation, Central Valley Project, Guide to Upper Sacramento River Chinook Salmon Life History, July 1991, David A. Vogel and Keith R. Marine.

Dissolved Oxygen

Reduction of dissolved oxygen concentration can impair swimming performance of adults. Maximum sustained swimming speeds of juvenile and adult salmon were reduced when oxygen concentrations were reduced from air saturation levels (Davis et al., 1963). Large decreases in swimming ability was observed at 6.5-7.0 mg/l for all temperatures. Low dissolved oxygen may also cause avoidance behavior (Whitmore et al., 1960) and migration to cease. Oxygen levels recommended for spawning fish (minimum 80% saturation with temporary levels not less than 5.0 mg/l) should prove adequate.

Turbidity

Salmon will avoid or cease migration in water with high silt loads. Turbid water may absorb more sunlight and create a temperature barrier for migration.

Barriers

Debris jams, waterfalls, and excessive velocities can also slow or stop migrating fish. Barriers observed at some flows may be accessible under other flows. For example, Kathy Hill of CDFG documented the presence of 29 Spring-run salmon above Butte Creek's barrier falls. Whereas, it is known that the vast majority of Spring-run and steelhead activity takes place below the barrier falls.

Jumping conditions for salmon are optimized when the pool depth below is 1.25x the height of the barrier (see Figure 6.3). Salmon have been observed jumping 6.6 - 9.9 ft. Woody debris jams can block or slow upstream migration. Debris jams can cause large pools to form, and both small and large woody debris function as beneficial cover.

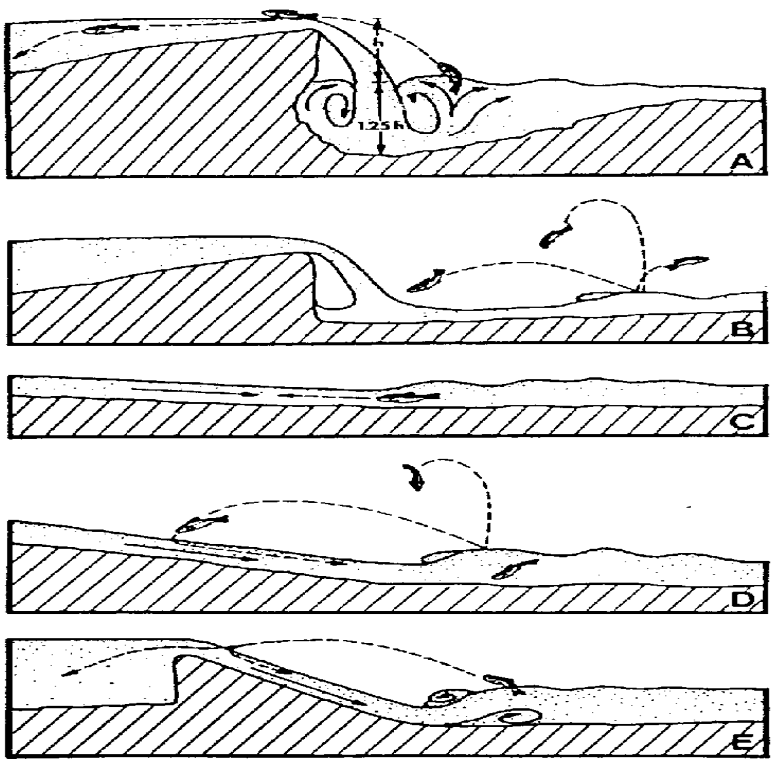


Figure 6.3
Leaping Ability of Salmon Under Various Conditions (Reiser and Bjornn, 1979)
A) Optimal. B) Suboptimal (no staging pool). C) Velocities too high, incline too long. D) High velocities section too long for fish endurance. E) Standing wave poorly developed. Note that condition B, C, and D occur at Butte Creek diversion dams.

Velocities at channel constrictions such as culverts, bedrock projections and boulders, narrow bridges, etc. during high water events can exceed the swimming ability of adults. Fish resume migrating when water flows decline.

Salmonid swimming abilities fall into the following three categories:

1) Cruising speed: the speed at which fish can swim for hours. Generally 2-4 body lengths/second (bl/sec) (For a 32 inch chinook this is 5.3 - 10.7 ft. per second.)

2) Sustained speed: the speed the fish can maintain for several minutes. Four to seven body lengths/second (bl/sec) (For a 32 inch chinook this is 10.7 - 18.7 ft. per second)

3) Burst speed: maintained for a few seconds. Eight to twelve body lengths/second (bl/sec) (For a 32 inch chinook this is 21 - 32 ft. per second).

Cruising speed is used for migration, sustained speed is used for passage through difficult areas, and burst speed is used for escape and feeding.

Streamflow

When water is too shallow migration can be impeded. The question of flow is complex, but our level of knowledge is increasing rapidly. Flow cannot be properly addressed in this document and requires much more study.

Spawning Requirements

Cover

Fish cover protects fish from disturbance and predators and provides shade. Cover is supplied by overhanging vegetation, logs, small woody debris, rocks and boulders, aquatic vegetation, turbulence (bubble curtains, etc.), and water depth.

Spring-run and steelhead enter Butte Creek months before spawning. Cover is essential to protect fish from disturbance (Hill, 1997). Spawning areas are usually very open, therefore adjacent cover may be a factor in selection of redd sites by some salmonids (Johnson et al., 1966). Reiser and Wesche (1977) observed that brown trout spawners selected areas close to undercut banks and overhanging vegetation and speculated that early spawners and dominant fish selected sites by cover. Smaller and later fish were forced to select unprotected sites. Implications for management are the protection and restoration of riparian (streamside) vegetation and large woody debris for cover.

Temperature

Spawning has been accomplished by salmonids in temperatures from 37º - 73º F. Abrupt drops in temperature can cause spawning activity to cease. The steelhead temperature range for spawning is somewhat lower, ranging from 46º - 52º F (Reiser and Bjjorn, 1979; McEwan and Jackson, 1993). In Butte Creek shading of the creek by riparian trees is important to reduce temperatures in spawning and holding reaches.

Substrate

Fish size is a primary factor that affects substrate selection for spawning. Larger fish can utilize larger substrate gravels. In general, the substrate chosen by salmon for spawning is composed mostly of gravels from 0.75 - 4.0 inches in diameter with smaller percentages of coarser and finer materials and no more than about 5 percent fines. Although spawning will occur in suboptimal substrates, incubation success will be lower. Gravel is completely unsatisfactory when it has been cemented with clays and other fines, or when sediments settle out and cover eggs during the spawning and incubation period. Gravel deposited for enhancement purposes should consist of 80 percent 0.5 - 2.5 inch diameter, and 20 percent 2.5 - 4.0 inch diameter (Reynolds et al., 1993).

Gravel particle sizes selected by steelhead vary from about 0.25 - 3.0 inches in diameter, somewhat smaller than those selected by Chinook salmon.

Implications for management: Dams can impound stream gravels making them unavailable for spawning. High flows can flush out existing spawning gravels especially if the stream lacks large woody debris which tends to catch and hold gravels in the system. When Butte Creek is artificially narrowed through the placement of riprap and the hardening of banks, velocities are increased and gravels are scoured from a reach of stream.

Redd Area

For successful reproduction, Chinook salmon require clean and loose gravel that will remain stable during incubation and emergence. The average size of Chinook salmon redds is approximately 165 square feet. In areas of heavy activity, the redds dug by late spawners may overlap with those dug by early spawners by more than 60%. The territory required for pre-mating activity has been estimated at 200-650 square feet for salmon but this varies according to population density.

Where spawning occurs through a protracted spawning season, as many as three or four redds may be dug in the territorial requirement of one pair. A conservative range for minimum spawning area per female is 75-100 square feet. Requirements also appear to vary according to the size of the fish and the characteristics of the stream. For example, actual redd areas in the San Joaquin basin range from 60 to 90 square feet (Reynolds et al., 1993). Johnson and Kier estimated that 196 square feet of gravel is needed per pair (1998).

Implications for management: assuming a restored population of 4000 Spring-run, 1000 Fall-run, and 1000 steelhead, then 525,000 square feet of clean spawning gravels would be required as an average minimum (a rough calculation).

Water Depth and Velocity

Salmon select spawning areas within a range of water velocity and depth. Spawning requires well-oxygenated, cool water. Velocity is generally regarded as a more important parameter than depth for determining the suitability of a particular site for spawning. The velocity determines the amount of water which will pass over the incubating eggs. In general, optimum velocity is considered to be between 1.5 feet per second (fps) (Reynolds et al., 1993) between 1.67 fps (Healey, 1991), and ranging from 1.0 to 3.5 fps. Depths under 6 inches can be physically prohibitive for spawning activities (Reynolds et al., 1993). An average based on several studies by Healey equaled a mean depth of between 1.0-1.1feet (Healey, 1991). Central Valley salmon typically spawn at depths ranging from 1-5 feet and exhibit some differences in preferred depths for spawning based on race and watershed.

Criteria for spawning of steelhead differ slightly from those for salmon. Velocity is about the same as for Chinook salmon at 1.5 fps but depth is slightly less, to about 0.75 feet.

With increasing flows, spawning area increases to the point where velocities become too high in some areas, while the area available for spawning increases more slowly. As velocities exceed maximums, available spawning area slowly decreases.

Depth and velocity relate strongly to the adequacy of stream flows. Diversions may reduce flows to the point where depths over spawning gravels are less than 0.5 feet or velocities are less than 1.5 fps making spawning difficult or impossible. Agreements regarding diversions must be carefully crafted to assure sufficient flows for spawning and holding.

Egg Incubation Requirements

Incubation is related to spawning but habitat conditions for embryos are different from those for adults.

Egg Quantities (Reynolds et al., 1993)

An average female Chinook Salmon produces 3,000 - 6,000 eggs depending on size and race of the fish. For steelhead, an average of 550 - 1,300 eggs are deposited in each redd.

Surface Stream/Intergravel Relation

To be available to eggs, oxygen must be dissolved into water, transported by water to the stream bottom, and exchanged into streambed gravels. Exchange is controlled by the stream surface profile, permeability of the gravel, depth of gravel, and irregularity of the streambed. High intergravel oxygen is related to highly permeable gravels and increased stream gradient. Temperatures of intergravel water lags 2-6 hours behind surface waters. Intergravel velocity increases as surface water depth increases. Thus as the width to depth ratio decreases and water depth increases (characteristic of healthier streams), oxygen exchange will increase.

The inter-gravel percolation rate (velocity dependent) is considered the most important factor determining the available oxygen for salmon eggs. Water flow brings oxygen to eggs and removes waste products. In two different redds, one with high dissolved oxygen levels and a low inter-gravel percolation rate and the second with low dissolved oxygen and high velocities, embryos may develop better in the second. When inter-gravel percolation rates are low, as for example when gravels are clogged with fines, little oxygen will be available to salmon eggs.

Fine sediment deposits reduce the interchange of water and the velocity through the gravels. In general, gravels chosen by salmonids should have no more than 5% fines (Reynolds et al., 1993). Steelhead are less tolerant of fines than Chinook salmon. (see Figure 6.4.)

The Johnson and Kier study (1998) above the Centerville Head Dam found that 75.13% of the spawning gravels in that reach of Butte Creek had embededness ratios greater than 26% (see Table 6.4). This indicates a significant problem with fines in the watershed. During the survey, Johnson noted and photographed two large landslides into Butte Creek. One is approximately 1.5 miles upstream of Forks of Butte (Pers. com., Boeger, 1998) the other is on the F-1 road near Butte Meadows (Pers. com., Johnson, 1998).

Table 6.4
Summary of Embeddedness in Stream Gravels On Upper Butte Creek

Gravel Class	Percent of Gravel	Embeddedness
3's	51.84%	50%+
2's	23.29%	26-50%
1's	42.29%	0-25%

(Johnson and Kier, 1998)

Watershed surveys to identify sediment transport corridors (STCs) together with action to repair the STC's are important to improving salmonid survival and restoration.

When stream gravels are clogged by fines the stream must flow over rather than through gravels which increases stream temperatures. Butte Creek stream temperatures are being studied by DWR.

The Johnson and Kier study (1998) was not an intensive gravel study. The quanity and condition of Butte Creek's spawning gravels is a data gap.

Dissolved Oxygen

Researchers found that sac fry from embryos incubated under low and intermediate dissolved oxygen conditions tended to be smaller and weaker, and took longer to hatch. These conditions may increase the percentage of defects and stimulated premature hatching (Silver et al., 1963). Comparisons of sockeye salmon fry reared at different dissolved oxygen levels found size differences and showed that the smaller ones eventually achieved almost the same weight (Brannon, 1965), though fry would be more vulnerable to predators during the time they were smaller.

Temperature

Temperatures can be too low or too high for successful incubation, though, low temperature is not generally a problem in Butte Creek. The preferred temperature for Chinook salmon spawning is 52º F with lower and upper threshold temperatures of 42º F and 56º F. Temperatures above these ranges result in reduced viability of eggs or heavy mortality of developing juveniles. As temperatures went from 43º F to 54º F the average weight of fry went from 690 mg to 604 mg, a 12.5% decrease (Heming, 1982 in Healey, 1991) Within the appropriate temperature range, eggs usually hatch in 40 - 60 days, and the young "sac fry" usually remain in the gravel for an additional four to six weeks until the yolk sac is completely absorbed. The rate of development is faster at high water temperatures. Significant egg mortalities occur at temperatures in excess of 57.5º F. Total mortality normally occurs at 62º F. The total time from spawning to emergence at 50º F is approximately 79 days (Reynolds et al., 1993).

For steelhead, the preferred incubation and hatching temperature is 50º F and the range is 48º - 52ºF, (McEwan and Jackson, 1993). During the egg's "tender" stage which may last for the first half of the incubation period, a sudden change in water temperature may result in excessive mortality. In stream gravels at 50º F, hatching occurs in 31 days and at 55º F in 24 days (Reynolds et al., 1993). Egg mortality begins to occur at 56ºF. Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft, 1954). Thus steelhead eggs hatch in less than one third the time of Chinook. This may be advantageous as Butte Creek warms up during springtime.

Again, overhanging riparian vegetation and adequate flows are essential to maintaining temperatures within the appropriate range for egg incubation.

Biochemical Oxygen Demand (BOD)

The presence of organic material in inter-gravel water may lower available oxygen to eggs. Organic impacts depend on hydraulics, gravel size, percentage of fines, chemical qualities, and ability of the stream to re-aerate. The presence of large quantities of organics, such as from fallen leaves, septic tank leachate, or other organic materials washed into the stream, can lower dissolved oxygen to the point where eggs are damaged. In Butte Creek Canyon where houses are located close to the creek and leach lines are in the coarse gravel substrate derived from tailings, the water table may be shared and can cause elevated nutrient levels. However, because of the large flow in the creek compared to the volume of waste water, it is unlikely that septic systems could cause measurable oxygen depletion (Pers. com., Dykstra, 1998).

Substrate Or Gravels

Substrate composition must be low in sand and fines so that it is highly permeable to water for successful incubation and emergence of fry. The oxygen requirements of developing eggs and alevins increase with increasing temperature. For these reasons, the minimum intra-gravel percolation rate needed to ensure good survival of incubating eggs and alevins can vary considerably according to flow rate, water depth, and water quality (CDFG, 1993). Fine sediments deposited on redds reduce percolation through the gravel and can suffocate eggs.

Researchers have found that highly productive spawning streams have gravel with high permeability (Reiser and Bjornn, 1979). High permeability is regarded as less than 5% fines and low permeability is more than 15% fines. Fry emergence can be slowed or prevented by sand and silt (fines) in gravels (see Figure 6.4). Fry emergence is generally inversely related to the amount of fines (Philips et al., 1975).

Streamflow

The assumption is that spawning flows are adequate for incubation. U.S. Fish and Wildlife has at times recommended increased flows. Watershed practices that include road building and logging can increase flows and contribute to flooding and unusually high flows which scour redds and cause deaths (Reiser and Bjornn, 1979). Moderately higher flows increase oxygen interchange of inter-gravel and surface waters and benefit eggs.

Juvenile Rearing Requirements

After emergence, fry attempt to hold position in the water column and feed in low velocity slack water and back eddies. They move to higher velocity areas as they grow larger. Length of rearing and migration timing vary for salmonids from months, for Fall-run, up to years for Steelhead. Newly emerged Steelhead fry move to the shallow, protected areas associated with the stream margin. They soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft, 1954). Most juveniles inhabit riffles but some of the larger ones will inhabit pools or deeper runs.

In California most young Chinook salmon enter the ocean as zero age smolts where they remain until their third or fourth year at which time they return to their home stream to spawn (two and five year old fish also participate in small numbers). The most successful young Steelhead spend from one to two years in fresh water before migrating downstream (McEwan and Jackson, 1993). Rearing happens through out the stream system with fry and yearlings rearing wherever they find habitat (Ward, 1997).

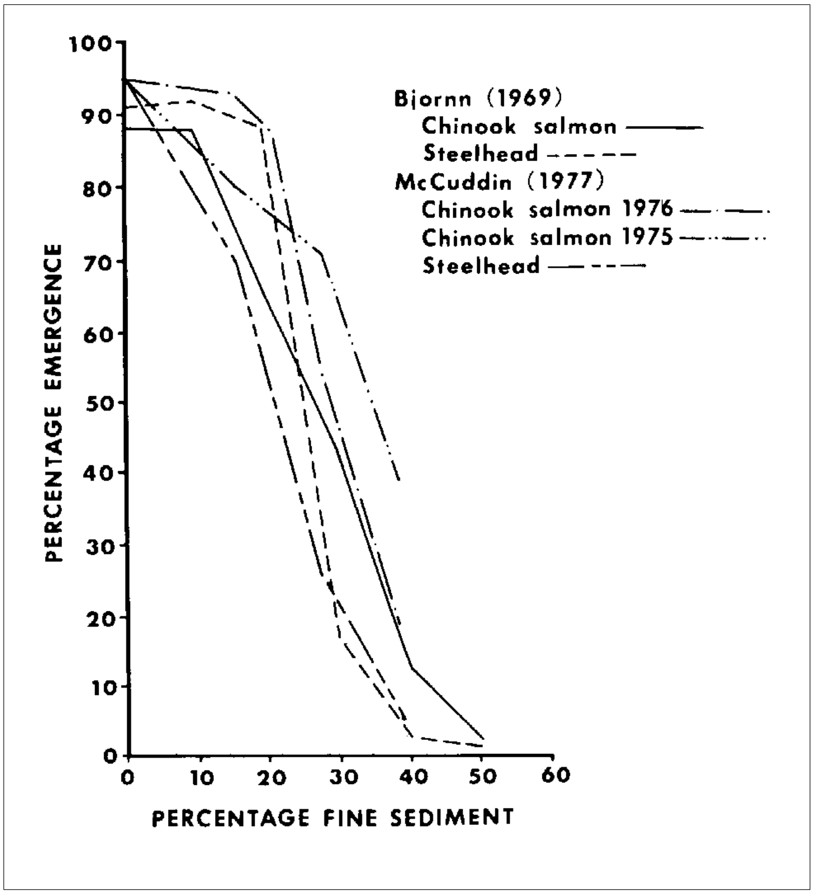


Figure 6.4

Percent Emergence of Fry from Fertile Eggs in Gravel Sand Mixture (Reiser and Bjornn, 1979) Note the sharp decline in survival rates for steelhead down to 70% at the 15% threshold of low permeability and Chinook survival down to an average of 85% at 15% fines.

Turbidity

One review concluded that salmonids ability to find and capture food is impaired at turbidities of 25-50 ntu (nephelometric turbidity units) (Lloyd et al., in MacDonald et al., 1991). Other studies indicated that growth is reduced and gill tissue damaged after 5-10 days of exposure to water with turbidities of 25 ntu (Sigler et al., 1984 in MacDonald et al., 1991). Turbidity varies according to discharge, occasional events such as road runoff, debris flows or landslides, etc.

The impact of recreational and other in-stream mining activities in the BLM reach of Butte Creek below Forks of the Butte (Black Prince and other mines) on rearing trout is a data gap.

Temperature

In Butte Creek's Watershed, low temperatures are not as great a concern as high temperatures, especially high temperatures that occur during juvenile rearing. Because juveniles rear in freshwater for at least 1 year, adequate stream flows and water temperatures are necessary year round. Steelhead prefer rearing temperatures of 45º- 60º F (McEwan and Jackson, 1993). In Butte Creek's rearing area, the Covered Bridge to the Quartz Bowl a mile below the Centerville Head Dam, summer flows generally keep temperatures below 68º F (Brown, 1993). In the Johnson and Kier (1998) study temperatures taken 1/2 mile above De Sabla Powerhouse remained between 62º - 48ºF during late July and August of 1997. Temperatures below Centerville Head Dam in critical spring-run holding and rearing area need to be studied. CDFG and DWR are conducting temperature studies of Butte Creek at this time (Reynolds et al., 1996).

Optimal rearing temperatures are between 45º - 60º F, but salmonids are known to rear in the Sutter Bypass where temperature are somewhat higher (Hill, 1998).

Good rearing habitat for salmonids consists of pools and riffles (in a 50/50 ratio), adequate cover, food (mostly macroinvertebrates), dissolved oxygen at saturation, and sixty percent of the riffles should be covered by stream flows. Riffles should contain less than 20% fine sediment for optimum macroinvertebrate production (Reiser and Bjornn, 1979).

Side Channel Rearing

Recent research has shown that side (or secondary) channels are the most productive habitats for salmonids in rivers (Sedell et al., 1980; Tuska et al., 1982). In the pristine South Fork Hoh River in Alaska they found that the greatest crop of salmonids occurred in side channels and in spring fed flood-plain tributaries. The main river channel had the lowest salmonids densities and biomass. Side-channel and terrace-tributary habitats accounted for 6 percent of the total salmonid habitat on the South Fork Hoh and reared about 70 percent of the potential smolts (Tuska et al., 1982). For the Upper Queets River system, side channels and terrace tributaries accounted for about 23 percent of the available fish habitat and 54 percent of the potential Coho salmon smolts. Both Sedell et al. (1980) and Tuska et al. (1982), reported that large woody debris was important in creating, stabilizing, and providing cover in these productive habitats. A stream habitat survey of Butte Creek can confirm or deny if side (secondary) channel habitat is a limiting factor. These channels are generally associated with unconfined stream reaches with floodplain access and plentiful large woody debris.

Nonnatal Rearing

Salmon will rear in nonnatal intermittent streams such as Dry Creek. Paul Maslin, CSUC Professor of Fisheries Biology, discovered salmon rearing in Sacramento River tributary creeks (Maslin et al., 1997). He found that 24 small tributaries with a near-mouth gradient of less than 1% contained juvenile chinook. He found a lot of "variation in numbers present and distance as they moved upstream." He concluded that the Chinook had grown rapidly, to the extent that it made race determination based on size questionable. The tributaries generally flowed long enough for juveniles to smolt and emigrate. Most streams observed by Maslin showed degradation from human activities including barriers, removal of woody debris and riparian vegetation and watershed alteration (Maslin et al., 1997). Brown (1993) caught steelhead smolts in Dry Creek. Salmonids may rear in Dry Creek or other intermittent tributaries of Butte Creek that offer suitable habitat.

Sutter Bypass

The Sutter Bypass serves as a rearing area for Butte Creek fish (Hill; Ward, 1997). During most of the year the Sutter Bypass functions as an extension of Butte Creek because the Butte Slough outfall gates are closed (Ward, 1997). It is the major route for migration through the Sacramento Slough. The Sutter Bypass is "very productive water" (Ward, 1997). In the Bypass salmonids grow well. Hill, in 1996-1997, trapped fish in a screw trap and found that Spring-run had grown (from 32mm to 80mm) (Hill, 1997). Unfortunately the Bypass has a large population of predators, including bass. CDFG Biologist Kathy Hill captured "hundreds" of juvenile rainbow trout in the Sutter Bypass. More work is needed to determine their origin, etc., as Sacramento River water can enter the Bypass over three weirs during high flows (Hill, 1997).

Fish Food Production For Rearing

Terrestrial insects are important food items for salmonids. They may enter streams by falling or being blown off riparian vegetation and by being washed in from shoreline areas by wave action or rapid flow fluctuations. Once in the stream, they become a part of the drift, and are fed upon by fish. Plant material that falls into the stream from riparian vegetation is an important source of food to aquatic invertebrates. Researchers found that terrestrial insects were second only to *chironomids* (midges) in importance as food for juvenile anadromous salmonids in the streams they studied.

Groups of insects and other arthropods that may become a part of terrestrial drift include: *Diptera* (flies), *Orthoptera* (grasshoppers and crickets), *Coleoptera* (beetles), *Hymenoptera* (bees, wasps, and ants), *Lepidoptera* (butterflies and moths), *Homoptera* (leaf hoppers), and *Araneida* (spiders). Becker's (1973) detailed study found that insects made up 95% of the fresh water Chinook diet year round. *Diptera* (flies) declining from (99-70%) from March to May, and increasing to 85% by July, *Nonectidae* were dominant in May, *Collembola* in April and May, and *Tricoptera* (caddisflies) dominant in June and July. Terrestrial based insects were dominant the rest of the year.

While in fresh water, juvenile chinook salmon take a wide variety of terrestrial and and aquatic insects (Moyle, 1976). This suggests that they feed in the water column or at the surface on drifting food. Their diet is similar to other salmonids in streams. Competition for food among salmonids is unknown but probably reduced by habitat segregation (Healey, 1991).

Density of juvenile anadromous salmonids may be regulated by the abundance of food in some streams (Chapman, 1966). Food for juveniles comes primarily from the surrounding land and from the substrate within the stream. The importance of terrestrial and aquatic insects varies with stream size, location, riparian vegetation, and time of year. Juveniles that rear in intermittent streams may be highly dependent on terrestrial insects from riparian vegetation early in the year before aquatic insect populations have rebounded (Pers. com. Maslin, 1998).

The importance of insects for salmonid food confirms that Butte Creek's riparian vegetation plays a critical role it is a production area for these insects.

Depth

The influence of water depth on aquatic insect production is poorly understood, generally the largest numbers of organisms are found in shallow areas typically riffles. Hooper (1973) reported that areas of highest invertebrate productivity usually occur in streams at depths between 0.5 and 3 feet if substrates and velocities are suitable.

Substrate

Stream substrate composition is another factor that regulates the production of invertebrates. Substrate size is a function of water velocity, with larger materials (cobble and boulder) associated with fast currents and smaller materials (silt and sand) with slow-moving water. Researchers noted a decrease in number of benthic invertebrates in the progression: cobble-bedrock-gravel-sand (Reiser and Bjornn, 1979). In general, diversity of cover for invertebrates decreases as substrate size decreases. Cobble seems to be the most productive substrate and supports the most diversity. Large cobble substrate provides insects with a firm surface to cling to and also provides protection from the current (Reiser and Bjornn, 1979). Higher coho production was found in pools with large riffles upstream than in pools with small riffles upstream (Reiser and Bjornn, 1979). A substrate (stream gravels) clean of fines is required for optimum aquatic insect production. Scouring of stream gravels from Butte Creek canyon above Centerville Head Dam, as reported by Johnson and Kier (1998), reduced aquatic insect production in that reach.

Large Woody Debris (LWD) and Rearing

Sedell (1988) describes how almost all juvenile anadromous fish are reared on stream edges in a wood rich environment. Table 6.5 demonstrates that in the presence of large woody debris, Juvenile Chinook densities increased from 5 individuals to 292, a 5,840% increase!

Table 6.5
Juvenile Chinook Densities in Different Woody Habitat Types in The Chickamin River, Southeast Alaska, March-April 1984

Woody Habitat Type	**Number of Sample Sites**	**Average Number of Chinook Salmon**
No woody habitat slack water along edges	3	5
Rootwads without boles, stumps	12	56
Single downed trees rootwad and trunk	14	87
Log Jam with several down trees	7	29

(Adapted from Sedell, 1988).

Temperature

Water temperature during rearing influences growth rate, swimming ability, availability of dissolved oxygen, ability to capture and use food, and ability to withstand disease outbreaks. Brett (1952, in Bjornn and Reiser, 1979) lists the upper lethal temperature for Chinook salmon as 77.2º F. The upper lethal temperature for rainbow trout lies between 75.2º - 85.1º F, depending on oxygen concentration, fish size, and acclimation temperature. In general, salmonids cease growth at temperatures above 68.5º F because of increased metabolic activity. Fall Chinook fingerlings had increasing percentage weight gains as temperature was increased from 40º to 60º F, and then weight decreased with a further increase in temperature to 65º F.

CDFG fishery biologist, K. Hill found lethal temperatures in lower Butte Creek in the West Borrow. From 6/28/95- 7/13/95 all days sampled and 6/1/96-7/8/96, she found 28 days that water temperatures at the surface exceeded 77º F, lethal for chinook. On 6 days in the sampling period in 1996 she found dead chinook juveniles in the screw trap (Hill, 1998).

Riparian vegetation moderates temperature in Butte Creek. Shade or lack of it can increase temperature by 11.7º -18º F (Reynolds et al., 1993). Scouring of riparian vegetation by the January 1997 storm exposes Butte Creek to more sunshine and will increase summer water temperatures maximums and decrease winter minimums.

Dissolved Oxygen

Rainbow trout swimming speeds were reduced 30 and 43 percent when oxygen was reduced to 50 percent of saturation at temperatures of 70º - 73.4º F and 16.4º - 40º F, respectively (Jones 1971, in Reiser and Bjornn, 1979). Generally in Butte Creek water quality is protected by Regional Water Quality and EPA requirements and dissolved oxygen levels are high (Dykstra, 1998).

Suspended And Deposited Sediment

Suspended and deposited fine sediment can adversely affect salmonid rearing when present in excessive amounts. High levels of suspended solids may abrade and clog fish gills, reduce feeding, and cause fish to avoid areas. Most frequently indirect, rather than direct, effects of too much fine sediment damage fish populations. Indirect damage to the fish population by destruction of the food supply, lowered egg or alevin survival, or changes in rearing habitat probably occurs long before the adult fish would be directly harmed.

Bjornn et al. (1977) added fine sediment (less than 6.4 mm in diameter) to natural stream channels, and found juvenile salmon abundance decreased in almost direct proportion to the amount of pool volume lost to fine sediment. In the Butte Creek watershed, sources of fines are typically development activities, agricultural activities, road construction and maintenance, wet season dirt road use, landslides, bank erosion, etc. A study of fines in Butte Creek's pools and riffles will be needed to determine fine levels in the system and to identify Sediment Transport Corridors (STC's) and suggest repairs.

Cover

Cover is perhaps more important to anadromous salmonids during rearing than at any other time. This is when they are most susceptible to predation. Cover needs of mixed populations of salmonids are not easily determined. Shelter needs may vary diurnally and seasonally and by species, and by fish size. Overhead cover, riparian vegetation, turbulent water, logs or undercut banks are used by most salmonids. Beside providing shelter from predators, overhead cover produces areas of shade near stream margins. These areas are the preferred habitat of many juvenile salmonids. Submerged cover, large rocks in the substrate, aquatic vegetation, large woody debris etc., are also used by rearing salmonids. Newly emerged salmonids tend to hide under stones.

Large wood controls the stream's flow in its channel and facilitates and maintains salmonid spawning habitats and some of the best habitat for young vertebrates. Trout and salmon require sites where food is plentiful within or close to cover and where little effort is needed to hold a position against the current while feeding. These sites are called by some biologists “focal points.” Stream riffles that are composed of small gravel have few such sites. Those that do exist are normally occupied by juvenile steelhead trout.

Habitat selected by fish is influenced by their age, ability and the availability of food. The importance of cover is illustrated by experiments in which salmonid abundance declined when cover was reduced and in experiments where salmonid abundance increased when cover was added to a stream. Quantities of fish cover in rearing areas of Butte Creek may be limiting to population restoration and should be investigated.

Space

Space needed by fish increases with age and size. For Chinook salmon 0+ fish require 8 - 18.2 ft. ^{2}/fish, steelhead at 0+ require 10-20.7 sq. ft. per fish. 1+ Steelhead ranged from 60.04-358.6 sq. ft.per fish. Chapman (1966) suggested that salmonids have a minimum spatial requirement that has been fixed over time by the minimum food supply. Measurement of rearing areas especially preferred side channel areas is a data gap to determine the rearing capacity of Butte Creek's system.

The Delta

Many chinook fry migrate downstream immediately after emerging from the spawning beds, take up residence in the river estuary, and rear there to smolt size. Recently emerged Chinook fry are known to rear in the Sacramento River estuaries (Rich, 1920; Kjelson et al., 1982). Rich (1920) reported observing Chinook fry early in October and November in the Sacramento River Estuary. More recently, Kjelson et al. (1982) provided more detailed observations on the Sacramento - San Joaquin River estuary. Most rearing occurs in freshwater habitats in the upper delta area, in the Sutter Bypass, and along the seaward migration of juvenile salmon. Juveniles do not move into brackish water until they smoltify.

Sasaki (1966) observed that young chinook salmon were most abundant in the Sacramento-San Joaquin River delta during April and June. However, Kjelson et al. (1981, 1982) observed that fry were most abundant in February and March in the Sacramento/ San Joaquin River system, and that these fry were replaced by smolts from upriver in April to June. These would include Butte Creek fish. In the Sacramento-San Joaquin River estuary, fingerling smolts were most abundant from April to mid-June but were scarce during summer months.

There was a small secondary peak in smolt abundance in the fall, representing fish that had remained in cooler water upstream over the summer (Kjelson et al., 1982, in Groot and Margulis, 1991).

Delta Pumps (From NMFS, 1997)

In 1948, the CVP began delivering water from the Delta. In 1951, an increased supply of Sacramento River water was directed south across the Delta to the Tracey Pumps. Under initial plant operations, water was exported primarily during the agricultural season (April - early Fall). As early as 1953, exports were so high that net flow in the San Joaquin River was reversed (Ganssle and Kelley, 1963, in NMFS, 1997).

In 1959, the State Water Project (SWP) was authorized. Its main components were the H.O. Banks Pump Plant, it's intake channel and forebay, the California Aquaduct, San Luis Resevoir, and Oroville Dam. The new SWP pumps had a capacity of 6,300 cfs, more than doubling the existing potential. The SWP began delivering water in 1962 but total water exports did not increase until 1967, when the SWP began to export water via the San Luis Reservoir and the California Aquaduct. In 1968, exports climbed from an average of 1.4 MAF (1958-67) prior to the SWP to 2.5 MAF (1968). Exports continued to increase over the next 20 years reaching an annual average of 5.3 MAF (1985-87). In addition to summer and fall irrigation seasons, water was exported during winter and spring to fill San Luis Reservoir. Eventually, a second peak in pumping developed typically between December and April.

Spring-run Chinook Salmon Problems

During wetter years, irrigators delay diverting Butte Creek water until mid-May. Most salmon have passed the diversion by then and are resting in pools in the canyon. Some spring-run Chinook salmon run late and those fish can be trapped in pools between 0.5 and 1.0 miles downstream of the Highway 99 Bridge. Those fish are usually rescued by DFG wardens and biologists.

Below the Western Canal Siphon, spring-run adults normally have sufficient water to migrate upstream. During dry years, there are several areas that must be carefully monitored to assure adequate passage, as diversions can substantially reduce Butte Creek flows as early as February or March. Most of the run is then trapped behind one of the upper diversion dams. Gorill Dam has never been put up until after April 1 (Pers. com., Hefren, 1998). Mortalities are high from elevated water temperatures and poaching until DFG can rescue the remaining fish. Above the Western Canal Siphon, spring-run adults encounter low, warm flows. CDFG has seined adult salmon from the Gorrill and Durham Mutual Dams and transporting them upstream into Butte Creek Canyon. Until flow conditions improve, it is anticipated that rescue operations for adult spring-runs will continue. Flows have improved with the new M&T Agreement.

Adult spring-run Chinook salmon are lost as they attempt to ascend Butte Creek in the spring. Salmon are drawn to relatively high irrigation return flows at Five Points and Drumheller Slough where they are stranded (Flint, 1972). Some late running spring-run salmon are drawn to surplus irrigation (spill) water from White Mallard Diversion. Migrating adults are attracted to these flows and are unable to pass outfall structures. Salmon stay in the area until they are lost to poachers or predators (CDFG, 1974).

Salmon are also attracted to the Cherokee Canal by high flows. They may find their way back to Butte Creek through Sanborn Slough, but many are thought to be lost in the channels and fields of the adjacent duck clubs (Flint, 1972).

Fall-run Chinook Salmon Problems

Fall-run adults enter Butte Creek during late September and early October. Their passage upstream is often delayed or blocked at diversion dams or blocked by dewatered sections caused by diversions for flooding duck clubs. Most fall-run salmon spawn in the area from Durham to the Parrott-Phelan Dam, although some are known to spawn above. Spawning generally takes place October through December. Below the Western Canal Siphon, adult fall-run fish encounter impassable barriers, dewatered areas, siltation, a lack of suitable gravels, and inadequate cover and shade. "During the peak irrigation season, nearly all of the creek's flow is diverted by the time it reaches Durham" (Beak Consultants, 1997). Above the Western Canal Siphon, several barrier dams exist which impede the adult migration until high flows occur. Water temperatures in excess of 73º F occur an average of six days per month at the Gorrill monitoring station (Beak Consultants, 1997). Extended periods of temperatures greater than 73º F can be lethal.

Migrating Fall-run Chinook salmon are susceptible to poachers. They are especially vulnerable because they swim upstream during periods of very low flows. They reach dead ends and congregate near outfalls from agricultural diversions, or are trapped in pools between Highway 99 and Adams Dam in wetter years. Migrating adult salmon that reach spawning areas above Highway 99 crossing find that spawning gravel is scarce and of poor quality. (Note: this information is from before the 1997 high water event. Conditions may have changed - data gap). Low flows force them to choose areas of marginal or poor quality toward the center of the channel to spawn.

Young Fall-run emigrate during April and May and are heavily impacted by diversions and poor water quality when diversions are active. Losses are higher than for spring-run Chinook salmon because agricultural diversions are generally in full operation as the juveniles leave their natal areas. These young salmon suffer heavy losses from diversions in the middle and lower reaches of Butte Creek, in some cases leaving little or no water in the creek bed, especially from Sanborn and White Mallard diversions (Brown, 1992a).

Outmigrant Fall-run Chinook salmon that survive diversions are passed into Butte Slough because the gates at the mouth of Butte Creek are closed to bypass water for agricultural diversions. Salmon that reach the twin borrow pits bordering Sutter Bypass are subject to high water temperatures and concentrations of very active predatory fishes such as largemouth bass, green sunfish, and squawfish. Outmigrants are also drawn into irrigated fields by diversion from the borrow pits (Brown, 1993).

Young Fall-run Chinook salmon are also lost as they migrate down the Sacramento River and through the Sacramento-San Joaquin Estuary. Like spring-run, their numbers are reduced by agricultural diversions in the Sacramento River, predators in the river and estuary, and by state and federal export pumps in the estuary (Stevens and Miller, 1983).

Late Fall-run Chinook Salmon Problems

Little is known of the late fall-run Chinook salmon in Butte Creek. They typically migrate in mid-winter and spawn in the gravel upstream from Parrott-Phelan Dam January through March. Their young emigrate in late May and June when they are especially susceptible to diversions in the Valley section of Butte Creek and in the Butte Basin. They share many of the same risks as the Fall-run (Brown, 1993).

Special Status Fish

Current Status of Chinook Salmon

Central Valley spring-run chinook salmon which includes Butte Creek fish, were designated as a "Candidate Species" for listing under the California Endangered Species Act on June 27, 1997. The designation initiates a one year status review by the California Department of Fish and Game, with a final report to be presented to the California Fish and Game Commission by June 1998. A decision by the Commission whether to list or not, is expected after August 1998.

In addition, the National Marine Fisheries Service listed the Central Valley steelhead as threatened under the Federal Endangered Species Act during March 1998, and has proposed a Federal listing of Central Valley fall/late fall-run. The proposed listings of spring-run and fall/late-fall-run initiates a one year review, with a final decision by the National Marine Fisheries Service during 1999.

Effects of Channel Stabilization

In most locations where flood related repairs are made, riprap is used. In particular, Parrott-Phelan Ranch Dam which was screened during 1993, was abandoned by the creek during the January 1997 flood event. A NRCS emergency project put Butte Creek's channel back to the dam and rip rapped a section of Butte Creek. A weir was built from stream gravels, "hardened" with rock facing and transformed into a overflow structure with one ton rip rap armoring during the summer of 1997. Many other sites including homes and bridges received riprap treatment.

G. Mathias Kondolf, U.C. Berkeley Professor of Geomorphology (writing as a private citizen), stated in a letter that "the hard engineering structures proposed will be detrimental to Butte Creek,“ and that negative environmental impacts of such projects have been well documented...” They include "loss of aquatic habitat area and diversity, reduction of shading of the channel with attendant increase in water temperature, loss of riparian habitat for wildlife, especially loss of undercut banks, and overhanging vegetation, loss of pool riffle structure, and loss of spawning habitat" (Kondolf, 1997). Kondolf further discussed that "hardening river banks in one location typically produces a reaction elsewhere along the channel, because flows speed up or slow down, or change in direction and as a result erosion is initiated elsewhere, and new bank protection is proposed for the new site of erosion, initiating a cycle of costly and damaging "serial engineering" (Mount, 1995).

He recommended that analysis be "based on explicit analysis of historical and channel dynamics, the potential interactions of the proposed structural measures and the ecological impacts of the proposed structural measures. Far better to step back, attempt to understand the river and propose a management approach that permits the river to behave as naturally as possible, leading in the long run to fewer maintenance headaches and optimizing the remarkable ecological resources of Butte Creek" (Kondolf, 1997).

Another approach that could have been used is that of Bioenginering - using plants as engineering matierials. Bioengineering techniques have been used in Europe since the early 1800's (Schliechtl, 1980). A project on Lindo Channel in Chico that utilized Bioengineering combined with a geomorphically guided approach used approximately one eighth of the riprap of the standard riprap proposal that proceeded it (Cole, 1991).

Large Woody Debris for Restoration

Improving fish habitat using large wood will not be easy because the long-term stability of woody debris in Butte Creek cannot be exactly predicted (Although CDFG has successfully cabled logs in place on some streams). Leaving debris in place has a high probability of enhancing rearing and spawning habitat for salmonids, either in the original location, or downstream after a storm. Streams are dynamic, and evolve within their physical and chemical constraints. Predicting with certainty the stability of debris at a point in space will only occur if the stream is 'trained" throughout its entire length, and thus damaged (Mount, 1995). Dam construction, bank revetments, levees, and chanellization efforts have shown the obvious whenever you tinker with a stream, it makes an adjustment. These natural adjustments may or may not be compatible with watershed-wide efforts towards habitat improvement (Sedell, 1982).

Butte Creek Fisheries Stressors

Wildlife Refuges and Hunting Clubs

The wildlife refuges and hunting clubs are dependent on Butte Creek water and provide some of the most valuable wildlife and waterfowl habitat in the Sacramento Valley. The timing of the need for water among duck clubs, agriculture, and anadromous fisheries causes competition. Seasonal flooding of refuges and duck clubs can conflict with the need for flows for spawning fall-run Chinook salmon and overlaps with the need for transportation flows for both spring-run adults and juvenile salmon in April and May.

Poaching

Loss to poachers is the largest threat to the continued existence of spring-run Chinook salmon in some streams in California (Moyle et al., 1989). Poaching is common in areas where adult salmon are blocked. Although most poaching may occur in Butte Creek Canyon, poaching also occurs at White Mallard Spill Dam, pools below Highway 99, in water behind any of the other diversion dams, and at control structures in the Sutter Bypass.

Warden Gayland Taylor confirmed that Spring-run salmon are tempting for poachers. CDFG allotted overtime for apprehending poachers of Spring-run and created the Spring-run Enhancement Project 1994 - 1997. The majority of 304 tickets were posted to Butte Creek (Pers. com., Taylor, 1998).

Diversion Losses and Competition for Flows

Each water diversion in Butte Creek can divert out migrant salmon and steelhead into rice fields, orchards, and waterfowl areas. Those that take the heaviest toll include Sanborn Slough, and White Mallard Outfall (CDFG, 1974). As an example: Brown (1992) estimated that during a sampling period that lasted December to June in 1991, 6,004 fry and 47 yearling were lost at the Parrott-Phelan Dam (Parrott-Phelan is now screened). Sampling was also conducted during spring at the Durham Mutual, Adams, and Gorrill Diversions. An estimated 350 salmon fry and smolts were lost at Durham Mutual; most were caught in February. An estimated 263 were lost at Adams; and no salmon were caught at Gorrill. Other sampling for outmigrant loss in diversions was conducted by Hallock and VanWoert (1959). They found "no fingerlings . . . present in spring of 1956 and none after mid-March in 1957, they were recovered in fair numbers in six of the eight diversions in 1955" (see Issues and Concerns chapter, #2).

The timing of the need for water among duck clubs, agriculture, and the anadromous fisheries causes competition for water. Irrigation of rice fields overlaps with the need for transportation flows for both spring-run adults and juvenile salmon in April and May.

Although no studies have been conducted to estimate losses of out migrants at all diversions over the entire migration period, they are considered sources of loss of salmon based on the portion of outflow they divert (Hallock and VanWoert, 1959). Fish ladders and screens at all diversion dams require continuous monitoring and maintenance to operate successfully.

Recreational impacts

Campbell and Moyle (1992) studied the effect of rafting activity on Butte (1990) and Deer (1991) Creeks, and found that human rafting activity caused an increase in spring-run Chinook salmon movement in pools, and may stress them if rafting is common. (See Scenic and Recreational Resources chapter). They documented substantial evidence of possible harassment and poaching of salmon in a 2.3 km study stretch of Deer Creek during 1991. This evidence included the presence of heavy line and treble hooks in pools containing adult salmon. They even observed people with snorkeling equipment trying to capture adult spring-run salmon with a dipnet (see Issues and Concerns chapter, # 1).

Trout Fishery Losses Due to the DeSabla-Centerville Project

In a CDFG Report, fishery biologists R.A. Flint and F.A. Meyer estimated the trout fishery losses at “approximately 38,000 (6 inch) trout in 15 3/4 miles of Butte Creek” (Flint and Meyer, 1977). The project canals support trout to varying degrees depending on substrate composition and flow. These estimates were before the current agreement with PG&E to provide 40 cfs in the low flow sections of Butte Creek, which has improved conditions for salmonids.

The current flow regime conditions and it's effect on resident trout population in the effected reach is a data gap.

Habitat Restrictions

It had been thought that PG&E's Butte Head and Centerville Head Dams in Butte Creek eliminated steelhead access to the headwaters of the Butte Meadows basin (Brown, 1992), and that steelhead were now restricted to the lower reaches of the canyon and tributaries such as Dry Creek. However, Holtgrieve and Holtgtrieve (1995) searched the literature and found that in feet no evidence exists of their presence in the upper watershed.

In *A Preliminary Assessment of the Salmon Habitat Potential of Butte Creek Between the Butte Head Dam and Centerville Diversion Dam*, Johnson and Kier (1998) concluded that "the eleven mile canyon section contains pools, spawning gravel and water quality sufficient to meet the summer holding and early fall spawning requirements of spring-run salmon. The number of barriers is daunting, however most of the falls and chutes may be surmountable by adult salmon at the higher flows.during springtime migration. If fish migration beyond.Centerville Dam were made possible then the accessibility of the upper.canyon would be determined largely but not exclusively by streamflow availability. They acknowledged several barriers would require modification.

Concerns expressed by CDFG and others include the presence of a 35-foot barrier approximately 0.34 miles above the Centerville Dam. This is one of the largest barriers on the entire reach.

These concerns must be weighed against the opportunity of accessing habitat capable of supporting 199 - 521 pairs of spring-run salmon (or steelhead). Another benefit might be the possibility of a "closable" fish ladder to separate spring-run spawners from fall-run in some years.

Sport Fishing

Butte Creek is closed to fishing for trout and salmon all year from confluence with the Sacramento River, in Butte Slough, the East and West canals of the Sutter Bypass, and Sacramento Slough upstream to the PG&E Centerville Head Dam. It is open all year to fishing for other species from the Oro-Chico Bridge crossing to the Sacramento River and in Butte Slough, the East and West canals of the Sutter Bypass, and the Sacramento Slough.

Butte Basin and Butte Sink (see Issues and Concerns chapter, #2)

Flint (1972) described the Butte Sink as the "greatest single hazard to downstream migrants on Butte Creek." Butte Slough outfall gates may cause losses in juvenile and adult salmon. DWR opens the gates to control flooding in winter and early spring; adult and juvenile salmon can pass freely from Butte Creek to the Sacramento River during this period.

Reclamation District 70 closes the gates later in the spring and in summer to retain water in the Butte Slough for irrigation. Young salmon are diverted into Butte Slough and may be lost to agricultural diversions when the Butte Slough outfall gates are closed (Brown, 1993). High temperatures (70º - 85º F) in summer threaten juvenile salmon and steelhead (Brown, 1993).

Numerous predators are present in this area including the Striped Bass, an introduced species and one of the most efficient predator fish in the Butte Creek system. Very evolutionarily advanced and well known for taking great numbers of prey items, Striped Bass are known predators of salmonids in the Delta and elsewhere (Maslin, 1998). They are often found in screw traps in the West Borrow (Hill, 1998). CDFG has acquired an incidental take permit under the Endangered Species Act for incidental take of Winter-Run chinook for the Striped Bass management program (CDFG, 1997).

High Temperatures

- PG&E in a two year (1992-3) water temperature and flow monitoring study (PG&E, 1993) found the following temperatures data:
- Lower Centerville Diversion Dam range: 54º.3 - 69.8º F, in 1992 and, 47º - 66ºF in 1993.
- Average July temperatures in 1992 were 63.1º F and 60.4º F in 1993.
- Average August temperatures in 1992 were 64.6º F and 60.4º F in 1993.
- Helltown Bridge range: 57.4º - 75.2º F in 1992 and 56.7º F - 73.4º F in 1993. Average July temperatures were 67.6º F in 1992 and 66.4º F in 1993.
- Average August temperatures were 68.4º F in 1992 and 66º F in 1993.
- Lower Centerville Canal range: 56.1º- 80.6º F in 1992 and 47.7º - 68.7 º F in 1993.
- Average July temperatures were 65.8 ºF in 1992 and 61.5 ºF in 1993
- Average August temperatures were 66.9º F in 1992 and 61.5 ºF in 1993. The maximum temperature occurred during a canal outage at 80.6 º F.
- At Pool 4, range: 54.7º - 75.4º F in 1992 and 48.2º - 72.1º F in 1993. Average July temperatures were 66.2º F in 1992 and 64º F in 1993
- Average August temperatures were 67.1º F in 1992 and 64º F in 1993.
- Butte Creek below Centerville Powerhouse range: 55.2º F - 76.5º F in 1992 and 48.2º F - 70º F in 1993.
- Average July temperatures were 66.7º F in 1992 and 62.4º F in 1993
- Average August temperatures were 67.1º F in 1992 and 62.8º F in 1993.
- Note that 1992-93 were drought years and flows were below "normal" (see Hydrology chapter)

Potential Improvement Due To Screening

Some idea of the possible improvement from installing fish screens is evident from a CDFG study at Roaring River Slough (1981-1982) In this study the screens were leaky and had to be removed for cleaning. They still reduced Chinook losses by 88% (37/284) and overall fish losses by 90% (565/5609 fish).

For a list of restoration actions and evaluations from the Revised Draft Anadramous Fish Restoration Program see Table 6.6.

Further Recomendations from USFRH

1) Conduct an in stream flow study.
2) Develop hydrologic model (Butte Basin Water Users have a model which is available (pers. com., Hefren, 1998).
3) Monitor water temperatures and water quality in Butte Creek (Ongoing DWR effort).
4) Develop genetic marker for racial identification.
5) Correct water temperature and agricultural drain problems as they significantly effect water quality.
6) Implement habitat restoration work in lower Butte Creek, such as sediment control and revegetation of stream banks.

Additional Findings (primarily data gaps)

1) The presence, quantity (pieces/mile), and quality of large woody debris in Butte Creek is a data gap. Numerical comparisions with similar stream types (such as Rosgyns' stream classification system) in more pristine areas would enable stakeholders to evaluate Butte Creek's condition.
2) The status of Butte Creeks aquatic insect population is a data gap that can be filled by the application of the Rapid Bio assessment technique (Harrington et al., 1997).
3) The scouring of Butte Creek by the January 1997 storm has increased width to depth ratio in some stream reaches, scoured out gravels, and decreased inter-gravel percolation rates. The quantity and condition of Butte Creek's spawning gravels is a data gap. Stream surveys can fill this data gap.
4) The impact of recreational and other in-stream mining activities in the BLM reach of Butte Creek below Forks of Butte (Black Prince and other mines) on rearing trout and holding spring-run salmon is a data gap.
5) Quantity of rearing areas, including pool/non-pool ratios and especially preferred side channel areas is a data gap. Stream suveys should be performed to determine if the rearing capacity of Butte Creek's system is a limiting factor.
6) Migrating adult salmon that reach spawning areas above the Highway 99 crossing find that spawning gravel is scarce and of poor quality. (Note: this information is from before the 1997 high water event. Conditions may have changed).
7) The current flow regime conditions and its effect on resident trout population in the effected reach of the De Sabla-Centerville Project is a data gap.

Historic Context for Butte Creek

Butte Creek's anadromous fish stocks evolved in streams that were obstructed by fallen trees, beaver dams, and vegetation growing in and beside the channels. Main stream channels contained abundant gravels and fine sediments. Habitat complexity was great due to scour around boulders and fallen trees, and the presence of multiple stable side channels and over flow sloughs. In the Butte Creek Watershed, logging, hydraulic mining, development, and agricultural operations removed the fallen trees and filled the side channels and sloughs, reducing habitat complexity and it's biological productivity. Human efforts seem focused on expediting the transportation of water for one human use another. As stated earlier Butte Creek's productivity of aquatic insects is partially based on decomposing woody debris as an energy source. After last January's storm, tons of logs were cut up into firewood and allowed to flush out of Butte Creek's system. A very large source of potential nutrients and diversity was removed from Butte Creek's ecosystem, and future aquatic insect populations were very likely reduced both in diversity and numbers. Additionally, other human efforts have simplified Butte Creek's habitat.

Restoration of wild stocks of salmonids is imperiled when present habitats appear to be so unlike their historic conditions. To the extent that we can incorporate the structure and processes of undisturbed habitats, like those where wild salmonids developed; protection and enhancement efforts will have a more effective direction (Sedell, 1982).

Limiting Factors Analysis (based on Kaczynskij, 1996)

Past land management, flood control, and road practices have resulted in some reaches of Butte Creek with: 1) low volumes of large woody debris; 2) loss of riparian areas in agricultural and urban areas; 3) riparian areas in forests that are dominated by small hardwoods; 4) loss of off channel, pond and attached wetland habitat; 5) loss of secondary channels, and; 6) especially the loss of critical deep pool, and off channel, winter flood, refuge habitat.

Table 6.6
Restoration Projects from Revised Draft Anadromous Fish Restoration Program 1998

Action	Involved Parties	Status
Obtain additional instream flows from Parrott-Phelan Diversion.	Diverters, CDFG, USFWS, USBR	
Maintain a minimum 40 cfs instream flow below Centerville Diversion Dam.	CDFG, PG&E, USFWS, USBR	
Purchase existing water rights from willing sellers.	Diverters, CDFG, USFWS, USBR, SWRCB	Ongoing
Build a new high water volume fish ladder at Durham Mutual Dam.	Diverters, CDFG, TNC, USFWS, USBR	
Install fish screens on both diversions at Durham Mutual Dam.	Diverters, TNC, USFWS, USBR, NMFS, CDFG, CDW	
Remove the Western Canal Dam and construct the Western Canal Siphon.	Western Canal Water District (WCWD), TNC, CDFG, USBR, USFWS, CALFED, CUWA	Complete
Remove McPherrin and McGowan dams and provide an alternate source of water as part of the Western Canal removal and siphon construction.	Diverters, WCWD, CDFG, USBR, USFWS, CALFED, CUWA	In progress.
As available, acquire water rights as a part of the Western Canal Siphon project.	WCWD, CDFG, SWRCB, USBR	
Adjudicate water rights and provide water master service for the entire creek; enforce or initiate legal action on Diverters who are violating water right allocations.	Diverters, CDFG, CDWR, SWRCB, USFWS, USBR	No Action
Build a new high water volume fish ladder at Adams Dam.	Diverters, CDFG, USFWS, USBR	In progress
Install fish screens on both diversions at Adams Dam.	Diverters, USFWS, USBR, NMFS, VDFG, CDWR	In progress
Build a new high water volume fish ladder at Gorrill Dam.	Diverters, CDFG, USFWS, USBR	In progress
Install fish screens on both diversions at Gorrill Dam.	Diverters, USFWS, USBR, NMFS, CDFG, CDWR	
Install a fish screen at White Mallard Dam	Diverters, Conservancy, CDFG, CDWR, NMFS, USFWS, USBR	
Eliminate chinook salmon stranding at White Mallard Duck Club outfall.	Diverters, Conservancy, CDFG, USFWS, USBR	
Rebuild and maintain existing culvert and riser at Drumheller Slough outfall.	Diverters, Conservancy, CDFG, USFWS, USBR	
Install screened portable pumps in Butte Creek as an alternative to the Little Dry Creek diversion.	Diverters, Conservancy, CDFG, USFWS, USBR	No Action. Deemed unnecessary.
Install a fish screen at White Mallard Dam.	Diverters, USFWS, USBR, NMFS, CDFG, CDWR	
Develop land use plans that create buffer zones between the creek and agricultural, urban, and industrial developments; and restore, and protect riparian and spring run chinook salmon summer-holding habitat along Butte Creek.	City and county government agencies, Conservation groups, Conservancy, CDFG, USFWS, USBR	
Install fish screens and fish ladder at Parrott-Phelan Diversion Dam.	Diverters, Conservancy, CDFG, USFWS, USBR	
Develop a watershed management program	Conservancy, USFWS, USBR, NMFS, CDFG, CDWR	In progress. Strategy expected in Fall 1998.
Establish operational criteria for Sanborn Slough Bifurcation.	Diverters, Conservancy, CDFG, USFWS, USBR	
Establish operational criteria for East Barrow pit and West Barrow pit.	Diverters, CDFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Establish operational criteria for Nelson Slough.	Diverters, Conservancy, CDFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.

Evaluation Studies from *Revised Draft Anadromous Fish Restoration Plan 1998*

How can we objectively and reasonably evaluate the conditions of Butte Creek relative to potential enhancements? One answer is by conducting a limiting factors analysis. To do a limiting factor analysis we must have basic stream condition information. Some stream survey is needed. The next step is an evaluation of the existing stream conditions. Professional judgment is then applied (or a more detailed and intensive study that we rarely can afford), to identify potential limiting factors and to select the most probable ones. In the Coast Range of Oregon, thousands of miles of stream habitat surveys have revealed some common patterns, and identified juvenile over wintering habitat (refuge from floods) as the most common limiting factor. This generality could very well apply to northern California and to Butte Creek.

This knowledge will help Butte Creek stakeholders narrow the list of potential enhancement efforts and make more cost effective walk through stream surveys.

The Shape of the Solution

Rebuilding salmon runs in Butte Creek will require a negotiated balance among wildlife, agriculture, urban, and fishery needs. Evaluating and determining water rights, water use, in-stream flow needs, flooding problems, riparian resources, property issues, and recreational needs will be a long-term effort requiring the involvement of irrigation districts, private landowners, agency personnel, anglers, environmentalists, and other stakeholders.

Chapter 7

Current Land Uses and Land Management

Land Ownership and Land Uses

The diversity in the terrain encompassed by the Butte Creek Watershed has resulted in very diverse landownership and land uses. This section describes ownership and land use patterns and is intended as a reference source for policy development and implementation measures that may be incorporated into the Butte Creek Watershed Management Strategy.

Land Use Map (see Map Appendix)

The Land Use map identifies the general land uses present in the Butte Creek Watershed. Land use is a term used to describe all aspects of human occupancy or modification of the face of the earth.

The Land Use Map was created by the Geographic Information Center (GIC) at CSU, Chico. In addition to graphically displaying information in the form of maps, the GIC can perform many useful analytical applications with data available from numerous sources including satellite imagery. This geographic analysis is possible through a technology known most commonly as geographic information systems or GIS.

The Land Use map was created with data provided by Butte, Tehama, Sutter, Glenn and Colusa County, as well as DFG. The land use categories used in the Land Use Map resulted from the combination of similar land uses from the various data sources. For example the DFG data identifies a vegetation type as “Flooded Agriculture.” For practicality and ease of use, the term was combined with an existing classification from Butte County data identified simply as “Rice.” The land use designations also broadly describe various types of land uses. For example, the designation “Residential” refers to a range of possible residential development from multi-family housing to rural residential housing. The Land Use Map, therefore, presents numerous generalizations and should be only used in a broad or regional context.

The Land Use map identifies the following land uses:

Commercial
Dry Farming
Field & Row Crops
Grazing
Irrigated Pasture
Industrial
Miscellaneous Agriculture
Orchards
Residential
Rice
Riparian Forest*
Upland Forest*
Unknown

* Most forests are multiple use including timber harvesting, recreation, wildlife habitat and flood protection.

A mathematical summary of the land uses from the Land Use GIS provides the following acreage for each land use category (see Table 7.1).

Table 7.1
Current Land Uses by Area

Land Use Category	# of Acres	% of Butte Creek Watershed
Commercial	3,518.48	<1%
Dry Farming	2,580.65	<1%
Field & Row Crops	24,167.99	5%
Grazing	84,871.37	17%
Irrigated Pasture	1,666.63	<1%
Industrial	1,690.02	<1%
Miscellaneous Agriculture	27,893.64	5%
Orchards	31,254.71	6%
Residential	62,362.34	12%
Rice	158,915.71	31%
Riparian Forest	2,033.56	<1%
Upland Forest	65,708.41	13%
Unknown	59.22	<1%
Total*	509,903.74	~100%

* The total acreage from the land use database differs from the total watershed acreage (517,848) due to the absence of land use value for things such as roads, rivers and creeks.

Not surprisingly, the land use analysis shows that much of the land in the Butte Creek Watershed is devoted to agricultural production. In fact, if the land use categories that can be associated with agriculture: Dry Farming, Field and Row Crops, Grazing, Irrigated Pasture, Miscellaneous Agriculture, and Orchards are combined; they would comprise nearly 65% of the total land use in the watershed.

Land Ownership (see Map Appendix)

Land in the upper watershed is owned primarily by Sierra Pacific Industries, USFS and BLM. Land in the canyon reach of the watershed is primarily privately owned with a few parcels of land owned by BLM and DFG. The valley portion of the watershed is made up primarily of private agricultural lands, again with some state and federal ownership.

The Land Ownership Map shows the larger land parcels (over ten acres) and municipal spheres of influence in the Butte Creek Watershed. The Land Ownership Map was developed with data provided by Butte County and DFG. (Data outside Butte County adjacent to the Sacramento River).

The lines on the map represent land parcels from the County of Butte Assessors Parcel Book as of mm\dd\yyyy. By examining the land ownership it becomes apparent that much of the residential development or potential residential development (small polygons) is located adjacent to the urban areas of Chico, Paradise and within the lower canyon area of Butte Creek.

For areas owned by private and public landowners see Tables 7.2 and 7.3, respectively.

Table 7.2
Eleven Largest Private Property Owners

Private Landowner	# Acres*
Sierra Pacific Industries	36,135.94
Parrott Investment Co. Inc.	11,724.42
Torrance Heritage Co.	7,472.04
Rancho Esquon Partners	7,245.91
Pacific Realty Associates LP	5,195.39
Nance Canyon Partners LP	4,519.11
Meline Edward & Charlene M IRR	4,435.77
Carmichael Francis L	4,176.39
Lucky Seven Ranch	3,788.20
G&M Ranches	3,407.39
Pacific Gas & Electric Co.	3,294.79
Total Public Land	91,282.59
Total Private Land	418,621.15
Total Butte Creek Watershed*	~509,903

Source: Geographic Information Center, CSU Chico.
* The total acreage from the land use database differs from the total watershed acreage (517,848) due to the absence of land use value for things such as roads, rivers and creeks.

Table 7.3
Public Landowners

Public Landowner	# Acres*	% total
Lassen National Forest	23,674.17	5%
California Dept. Fish and Game	15,180.76	3%
Bureau of Land Management	4,769.25	<1%
California Parks and Recreation	816.50	<1%
Other United States Forest Service	213.76	<1%
State Lands Commission	37.36	<1%
US Fish & Wildlife Service	1,898.99	<1%
Total Public Land	91,282.59	18%
Total Private Land	418,621.15	82%
Total Butte Creek Watershed*	~509,903.74	100%

Source: Geographic Information Center, CSU Chico.
* The total acreage from the land use database differs from the total watershed acreage (517,848) due to the absence of land use value for things such as roads, rivers and creeks.

Land Use Policies

Public Land Use and Management

Several local jurisdictions regulate planning processes over private land use decisions in the Butte Creek Watershed. The local jurisdictions include Butte County and the Cities of Biggs, Chico, Gridley and Paradise. These local governments have each adopted a comprehensive, long-term general plan, as required by California law, for the physical development within their boundaries.

The General Plan

The General Plan presents a policy framework within which local agencies review proposals for developing their resources. The policy statements contained in the plan must be brought about or implemented through a series of clear statements concerning the standards which must be met prior to development, and programs for financing, operating, and maintaining facilities that service existing and new development. California law provides local governments with a variety of ways to implement general plans. These implementation tools must, however be based upon the policies contained in the plan. Implementation measures most commonly used by cities and counties include: zoning regulations, subdivision regulations, specific plans, capital improvements, building and housing codes, environmental impact procedures, and citizen participation in decision making (with the understanding that final decisions will be made by elected bodies).

All discretionary decisions regarding land use, resource management, development approvals, environmental impact assessment and related matters must be considered by the Board of Supervisors or City Councils in the context of their current General Plan.

Butte County

The primary regulatory agency for private land use decisionmaking in the Butte Creek Watershed is Butte County. The policy making body for that agency is the Butte County Board of Supervisors with advisory input from the Butte County Planning Commission. The current Land Use Element of the Butte County General Plan was adopted in 1979 in compliance with Government Code Section 65302.

The total land area of Butte County is approximately 1,670 square miles. Most of the Butte Creek Watershed (809 square miles) lies within Butte County boundaries. Small portions of the watershed lie in Tehama, Glenn, Sutter, and Colusa County (see Map Appendix). These areas are relatively small, and except for Tehama County, are located in the lower valley section of the watershed near the Sacramento River.

Butte County General Plan Land Use Element/Area Plans

The Butte County General Plan, as amended by the adoption of the 1979 Land Use Element, consists of 16 "area plans." The area plan concept was designed to refine the designations shown on the countywide Land Use Plan, and to provide policy better tailored to the needs and conditions of the specific areas. Eight areas and communities identified in the Land Use Element are located in the Butte Creek Watershed. Several of these areas do not yet have Area Plans. The Butte County Master Environmental Assessment (BCMEA), 1996, summarizes the existing land uses in these eight areas as follows:

Cohasset-Forest Ranch
Located in the lower foothills adjacent to Chico and the Mountain areas around Butte Meadows, the Forest Ranch-Cohasset planning area occupies 139,000 acres. Land use in the area is dominated by forestry, livestock, and rural residential development. Forest Ranch and Cohasset are the two small communities in the area and new development is expected to concentrate in these communities, particularly for commuters to Chico. Development constraints in this area include steep slopes, poor erodible soils, limited groundwater, poor access, and high to extreme fire hazard.

Durham-Dayton-Nelson
Located south of Chico between the Sacramento River and State Route 99, the Durham-Dayton-Nelson planning area occupies 90,900 acres, mostly in agriculture. Urban uses are concentrated in the unincorporated communties of Durham, Dayton, and Nelson. Development constraints include county and city land use poolciies to protect agricultural lands.

The Durham-Dayton-Nelson Area Plan was adopted in 1992. The Plan establishes areawide land use policies that provide less potential for future development than had been allowed under the County’s old Durham Area

Plan. In order to separate land use policies for the Durham area from those for the Chico area, the plan also removed approximately 2,200 acres of land from the Chico Area Plan “greenline” policies.

Chico

Located in the northern portion of the valley adjoining the foothills, the Chico planning area occupies 22,300 acres. Urban land uses with significant public and regional retail uses predominate the area. Existing policies seek to preserve agricultural land, centralize development, and steer new urban growth to the north, east, and southeast. Development constraints include agricultural lands and poor soils in the foothills area.

The Chico Area Land Use Plan establishes a "greenline," generally around the western portion of Chico, corresponding to the "greenline" established by the City of Chico General Plan. The greenline constitutes the boundary between urban and agricultural uses on the western side of the Chico urban area. The County's area plan states that all land use on the "agricultural side" of the greenline “shall consist solely of Agricultural land uses as provided by the Orchard and Field Crop designation." Agricultural Residential land uses are also permitted on the agricultural side of the greenline, where designated by the Chico Area Plan. The Chico Area Plan further states that land uses on the urban side of the greenline "shall be guided by the policies of the Land Use Element and the applicable urban land use designation contained in the Land Use Element."

The area plan also establishes development policies for the Highway 32 corridor, which extends in an east-west direction through eastern Chico. Land use designations for this area are generally consistent with those of the City of Chico General Plan.

Magalia (Upper Ridge)

Located on the ridge above the Town of Paradise, the Magalia area is bounded by Butte Creek Canyon on the West and the West Branch Canyon on the east, covering approximately 13,900 acres. Magalia, an historic community, is characterized by rural residences nestled among the pines. Principal land uses include rural residential, commercial, and timber. Constraints include limitations on septic tank use, conflicts with watershed/water supply, and limited transportation access (only via Skyway).

Magalia has an area plan.

Paradise

Located on the major ridge in north Central Butte County, the planning area occupies 14,700 acres. Paradise is the third largest incorporated community in the county. Land use is dominated by residential and commercial uses with a limited number of industrial activities. Constraints include a shortage of flat developable land, no sewer system, and potential water supply limitations.

The Paradise Area Plan, adopted in 1981, prescribes land use for the Upper Ridge and the unincorporated areas adjacent to the Town of Paradise on the lower Ridge (including Lime Saddle). The area plan designates most of the Upper Ridge Area and Lime Saddle Area for residential uses at rural and low densities, and for open space (e.g. Grazing and Open Land and Timber Mountain). Area plan land use designations for the county areas within Paradise's Town limits are generally consistent with those of the Town of Paradise General Plan.

The Land Use Element (pages 82-83) contains a "Paradise Urban Reserve Policy Statement" which establishes further regulations for the "South Paradise Area," the area immediately adjacent to the area plan's southern boundary. The intent of the policy is to regulate future urban/residential development in an area currently devoted to mountain recreation, open space, and rural residential uses. The policy statements establishes an Agricultural-Residential land use designation in this area and calls for its management as an "urban reserve." The policy permits rural residential development on parcels of 1) not less than 40 acres in areas designated by the DFG as "No Development Zones" for protection of critical deer herd winter ranges, and 2) not less than 20 acres on all other properties until they are needed for development and adequate services are available.

Central Butte
Located south of Paradise and bounded by the Skyway, State Route 99, State Route 70, and the West Branch of the Feather River, the Central Butte planning area occupies 45,500 acres. Principal uses include cattle grazing and rural residential development. Butte College is also located in the area, but population is sparse. Development constraints include shallow soils, fire hazards, poor access, soil erosion, and possible conflicts with livestock operations.

This area has no plan.

Table Mountain
Located north of Oroville, between Lake Oroville and State Route 70, the Table Mountain planning area occupies approximately 55,500 acres. Livestock operations and rural residential are the main land uses. Development constraints include a lack of public services, poor access, fire hazards and shallow soils.

This area has no plan.

Gridley-Biggs
Located in the southwestern portion of Butte County, the Gridley-Biggs planning area occupies 129,700 acres. Principal land use is intensive agricultural, with urban uses concentrated in the cities of Gridley and Biggs. Constraints to future development include agriculture preservation policies and lack of capacity of sewer systems.

This area has no plan.

The land Use element of the Butte County General Plan also contains several policies which relate to the protection of the Butte Creek Watershed:

1.7.c Encourage development in and around existing communities with public facilities.

2.4.a Maintain quantity and quality of water resources adequate for all uses in the County (see Issues and Concerns chapter, # 2 - 8).

2.4.c Control development in watershed areas to minimize erosion and water pollution (see Issues and Concerns chapter, # 5 - 8).

5.3.d Direct future urban growth away from flood-plain areas (see Issues and Concerns chapter, # 6, 9).

6.4.c Encourage compatible land use patterns in scenic corridors and adjacent to scenic waterways, rivers, and creeks.

6.5.b Prevent development and site clearance other than bank protection of marshes and significant riparian habitats (see Issues and Concerns chapter, # 8, 9).

6.6.a Encourage the creation and expansion of natural and wilderness areas.

7.3a Limit development in areas with significant drainage and flooding problems until adequate drainage or flood control facilities are provided (see Issues and Concerns chapter, # 9).

The following policies from the land use element of the Butte County General Plan may be significant in future land use decisions:

1.4.a Based upon continuous analysis of population trends, provide plans which allow reasonable “freedom of choice” of sites and facilities for the population growth of the County, both in the County as a whole and in its various sections.

2.2.a Maintain extensive areas for primary use as livestock grazing land (see Issues and Concerns chapter, # 6).

2.2.b Allow livestock grazing on all suitable sites not needed for development or crop production.

4.2a Maintain economic use and value of private property.

Butte County General Plan- Other Elements

Most regulatory or development policy is located in the land use element of general plans. There are, however, several policy statements that might relate to the protection of the Butte Creek Watershed in other elements. In California all elements have equal legal status, and no element may be made subordinate to another. (California Land-Use & Planning Law, Daniel J. Curtin Jr., 1992)

The Open Space Element of the Butte County General Plan was adopted on December 21, 1976. The element addresses concerns about the conversion of agricultural lands into urban uses. The following are some of the *recommendations* listed in the element:

The County should allow urban development only in areas physically suited to such use (see Issues and Concerns chapter, # 9).

The County should not allow urban development of open space land described in this plan (see Issues and Concerns chapter, # 6).

The County should discourage urban development isolated from existing development and urban centers unless such a need can be determined.

Logging, mining, recreational vehicles and other open space uses should be regulated to prevent erosion and protect water resources (see Issues and Concerns chapter, # 4, 5).

The County should not allow any urban development in the Butte Sink area…

The County should permit the creation of residential parcels near large numbers of vacant sites of similar characteristics only if such a need can be demonstrated.

Specific Plans

A Specific plan is a planning tool used by local governments to implement general plan policies. Specifc plans offer an opportunity to combine zoning regulations, site development standards, and capital improvements into one document tailored for a particular area.

There are no county-approved specific plans located in the Butte Creek Watershed.

Butte County Zoning

The Butte County Comprehensive Zoning Ordinance. Approved January 1995, provides for a total of 70 zoning districts. Many of these zoning districts provide varying regulations within the same basic zoning district. For example Zoning District A-5 and A-10 are both Agricultural zones but differ according to their prescribed lot size, in this case 5 and 10 acres.

The following is a list of the basic zoning districts in the County of Butte:

Agricultural Zones
Timber Mountain Zones
Foothill Recreation Zones
Agricultural-Residential Zones
Suburban Residential Zones
Residential Zones
Commercial Zones
Industrial Zones
Resource Conservation Zone
Scenic Highway Zone

TPZ Zone
PUD Zone
Mobile Home Park Zone
Public, Quasi-Public Zone
Unclassified Zone

Zoning Amendments

Butte County is presently in the process of developing a zoning amendment that would affect 11.2 sq. miles in the Upper Butte Creek Watershed. This Watershed Protection Zone amendment is intended to protect the water quality of the Paradise Reservoir, Magalia Reservoir, and Firhaven Creek. This watershed protection policy was adopted by the Board of Supervisors by resolution. In order to codify the regulations to make them into an Ordinance, it has been necessary to again get the approval of the Butte County Planning Commission and the Board of Supervisors. The Planning Commission approved the amendment unanimously. The Butte County Board of Supervisors passed the Ordinance in June 1998.

The Watershed Protection Zone amendment will prohibit the future division of lots or parcels. It will restrict future zoning changes until studies can show that the zoning changes would have no adverse effects upon the water quality of the watershed. The amendment will also require specific sewage setbacks from streams and waterbodies.

Another proposed watershed protection amendment, the Stream Corridor (-SC) combining zone, was rejected by the Butte County Planning Commission in 1996. This amendment would have specified development standards in the Butte Creek Canyon as far as 300’ from the top of the bank of Butte Creek. It would have also created a “No Development Zone” within 100’ feet of Butte Creek.

New Town Proposals/ General Plan Amendment

In the past decade there have been several “new town” developments proposed in Butte County. Most recently a new town proposal called Central Buttes proposed to build 6,000 new homes adjacent to Highway 99 and the Durham/Dayton Pentz Road exit.

In order to legally accommodate such an expansive project, a General Plan amendment was proposed that would add a new land use designation. This designation, Agricultural Preserve/Planned Community, would allow for the development of the project while preserving a portion of the land for agricultural use and open space. The Board of Supervisors rejected the proposed General Plan amendment.

Incorporated Cities

The Butte Creek Watershed contains four incorporated cities all within Butte County: Biggs, Chico, Gridley and Paradise. Each city has a General Plan to guide development within the city limits and within the city's larger planning areas (BCMEA).

City of Chico

Located in the valley zone of the Butte Creek Watershed, the City of Chico holds regulatory authority over 80,000 acres within the watershed. The County of Butte has regulatory authority over 22,300 acres of land in adjacent unincorporated areas surrounding the City of Chico.

The City of Chico is Butte County’s largest urban community. The City grew rapidly during the 1960’s and the first half of the 1970’s mostly due to increased student enrollment at California State University, Chico. This growth established the City of Chico as a retail, service, and medical center for the region. According to the City of Chico Planning Department, the City’s population as of January 1, 1997 was 50,116. The total population for the Chico urban area was 92,500.

In the non-urban part of the City of Chico, the predominant land use on the valley floor is agriculture, including a variety of crops. Prime agriculture soils are found on the valley floor on the west side of the city.

Generally, soils to the east of the city are suitable only for grazing. In the foothill areas, the predominant uses are low-density housing, marginal agricultural activity, and recreation/open space (BCMEA).

General Plan

The City of Chico updated its General Plan with approval on November 16, 1994. The following policies are found in the “Guiding Policies: Growth and Physical Expansion” chapter of the Chico General Plan:

Promote orderly and balanced growth by working with the County and LAFCO to establish long-term growth boundaries for the Planning Area consistent with Plan objectives.

Promote infill development

Ensure that new development is at an intensity to ensure a long-term compact urban form.

Maintain long term boundaries between urban and agricultural use in the west, and urban uses and the hillside in the east, and limit expansion north and south to maintain compact urban form. Multiple approaches to restrict urbanization outside the City’s sphere of influence will be used, including large-lot zoning, and possibly acquisition of land for a greenbelt.

The General Plan identifies a portion of land within the Butte Creek Watershed as a Special Development Area. Special Development Areas are intended to "provide direction that adequately reflects the City's concern and the debate that has accompanied Plan preparation" (Chico General Plan 3.11 p. 3-49).

The Special Development Area is identified as "Westside of South Highway 99 - South of Entler Avenue." Two policies guide the development of this area:

LU-I-41

Require Manufacturing and Warehousing development designated on the General Plan Diagram on the westside of Highway 99 south of the proposed interchange and Entler Avenue, and development on the East side of Highway 99, east of Peterson Tractor, to be clustered. Provide for transfer of development rights, if necessary, in order to preserve the cottonwood riparian habitat along Highway 99, and biological resources along the southern boundary of the sites.

LU-I-42

Retain the existing stand of mature trees along the southern border of the Manufacturing and Warehousing development site.

In addition to the identified special area, the City of Chico General Plan has numerous guiding policies that may pertain to the protection of the Butte Creek Watershed:

Community Design

CD-G-10

Heighten the Visual prominence of the creek corridors that help to establish a sense of orientation and identity within the City.

CD-G-11

Open up creeks to public view and access

CD-G-12

Extend the amenity value of creeks

CD-I-6

Adopt design guidelines for development adjacent to creeks.

Parks and Public Facilities and Services

Use the creeks as a framework to provide a network of open space.

Open Space and Environmental Conservation

OS-G-5
Protect habitats that are sensitive, rare, declining, unique, or represent valuable biological resources in the Planning Area.

OS-G-7
Minimize impacts to sensitive natural habitats throughout the Planning Area.

OS-G-8
Preserve and protect areas determined to function as regional wildlife corridors, particularly those areas that provide natural connections permitting wildlife movements between sensitive habitats and areas being considered for future conservation because of their high value.

OS-I-18
Explore and implement, where feasible, linking Resource Conservation Areas with interconnecting open space corridors, particularly those which provide access to water sources and enhance overall biological diversity of the resource area.

OS-I-20
Explore and implement, where feasible, means to minimize or avoid interference with sensitive wildlife on the urban fringe by domestic pets.

OS-I-21
Ensure that all new developments restrict the use of fencing in locations essential for wildlife movement and place structures so as to minimize interference with wildlife corridors.

OS-I-22
Ensure that open space corridors along creeks include protective buffers (non-development setbacks) preserve existing riparian vegetation through the environmental review process, and continue to require a minimum of 25-foot dedication and acquisition of 75 feet for a total of 100-foot setback from top-of-bank along creeks.

OS-I-35
Work with the California Department of Fish and Game to ensure the preservation and enhancement of species of residents and anadromous fish in creeks in the Planning Area.

Water Quality

OS-G10
Enhance the quality of surface water resources of the Planning Area and prevent their contamination.

OS-G-11
Comply with the Regional Water Quality Control Board's regulations and standards to maintain and improve groundwater quality.

OS-G-12
Where feasible, given flood control requirements, maintain the natural condition of waterways and flood plains and protect watersheds to ensure adequate groundwater recharge and water quality.

OS-I-36
Continue to work with the Central Valley Regional Water Quality Control Board and Butte County Environmental Health Department in the implementation of the Nitrate Action Plan and land use controls for the protection of groundwater quality and the foothill primary recharge area.

OS-G-15
Preserve and enhance Chico's creeks and the riparian corridors adjacent to them as open space corridors for the visual amenity, drainage, fisheries, wildlife, habitats, flood control and water quality value.

Open Space

Maintain hillsides and viable agricultural lands as open space for resource conservation and preservation of views.

OS-G-16
Where feasible, integrate creekside greenways with the City's open space system and encourage public access to creek corridors.

OS-G-17
Protect aquifer recharge areas needed to maintain adequate groundwater supplies.

OS-G-18
Maintain oak woodlands and habitat for sensitive biological resources as open space for resource conservation/resource management.

Archaeological, Historic, and Paleontological Resources

OS-G-26
Protect archaeological, historic, and paleontological resources for their aesthetic, scientific, educational, and cultural values.

OS-I-52
Require a records search for any development project proposed in areas of high archaeological sensitivity.

OS-I-53
Require that sponsors of projects on sites where probable cause for discovery of archaeological resources (as indicated by records search and where resources have been discovered in the vicinity of the project) retain a consulting archaeologist to survey the project site.

Safety and Safety Services- Flooding and Dam Inundation

S-G-1
Minimize threat to life and property from flooding and dam inundation.

Town of Paradise

In 1960 the Town of Paradise area population was 11,000. Since that time, however, the area has been one of the fastest growing areas in Butte County. The Town’s population as of June, 1997 is 26,076.

The town of Paradise is predominantly residential in character with a significant retirement population. The existing agricultural uses, including vineyards, orchards, and grazing land, are located primarily in the southern and southeastern areas of town. Many of the residents of Paradise regularly travel 20 miles to urban services located in Chico.

The Town of Paradise is one of the largest urban areas (in the United States) without a municipal sewer system.

Growth has been constrained since the mid-1980's by the adoption of various sewage disposal ordinances. One ordinance requires approximately 20 to 25 percent more land per dwelling unit for septic-leach field than was previously required. Typically the minimum parcel sized for newly created parcels is greater than 1/3 acre to accommodate a single family on the required septic system and septic system repair area.

General Plan

The Town of Paradise updated its current General Plan in 1994. Key policies of the General Plan state the following:

The limitations imposed on the Paradise area by topography, soils, and other physical features shall be recognized in site-specific development design as well as when establishing long-term growth objectives.

The environmental and infrastructure constraints analysis system should be used to determine future zoning classifications, densities and intensities of land use and to evaluate future development projects.

The town should require all development proposals on sites which contain slopes exceeding twenty percent, and/or which border or include significantly important stream courses or natural drainageways, to include programs for replanting and slop stabilization, erosion control plans, and to incorporate designs which minimize grading and cut-and-fill.

In conjunction with input from Butte County, as soon as feasible the town shall prepare a specific plan for an orderly and balanced development of the secondary planning area south of the town limits which will more precisely determine residential densities, roads, drainage, utilities, and sewage disposal.

The Open Space/Agriculture" land use designation shall be applied to most lands within the Butte County urban reserve area in the southerly secondary planning area as a holding designation to prevent premature conversion to urban uses until such time as a specific plan is adopted and public facilities and services are available.

Development projects should be designed in a manner to accommodate the constraints on a parcel by avoiding them altogether or creating minimal loss or conflict.

City of Biggs

The City of Biggs is located in the southwest portion of the Butte Creek Watershed. Much of the growth of the City has depended upon agricultural development. Small fruit and field-crop farms and large rice-growing ranches presently occupy a major portion of the immediately surrounding area. Local economic growth is tied to agricultural productivity and the prospects of non-agricultural development appear limited. The population as of January, 1997 in the City of Biggs is 1,721.

The City of Biggs has very little development opportunity given that there is limited supply of vacant land. The City, however is proposing to increase the sphere of influence in order to accommodate more growth. Anticipated freeway improvements are expected to increase the development potential of Biggs and Gridley. It is projected that the growth rate of Biggs will remain at 1.2% where it has been for the last 10 years.

The City of Biggs General Plan was adopted in 1977. Policies in the General Plan call upon the City to:

Provide adequate space for anticipated residential, commercial, industrial, and agricultural growth as well as providing areas for public facilities and open space.

Encourage an orderly, functional and compatible land use pattern resulting in the reduction of land use conflicts

Discourage unnecessary urban sprawl thereby protecting surrounding prime agricultural lands and maintaining and enhancing the natural environmental setting.

Encourage the development of vacant land a redevelopment of blighted areas within the City in order to provide more efficient service at lower costs.

Protect the character and value of existing land use.

Achieve a balance of conservation and utilization of natural resources which meet the physical, economic, and social needs of the community.

Preserve lands highly suited for agriculture through encouragement of infilling and directing future development to areas contiguous with the urban area in order to minimize the loss of prime soils.

City of Gridley

The City of Gridley is located in the southwestern portion of the Butte Creek Watershed. Like Biggs five miles to the north, the City of Gridley is an agricultural town. Most of Gridley's residents are employed in activities related to farming, or in retail or service sectors. A large percentage of the population is retired (BCMEA).

In December, 1997 the estimated population in Gridley was 4,775. Much of the development in Gridley is single-family residential in character.

The following policies from the City of Gridley General Plan, Land Use Element adopted in 1992, call upon the City to:

Limit commercial, industrial, and residential growth to an overall historic growth rate of 1.3 percent.

Confine urban growth to the City's Primary Sphere of Influence.

Direct the majority of future urban expansion to the portion of the community served by Highway 99.

Locate the lowest appropriate residential density adjacent to county agricultural lands around the city periphery.

Prevent urban encroachment into productive agricultural lands by directing the City's expansion to the southeast to avoid the largest agricultural parcels.

Seek changes form the County plans and zoning that minimize the potential amount of agricultural land that could be removed form production.

Seek maximum coordination and compatibility between City and County planning activities in agricultural areas outside city limits.

Public Land Use and Management

Government land in the watershed amounts to 44,692 acres or 11% of the area. This land is located primarily in the upper section of the watershed.

A number of State and Federal agencies exercise some level of regulatory control over land use decisions in the Butte Creek Watershed, either through permitting and review or ownership of land. (BCMEA) For a description of the agencies with permitting and review authority please see the Existing Resource Protection Measures Chapter.

The Lassen Land and Resource Management Plan (LMRP) provides direction for planning and conducting resource management activities on National Forest land, including those public lands within the Butte Creek Watershed which are managed by the USFS. The USFS has the authority to dictate land use activities for the

Forest lands that are consistent with the Forest Plan. The LRMP was formally adopted in 1993 after several years of gathering data and public input.

Preparation of Forest Plans is required by the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1986 (NFMA), and implementing regulations found in the Code of Federal Regulations (36 CFR 219, issued September 30, 1982).

As directed by NFMA, the Forest Plan will be revised at least every 15 years and ordinarily every 10 years. It may be revised whenever the Forest Supervisors determines that the conditions or demands, including the RPA program, have changed sufficiently to affect goals or uses for the entire Forest. The Forest Supervisor will review conditions of the lands covered by the LRMP at least every 5 years.

Between Plan revisions, the Plan can be amended to reflect changing conditions. The Forest Supervisor can prepare and approve an amendment if the change is not significant. If the change is significant, the Forest Supervisor prepares the amendment for the Regional Forester's approval. Public notifications and adherence to NEPA procedures are required in either case.

LRMP Amendments

Since 1993, the LRMP has been revised twice by administrative amendments and once by legislation. These revisions include the following:

The 1992 CASPO interim guidelines which restrict logging in spotted owl habitat and restrict harvesting trees greater that 30 inch diameter at breast height. The guidelines were designed to maintain future management options by retaining stand components most at risk, difficult to replace and to protect spotted owl nest/roost stands.

The 1995 PACFISH interim strategy which was developed to protect at risk anadromous fish stocks. The strategy provides new riparian goals, interim Riparian Management Objectives, special standards and guidelines and delineates Riparian Conservation Areas. Additionally, it provides for identification of a network of key watersheds and initiation of watershed analyses. The watershed analysis process is intended to provide the site specific data and foundation for refinement of the long-term strategy. The PACFISH interim strategy has been extended until it is replaced by a long-term strategy.

The overall management scenario displayed by the LMRP and its subsequent administrative amendments indicates a clear direction toward watershed protection, particularly for anadromous fish habitat, old growth forests, and roadless areas.

Future issues and trends for management of public land in the Butte Creek Watershed include the following:

Continued movement toward an ecosystem approach to the management of public lands. This includes assessment of existing and desired conditions in developing vegetation management prescriptions. For instance, managing stands to achieve a desired habitat characteristic and fire risk, rather than a timber volume objective.

Greater emphasis on monitoring of activities and conditions to provide information necessary to adapt management strategies and prescriptions. Collecting monitoring data by efficient and effective means.

Increased coordination with private land owners and agencies to accomplish watershed and other large scale management objectives.

USFS Management Direction

The purpose of the LMRP is to:

Define the resources to be emphasized in different parts of the Forest

Establish goals and objectives for commodities and services to be provided

Prescribe standards, guidelines, and practices to achieve the goals and objectives. This management direction provides the framework for interdisciplinary project-level planning.

Direction for management of National Forests comes from law, regulation, policy, and procedures. The many laws enacted by Congress for this purpose include, among others: the Organic Administration Act of 1897, the Multiple-Us Sustained Yield Act of 1960, the Forest and Rangeland Renewable Resources Planning Act of 1974, and the National Forest Management Act of 1976. Regulations developed by the Secretary of Agriculture are found in the code of Federal Regulations (CFR). Policies developed by the agency are listed in the Forest Service Manual (FSM), and procedures developed by the agency are described in the Forest Service Handbooks (FSH).

The Forest will continue to be guided by these laws, regulations, and Forest Service Manual policy and Handbook procedures. This Forest Plan supplements, but does not replace, the direction from these sources. The Plan generally does not restate this direction, except where it is necessary to clarify treatment of an issues or concern.

USFS Management Areas

There are seven USFS Management Areas located in the Butte Creek Watershed:

Management Area 37	Butte Creek
Management Area 41	Middle Deer Creek
Management Area 43	Lomo
Management Area 44	Jonesville
Management Area 45	Soda Ridge
Management Area 46	Philbrook
Management Area 47	Mt. Hope

Much of the USFS land in the Butte Creek Watershed is located in Management Area 43 (Lomo) (see Table 7.4) and Management Area 44 (Jonesville) (see Table 7.9). The following section provides a description and standards and guidelines for Management Area 43 and Management Area 44 in the Butte Creek Watershed.

Table 7.4
Management Area 43 - Lomo

County	Butte
Ranger District	Almanor
Acreage:	
National Forest	5,025
Other	25,142

Location
The Lomo Management Area has the least amount of National Forest lands of any management area on the Almanor Ranger District. It contains scattered National Forest parcels ranging in size from 80 to 640 acres; the majority are plantations and reforestation sites initiated by the former Magalia Ranger District in the 1950's.

Physical Environment
The terrain is mountainous, especially in the vicinity of Big Chico and West Branch Canyons. The highest elevation is 5,307 feet at Bottle Hill. Short reaches of Big Chico and cascade creeks are on Forest lands; these streams support fisheries. Precipitation averages 65 inches a year. The soils are generally moderately deep and weathered from andesite, metavolcanic, and metasedimentary.

Biological Environment
Vegetation is predominantly the mixed conifer type. Fuel loads vary from light to heavy. Fires burn an average of once every three years. While records show the occurrence of large fires in the past, in recent years none has exceeded 10 acres. Almost 70 percent has been human caused. Wildlife species are typical of the mixed-conifer community, and include goshawks and black bears. Big Chico Creek supports a high quality trout fishery and contributes high quality water to a reach downstream occupied by anadromous fish. It was listed on the USDI Nationwide Rivers Inventory of 1981.

Management
The area was the scene of early logging. Small mills were located at various places, including the West Branch of the Feather River. Lumber was flumed from an early mill at Chico Meadows down Big Chico Creek Canyon to the Central Valley. Butte Meadows was an important logging center for Diamond International and supported a large camp. In addition to logging, mining was an important activity. The community of Inskip was a thriving commercial center for the mines in the area long before large scale lumbering began; all that remains is a hotel and a few buildings. The area is part of the Bull Hill and Butte Meadows Range Allotments. Developed sites are Soda Springs Campground and Butte Meadows Campground; Butte Meadows also has a summer home tract.

Facilities
The Butte Meadows fire station is occupied in the summer and fall. Butte Creek has been the subject of applications for small hydroelectric generation facilities. State Highway 32 and the road to Butte Meadows and Jonesville give access to many private roads in the area.

USFS Standards and Guidelines for Management Area 43

Facilities

1. Evaluate the Butte Meadows fire station for future administrative purposes.

Lands

1. Assess the need to preserve biodiversity when selected isolated parcels are proposed for land exchange.

Sensitive Plants

1. Inventory for possible populations of Constance's rock cress (Arabis constancei), Stebbin's monardella (Monardella stebbinsii), and Feather River stonecrop (Sedum albomarginatum) on serpentine soils.
2. Inventory for closed-throated beardtongue (Penstemon personatus) in red fir and mixed conifer stands.

USFS Prescription Allocation for Management Area 43
Prescription allocations apply a theme for management of specific land areas. Only one prescription can be applied to a given acre of land. Each prescription listed below (see Table 7.5 - 7.8), for example Range-Wildlife, has a specific purpose, management practices, application areas and standards and guidelines. For a detailed description of these prescriptions, readers are encouraged to review the Lassen National Forest Land and Resource Management Plan.

Table 7.5
Areas of Prescription Types

Prescription		**Acres**
B	Range-Wildlife	900
D	Developed Recreation	15
E	Early Successional	100
K	Rocky/Sparse Timber	600
T	Timber	410
V	View/Timber	3,000
Total		5,025

Table 7.6
Wildlife Habitat Allocation for Management Area 43

Goshawk Territories	1
Other Emphasis Species:	Black bear, rainbow trout.

Table 7.7
Desired State for Diversity for Management Area 43

	Vegetation	**Acres**
Shrub		
	Chaparral	635
	Montane Shrub	0
	Sagebrush	0
Conifer Forest		
	Eastside Pine	0
	Mixed Conifer	140
	Red Fir	0

Table 7.8
USFS Range Allotment Strategies for Management Area 43

Allotment	**Strategy**
Bull Hill (100%)	A
Butte Meadows (50%)	C

(See Appendix N for Range Allotment Management Strategies)

Location
The Jonesville Management Area (Area 44) is located in the south central portion of the District. Several scattered inholdings occur along creeks and valley floors. For prescription allocations see Tables 7.9 - 7.13.

Physical Environment
The terrain is mountainous. The highest elevation is Humboldt peak at 7,087 feet. The Pacific Crest Trail crosses the area in the vicinity of the peak. Butte Creek and its tributaries drain most of the area. Precipitation averages 75 inches a year. Soils are stony and moderately deep to deep. The Snow Mountain area has been glaciated and has large numbers of stones on the surface.

Biological Environment

The forest at higher elevations is composed of red fir, while a mixed conifer forest characterizes the middle and lower elevations. Fuel loads vary from light to heavy. Approximately one third of the area consists of vast brushfield resulting from fires. Several pine plantations have recently been established in them. In 1970, a 75-acre fire burned in this area, but since then no fire has exceeded ten acres. Fires average one per year, and all are human-caused. Goshawks are known to nest here. Black-tailed deer summer in the meadows and brushy areas. Butte Creek and other fish streams flow through the area.

Management

Timber has been harvested throughout the eastern two-thirds of the area. It is part of the Soda Creek- North Butte, Butte Meadows and Coon Hollow Range Allotments. Cherry Hill campground is along Butte Creek, and the Jonesville summer home tract is located nearby. Some hiking, fishing, and camping occurs along Butte Creek and Scotts Creek. Two gold mining claims are present near Colby Mountain.

Facilities

The are is crossed by the Humbug and Humboldt County Roads. These were developed on early competing stage from the Sacramento Valley to mining communities in Nevada and Idaho. Remnants of the original Humboldt Grade are found near Humboldt Summit. Jonesville, in the approximate center of the area, was one of the stage stops. The Pacific Crest National Scenic Trail follows the eastern edge of this area.

USFS Standards and Guidelines for Management Area 44

Facilities

1. Assess the Cold Springs location for a proposed administrative site.

Fish

1. Evaluate the fish habitat conditions and use in the Butte Creek Watershed

Recreation

1. Interpret significant land management activities along the Pacific Crest National Scenic Trail for trail users.
2. Manage the undeveloped camping area at Cold Springs as dispersed campsites.
3. Analyze the developed recreation potential of newly acquired parcels along Colby Creek before engaging in any activities that could adversely affect that potential.

Sensitive Plants

1. Inventory for possible occurrences of short petalled campion (Silene invisa) and closed throated beard tongue (Penstemon personatus) in red fir stands.

Visual Resources

1. Meet a visual quality objective of Partial Retention in the foreground of Pacific Crest Trail.

Wildlife

1. Maintain or enhance potential willow flycatcher habitat.

Table 7.9
USFS Management Area 44- Jonesville

County	Butte
Ranger District	Almanor
Acreage	
National Forest	23,120
Other	4,561

Table 7.10
USFS Prescription Allocation for Management Area 44

Prescription		Acres
A	Non-Timber Wildlife	900
B	Range-Wildlife	1,860
D	Developed Recreation	20
E	Early Successional	100
F	Riparian/Fish	900
K	Rocky/Sparse Timber	1,350
L	Late Successional	330
T	Timber	11,030
V	View/Timber	6,630
Total		23,120

Table 7.11
USFS Wildlife Habitat Allocations

Goshawk Territories	1
Other Emphasis Species:	Deer (summer range), black bear, rainbow trout, spotted owls.

Table 7.12
USFS Desired State for Diversity

Vegetation		Acres
Shrub		
	Chaparral	9
	Montane Shrub	25
	Sagebrush	0
Conifer Forest		
	Eastside Pine	0
	Mixed Conifer	685
	Red Fir	275

Table 7.13
USFS Range Allotment Strategies

Allotment	Strategy
Butte Meadows (25%)	C
Coon Hollow (40%)	C
Soda Creek-North Butte (45%)	C

Bureau of Land Management (BLM)

The Bureau of Land Management owns and manages various small land holdings throughout the Butte Creek Watershed. This BLM land falls within the "Forks of Butte Creek" subsection of the Ishi Management Area. (Redding Resource Management Plan and Record Decision). The following policies have been established for this BLM property:

The Redding Resource Management Plan (RMP) guides the BLM in managing its public land and mineral reserve estate within the Redding Resource Area of northern California. Sections 102 and 202 of the Federal Land Policy and Management Act (FLPMA) requires the Secretary of the Interior to develop land-use plans for all public land under the administration of the BLM.

The primary purpose of the RMP is to update and integrate BLM land use planning into a single comprehensive land use plan. The RMP is a fifteen year strategy on where and how BLM will administer public lands under their jurisdiction within the Redding Resource Area. When fully implemented, the BLM public land ownership pattern will shift dramatically from more than 1,000 scattered parcels to less than twenty-five large aggregates of accessible and useful public lands. This will be accomplished principally through land exchanges with the private sector and some transfers of jurisdiction with other agencies and organizations.

BLM Planning Area

The Redding RMP covers a planning area which is identical to the Redding Resource Area. The planning area encompasses approximately 9,914,000 acres within the north central portion of California. BLM administered public lands total approximately 247,500 acres of roughly 2.5% of the surface of the area within the Redding Resource Area boundary. These public lands are generally scattered throughout the middle and to a lesser degree, lower elevations of the planning area. The over 1,000 individual parcels of BLM administered public land range in size from a fraction of an acre to over 8,000 acres.

The planning area encompasses all or portions of five counties including: Butte, Shasta, Siskiyou, Tehama, and Trinity. Approximately one half of the planning area is privately owned land predominately within the lower elevations or valleys. The public owned half of the resource area is dominated by the U.S. Forest Service, notably the Shasta, Trinity, Klamath and Lassen National Forests. The overwhelming majority of forest Service administered public lands are located within the upper elevations of the planning area.

BLM Planning Issues

Planning issues are the major concerns with the management of BLM administered public land within the Redding Resource Area. These issues drive the entire RMP process through all steps of the planning process since the land-use management alternatives, including the proposed action, are designed to address these planning issues. There are four planning issues that the BLM has defined which encompass the majority of concerns for management of BLM administered public lands. These issues include land tenure adjustment, recreation management, access and forest management.

BLM Management Concerns

The BLM uses the RMP process to make other decisions to resolve management concerns. Many of these decisions are required through Supplemental Program Guidance (BLM Manual 1620) and California BLM State Director Guidance. A few decisions are made to address management situations especially applicable or unique to the planning area. These decisions or management concerns are treated within the context of the proposed action or as Resource Area-Wide Decisions.

Some of the more significant decisions include: designation of Areas of Critical Environmental Concern (ACEC), designation of Special Recreation Management Areas, determinations of eligibility (and preliminary classification) for inclusion of specific streams in the national Wild and Scenic Rivers System, determinations of Recreation Opportunity Spectrum settings to be maintained, and closure of areas to domestic livestock grazing.

BLM Monitoring and Implementation

BLM will monitor the RMP on an annual or as needed basis. The purpose of the monitoring is to track successful completion of the actions approved by the RMP and to identify needed changes to the RMP. Minor changes in data not necessitating changes in land use allocations, restrictions or uses are documented in supporting records. Public involvement is not necessary to perform this plan maintenance. However, the BLM will be required to fully involve the public in any substantive modification of the RMP. Any change to land use allocations, restrictions or uses will be effected only through a formal plan amendment or revision prepared in conformance with BLM planning regulations found in Section 1610.4 of Title 43 of the code of Federal Regulations.

Management Area Decisions

The BLM's objectives for Ishi Management Area as described in the RMP for resource condition objectives, land use allocations, and management actions for Butte Creek are as follows:

Resource Condition Objectives

1. Protect and Enhance the scenic quality of the canyon.
2. Maintain the fisheries habitat.
3. Improve the quality of riparian vegetation to Class I.
4. Maintain semi-private recreation opportunities.
5. Protect the historic values of the canyon.
6. Maintain the long-term sustained yield of forest products from the available commercial forest land outside the Butte Creek canyon.

BLM Land Use Allocations

Forks of Butte Creek

1. Designate Butte Creek Canyon from above the Forks of Butte Creek to Helltown as an Outstanding Natural Area/ACEC.
2. Manage as Semi-Primitive Motorized.
3. Vehicle use is limited to designated roads and trails.
4. Withdraw public lands from mineral entry.

5. Recreational mineral collection is permitted within the canyon.
6. Manage as VRM Class II.
7. The area is closed to grazing.
8. Acquire available, unimproved lands to protect scenic quality and enhance recreational experience.
9. All of the available commercial forest land within Butte Creek canyon would be managed for the enhancement of other resource values. All other available commercial forest land would be managed as restricted.

Remainder of Management Area

6. Transfer via exchange of R&PP to a qualified organization administrative responsibility of 35 acres of public land in Lower Butte Creek (near Honey Run Bridge) within the NE ¼ Section 36, T.22N., R. 2 E. Offer for exchange to any party after two years from approval of the Final RMP.

BLM Management Actions

A. Develop suitability reports for the final classification and potential inclusion of Battle, Butte, and Deer Creeks in the National Wild and Scenic Rivers System.

D. Develop ACEC management plans for Deer Creek and Forks of Butte Creek. The results of reports addressing the suitability for inclusion in the National Wild and Scenic Rivers System will be included as appropriate.

G. Publish Federal Register notices regarding vehicle designations, mineral withdrawals, ACEC designations, and intent to develop a report(s) addressing the suitability of Battle, Butte, Deer, Bear and Big Chico Creeks for inclusion in the National Wild and Scenic Rivers System.

Rationale for the Ishi Proposed Action

Butte Creek has regionally significant recreational and cultural values, coupled with local mineral and hydroelectric importance. Consolidation of public land within this area will benefit the public for a very long time. The stream is considered eligible for inclusion in the National Wild and Scenic Rivers System. Competing public demands and proximity to a large population, however, warrant additional management attention and designation as an Outstanding Natural Area/ACEC. The existing mineral withdrawal coupled with a recreational mineral collection program has worked well for the public and natural resources. Expansion of this management strategy will enable BLM to protect sensitive resources while enhancing the recreational experience of most public land users. (Redding Resource Management Plan and Record of Decision. Bureau of Land Management, 1993)

California Department of Fish and Game

The California Department of Fish and Game owns a significant amount of land within the Butte Creek Watershed (15,180.87 acres). A majority of the Department’s land is contained in their large landholdings including the Graylodge Wildlife Area and the Howard Slough Unit. Specific land management policies have been developed for these large parcels.

The California Department of Fish and Game has the following policies regarding the use of its property, as outlined in the *Fish and Game Operations Manual, February 1994*:

Department Owned or Controlled Real Property

The policy of the Department on real property, which is owned or controlled by the Department, is that it shall be used, managed, maintained, or developed in accordance with the primary purpose for acquiring the property.

Guidelines for the use of real property will include, but are not limited to the following:

Providing suitable habitat and living space for the preservation of native species and endangered animals and plants.

Protecting surrounding agricultural lands from depredating waterfowl by providing feeding and resting areas for waterfowl.

Providing access to public lands for hunting and fishing opportunities.

Providing for multiple use of the area when this use will not unduly interfere with the primary use of the land.

For the purpose of this policy, real property shall include but is not limited to wildlife areas, hatcheries, refuges, and ecological reserves.

Chapter 8

Historical Uses and Cultural Resources

Prehistory

Although human occupation of the northern Sacramento Valley extends back 10,000 years or more, reliable evidence of the presence of such early inhabitants is lacking. If humans did occupy the area during this period, much of the evidence of their presence has been deeply buried under alluvium (Moratto, 1984).

Recent archaeological evidence suggests the earliest residents of the Butte Creek Watershed descended from the Hokan-speaking people and eventually radiated into the northern Sierra Nevada, southern Cascades, southern Klamath, and northern Coast Ranges (Jensen and Associates, 1994). After 100-200 AD, Penutian-speaking people displaced some of the Hokan populations in the Sacramento Valley and the northern Sierra Nevada foothills.

Ethnographically, the project area corresponds roughly to the territory claimed by the Maidu (also known as the Mountain or Northeastern Maidu) and Konkow (also known as the Northwestern Maidu) (Riddell, 1978). The Maidu inhabited an area of northern California extending from Lassen Peak to the Cosumnes River and from the Sacramento River to Honey Lake. Ethnographic boundary zones with other tribal populations are also located in the Butte Creek Watershed. The division of these groups is based on linguistic and environmental differences. Three distinct languages within the Maiduan family Penutian stock have been classified (Shipley, 1964). Several dialects existed within each language.

The Watershed Project study area is located within the original territory of the Northwestern Maidu or Konkow (Riddell, 1978) (see Figure 8.1). The Konkow inhabited the Feather River area west of Richbar, extending to the southwest short of the Sutter Buttes, and along the Sacramento River near Butte City in the south and to Vina in the north. The Konkow shared their southern and eastern borders with the Nisenan, the west with the Momlaki, and the north with the Yan and Northeastern Maidu (Riddell, 1978). They lived primarily in family units in small villages located along streams. Villages were inhabited full-time mainly in the winter months, as spring, summer, and fall were prime gathering and hunting times in nearby foothills and higher elevations. Housing was constructed of bark; earthen materials were most often used only for lodges and sweathouses.

The Konkow were politically organized by tribelet; each tribelet was composed of several villages. When needed for group decisions or activities, a leader for the tribelet was selected from the headmen of the villages. Headmen acted as advisors to the group; they were chosen through the auspices of a shaman for qualities such as wealth, maturity, ability, and generosity.

The Konkow were seasonally mobile gatherers and hunters, subsisting on an opportunistic diet of plants and animals. Acorns were a primary staple for the Konkow of Butte Creek who preferred the seeds of the black, canyon, and live oaks (Kowta, 1988). Pine nuts (digger, Ponderosa, sugar pines), buckeye, nutmeg (Maniery et al., 1985), and manzanita berries supplemented acorns. Roots, bulbs, and wild mint also provided nutrition and doubled as medicinal curatives (Riddell, 1978). Deer and elk were the primary game hunted by individuals and groups of men. Other sources of meat included mountain sheep, bobcat, lion, bear, rabbit, raccoon, squirrel, duck, geese, quail, and pigeon.

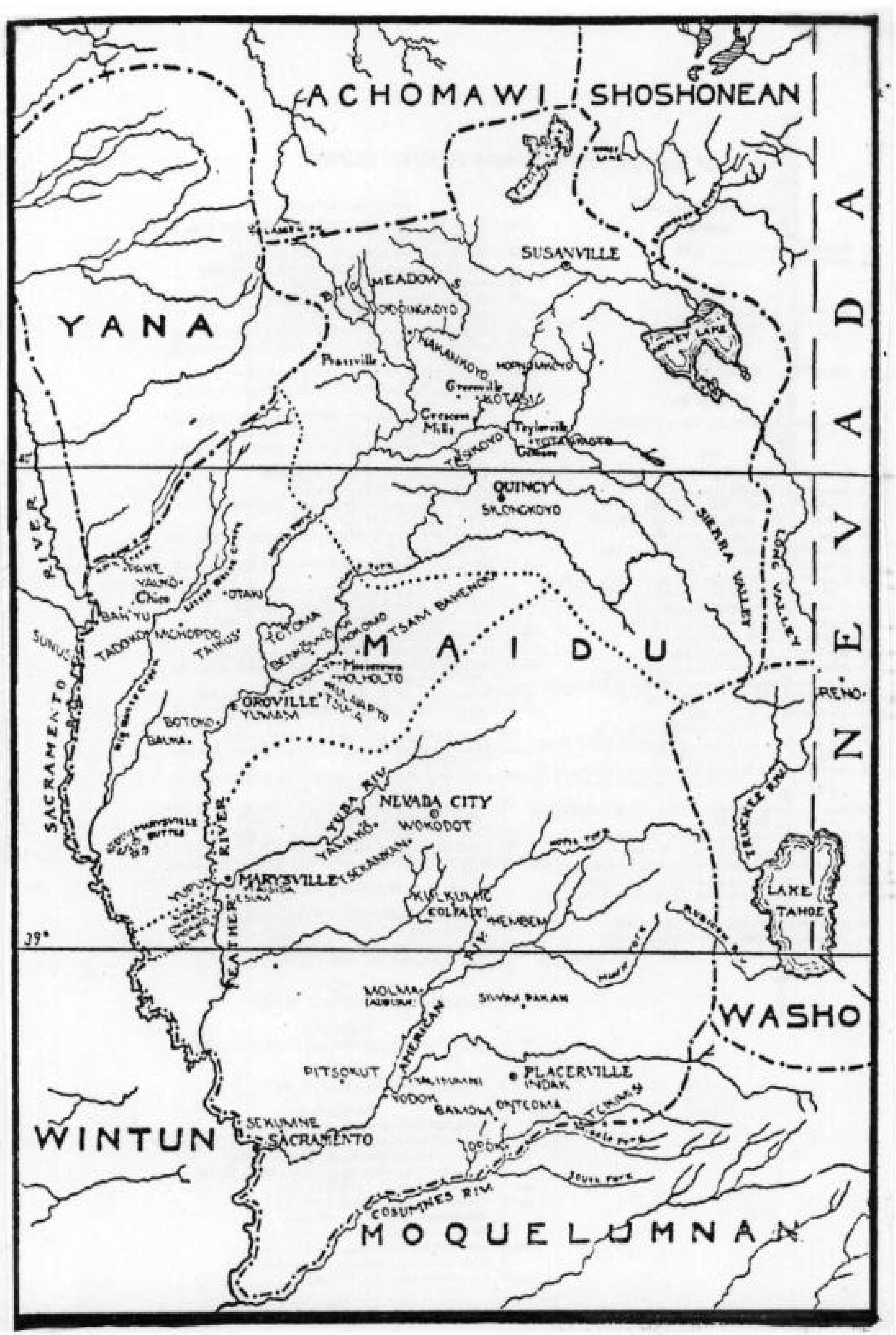


Figure 8.1 Map showing mines in the Butte Creek watershed circa 1945
(Source: Department of Mines and Geology, 1949)

The use of salmon as a primary food source is significant in this analysis of Native American occupancy in the Butte Creek Watershed. Given the relatively low population densities of Maidu in the region, their take of salmon is not considered to have been overly intense. Fish were most often harvested with spears or taken in nets, although occasionally small hooks were made from two pieces of bone tied together. However, despite widespread use of salmon and other fish from the creek, no permanent structures were placed in the water to catch salmon. The Maidu that lived in the foothill region always had a celebration when the first salmon came up the creek. No one could fish for the salmon until a shaman caught one. The shaman would then cook the fish on site and give pieces to everyone present. After this ceremony was complete anyone could harvest the salmon that were migrating up the creek. These celebrations in spring and autumn were important cultural and religious events, as the salmon were regarded as sacred. Fish of many kinds were available but salmon were caught in considerable quantities in the early days (Dixon, 1905). All fish that were ready to lay eggs were handled with care and gently put back in the water. This was a common practice of the Maidu concerning any living animal that was ready to bear young.

As with many other Native American groups in the United States, the Maidu burnt large areas in Butte Creek canyon and in its lower drainage basin to encourage growth of preferred plants (Dempsey, 1996). Centuries of induced burning altered the vegetation distribution in the region by controlling plant succession. The effects of deliberate fires, although difficult to quantify, may be the most significant evidence of Maidu-induced environmental impact in the region.

Despite the long occupancy of these aboriginal people in the Butte Creek drainage area, this group sustained only minor environmental impacts in the region. In contrast, the arrival of Euro-American and Asian settlers not only displaced the majority of native peoples but also brought about significant changes to both land and water ecosystems.

Historical Land Use

Although the first contacts with Euro-Americans occurred in 1808, it was not until 1828 and after that Maidu exposure to Euro-Americans became intensive. The increased contact was a result of fur trapping in the region by Hudson's Bay Company. In 1833, an epidemic, possibly of malaria and smallpox, killed up to 75% of the Konkow population. The establishment of Sutter's Fort in the Nisenan territory in 1839 became the focal point of settlers' and miners' incursions into Konkow lands, especially after the 1848 discovery of gold. The reduction in population as a result of the epidemic left the Konkow unable to resist the overwhelming flood of miners and settlers. Many of the few survivors became wage laborers at mines and ranches, while their language and culture nearly disappeared.

In 1840 Peter Lassen and a partner started a ranch on Deer Creek, marking the first real settlement of Euro-Americans in Maidu territory. Around this time, Oregon settlers opened a new road from the Fort Hall Area on the Snake River in Idaho to the Willamette River in Oregon. This road passed by Goose Lake in Northern California where Lassen decided to extend it for his own use through Maidu country. He brought the road along the Pit River around the east side of Lassen Peak, west to Big Meadow (Lake Almanor) and down to his Deer Creek ranch. The Maidu didn't think much of Lassen, referring to him as a squaw chaser. Maidu tradition actually claims that Lassen was killed by a Maidu man for stealing his wife (Potts, 1977).

As more white miners and ranchers began appearing on traditional Maidu land there was no initial conflict because the Maidu didn't understand the concept of land ownership. Ranches developed so fast that it wasn't long before the Maidu were left as laborers or homeless wanderers. Finally in 1910 the Maidu presented a case to the U.S. Land Commission and had their claim settled for 75 cents per acre. It is unbelievable that with the amazingly fast settlement of the area that there are no documented Maidu uprisings, but they were notoriously a very peaceable people only having slight conflicts with a neighboring tribe from the Mill Creek area (Potts, 1977).

By 1850, the United States government had passed a series of laws that established reservations for the remaining members of the Konkow Maidu living along Butte Creek. In 1855, up to one thousand people from

By 1850, the United States government had passed a series of laws that established reservations for the remaining members of the Konkow Maidu living along Butte Creek. In 1855, up to one thousand people from several tribes were guarded under tight security at the Nome Lackee Reservation in Tehama County (Hardwick and Holtgrieve, 1996). Riddell, (1978) estimated that there were perhaps only 600 individuals claiming Maidu or Konkow ancestry in the northern California counties of Butte, Plumas, and Lassen in the late 1970's. Although crude census counts often overlooked many individuals in the area, Table 1 below provides evidence that the most drastic decline in population totals of the Maidu occurred in the late nineteenth and early twentieth centuries.

Table 8.1
Total Maidu Population

Year	Population
1846	8,000
1850	3,500-4,500
1852	5,000
1856	2,300
1865	1,550
1880	1,000
1910	900

(Source: Riddell, 1978)

The Butte Creek Watershed area is located on the 1844 Mexican land grant once owned by William Dickey and Edward Farwell. The grant was known variously as Rancho Arroyo Chico, Rancho Chico, and Rancho Farwell. The land was purchased from Dickey and Farwell in 1849 by John Bidwell, who later established the town of Chico (Bidwell 1863). Chico Landing, also known as Bidwell’s Landing, is located on the Sacramento River approximately 3,000 feet northwest of the project area. This site was used as a ferry crossing and loading dock and is shown on the 1862 County Map.

In 1863, John Bidwell and a small group of partners purchased a road building franchise for $40,000 from the State of California. Bidwell and his partners utilized the labor of the Maidu people and their knowledge of existing footpaths and game trails to build a road across the Sierra Nevada. Ready for use in 1864, Humboldt Wagon Road provided a new route over the Sierra to access mining areas in Northern Nevada (Bidwell, 1863). The wagon road served many other purposes as well by opening previously inaccessible areas for development. Timber harvest increased dramatically in the region. The road provided a route for cattle drives, as well as for mail service from Boise City, Idaho to Chico beginning in 1866 (Hill, 1997). During the late 1860's and 1870's the road brought settlers into the Butte Meadows and Jonesville areas. Cabins and hotels sprung up along the road, serving as summer retreats and rest stops for travelers. Butte Meadows became the social center of the area hosting a hotel, bar and store (Pers. com. Jessee, 1997).

Logging

The upper basins of Chico Creek and Butte Meadows were at elevations well suited to conifer growth, and the trees were of remarkable size and quality. These forests were made up of huge sugar pines, as well as ponderosa pine, spruce, fir cedar and madrone.

Logging was the second industry to arise in the watershed after mining. As the miners first arrived, they cut just a few trees to build cabins, fences, bridges, to use as fuel and eventually for flumes. Inevitably some of the pioneers turned to harvesting the timber as a source of income, instead of searching for gold. Small mills began to spring up in the mid 1850’s but it wasn’t until the 1860’s that the larger mills began to appear.

It is believed that the first mill in the area was the Woodsum Brothers “lower mill,” about 2 miles below Lomo (Pers. com. Nopel, 1998). This mill was built in about 1864 with the completion of the Humboldt Road. The

Woodsum Brothers also had an “upper mill” at Chico Meadows, which was built soon after their first mill. For the next few years the lumber was brought down the Humboldt Road, by wagons pulled by six or eight yoke (teams) of oxen. The oxen were the first animals to be used for labor by the lumbermen. Not only were they used to pull the logs out of the woods to the mill and then down to the valley, but during the winter they were used to trample down the snow on Humboldt Road. The oxen were used until the 1880’s when horses and mules replaced them.

In the late 1860’s, Benjamin F. Allen, George M. Taylor and Charles H. Holbrook bought the Woodsum Brothers upper mill. In 1870 they built the Cascade Mill and at that time joined forces with the Woodsum Brothers, who had retained their lower mill, to form the Butte Flume and Lumber Company (Hutchinson, 1956). At this time more mills began to appear in the upper watersheds of Chico and Butte Creeks.

It was decided in 1872 to build a flume down Chico Creek Canyon and construction began in November of that year. Valley residents' fears about shortages of water were put to rest the following summer when D.S. Baker built a ditch from his spring in Butte Meadows to the flume carrying 600 inches of water (Hutchinson, 1956). In August of 1874 the flume was finished, extending 33 miles from Chico Meadows to the present five-mile picnic area in Bidwell Park. The v-shaped flume was made completely of wood, except for the nails. It was 12 inches across at the bottom, 5 feet across at the top and carried 2 feet of water (Nopel, 1998). Four ditch tender’s cabins were built along the flume with at least two tenders at each cabin.

The building of the flume made the local lumber industry much more economically efficient. Where it used to take two to three days for cut lumber to be loaded and hauled to Chico, now it took just four hours to reach the valley. The first day the flume was opened it carried 100,000 feet of cut lumber down to Chico (Hutchinson, 1956). The local lumber costs dropped drastically and became increasingly more competitive in the larger market. It wasn’t long before Butte County became the leading pine producing county on the western slope of the Sierra Nevada. By 1876 Sierra Lumber Company had moved into the area and bought up all of Butte Flume and Lumber Company’s holdings. The first thing Sierra Lumber did was to relocate the main mill down to the Providence Mill, where Campbell Creek spills into Big Chico Creek. They extended the flume two miles to a new lumber yard at the corner of East Eighth and Pine streets. From there the flume made a 90 degree turn and emptied back into Chico Creek (Nopel, 1998). By the 1890’s Sierra Lumber Company was running one of the largest saw mills in the world.

The first Dolbeer steam donkey engines to be used in the Sierra Nevada were by Barney Cussick at Chico Meadows in 1886 (Hutchinson, 1956). This allowed for logs to be attached to a cable and dragged out of the woods, utilizing steam power. The new Dolbeer engines allowed the smaller mills to be able to move to new locations more often. For example John Hupp ran a mill near De Sabla that he had on skids. He would simply hook up his team of horses and drag the mill to a new spot. It wasn’t long after that steam powered tractors began to be used to haul the cut trees to the mills. This gave rise to the first railroad tracks being built in the area. At first the tracks were simple wooden rails that supported wagons. Soon iron tracks were laid and it was not long before the steam locomotive would be introduced. Although Sierra Lumber never had a complete system of tracks, it still opened up vast areas of timber to be harvested.

In 1903, the Sierra Lumber Company’s mill in Chico burned to the ground. The following year they rebuilt only to have another disastrous fire burn it down. This pushed the company to sell all their holdings, about 90,000 acres, to the Diamond Match Company in 1907 (McGie, 1982).

Diamond Match was a national company based out of the New England area. Diamond Match set up their main mill at Stirling City. They quickly began building a system of railways, utilizing Sierra Lumber Company’s old sections, and discontinued use of the flume. They actually gave permission to people to tear down the flume and use the lumber to build homes. Today there are no known traces left of the flume (Nopel, 1998).

Diamond Match soon constructed railways from Stirling City to Deer Creek, and by 1906, down to Chico. To deal with getting lumber across Butte Creek Canyon, Diamond Match engineers came up with an ingenious idea. At a spot called Incline, dropping down Powelltown Ridge, the cars carrying the lumber were attached to a cable and slowly let down the side of the canyon. At the bottom the cars were attached to another cable, coming off the other side of the canyon, and pulled by an electric motor across a trestle and up out of the canyon. Although it was a good idea it didn't last long due to the huge amount of time and energy it took (Nopel, 1998).

Diamond Match had been a match making company and it was assumed that they were going to continue that trade in California. They actually engaged in the general lumber business and match production was just a sideline. Diamond Match went on to become known as an early leader in forest conservation, making efforts to make the most out of every tree felled. Eventually, Diamond Match became the first Pacific coast company to be certified by an agency of the Federal government as a sustained-yield operator of timber lands and the first company in California to gain tree farm status (Hutchinson, 1956).

Today the Diamond Match name is still in use but the company has changed ownership several times. In 1988 the Diamond Roseburg Resources Company bought the holdings. Then in 1992 Sierra Pacific Industries took over the company and are the current owners (Bean, 1998). Currently the other responsible entity in the watershed dealing in the timber industry is the U.S. Forest Service, which owns a small amount of land located in the uppermost reaches of the watershed.

Mining

After gold was discovered in Coloma in 1848, people from many parts of the world began to migrate into northern California. Between 1850 and 1855, thousands of these new arrivals from the United States, Europe, and Latin America came to mine the legendary "motherlode" of placer deposits along Butte Creek. By 1853, mining camps had been constructed at Diamondville, Centerville, Whiskey Flat, Forks of the Butte, Coxes Landing, Paradise Flat, and Helltown (Furr, 1968; Mansfield, 1918). All of these places existed as small settlements (along with a Chinese camp and cemetery located between Centerville and Diamondville) at the turn of the century (see Figure 8.2).

A second boom in mining occurred during the 1880's after new mining techniques and new sources of labor (especially the Chinese) were brought into the area. Although mining activities never regained the momentum of the late nineteenth century, several mines near Toadtown and on Big Butte Creek were pumped out and reopened in the 1930s as a reaction to the hard times of the Depression years (Logan, 1930). Unfortunately records of the amounts of gold extracted were not kept until 1880. Miners were reluctant to divulge exact amounts of gold out of fear that other miners would figure the worth of their claim. Records documenting gold traded for dollars were compiled by the State Department of Mines and Geology and were kept by county, not by individual claims. Records emphasizing precious metals were kept until the 1940s. During the 1940's there were still many sites being mined in the Butte Creek Watershed (see Figure 8.3)

As the gold miners arrived in the foothills of the Sierra Nevada, they began to explore different techniques for extracting gold. At first they simply panned the rivers and creeks for gold that had settled to the bottom of the waterways. In 1850, an early form of the sluice box was introduced known as the "Long Tom." The "Long Tom" was a ten to thirty foot-long wooden trough, positioned at an incline in a creek or river. Gravel was shoveled into the trough and flushed by a continuous flow of water, forcing the heavier gold to settle out through perforated holes in the metal plate into a holding chamber (McGie, 1956). This process was more efficient and allowed miners to band together as companies.

Flume systems were constructed to divert water and regulate the flow into the sluice boxes. A "miner's inch" or approximately 1.5 cubic meters flow per minute was the original unit of measurement used (Rice, 1960). During the summer dry season many streams were totally diverted into the flumes. To ensure adequate flow, water was pumped from deep holes in the creeks and derricks were used to move large boulders. Along with passing over sluice boxes, the flow of flume water rushed over paddle water wheels to provide hydroelectric power to run mining machinery. The flumes were also valued as a fishing tool. Miners rigged burlap sacks at the spillways to catch trout (Hanford, 1993).

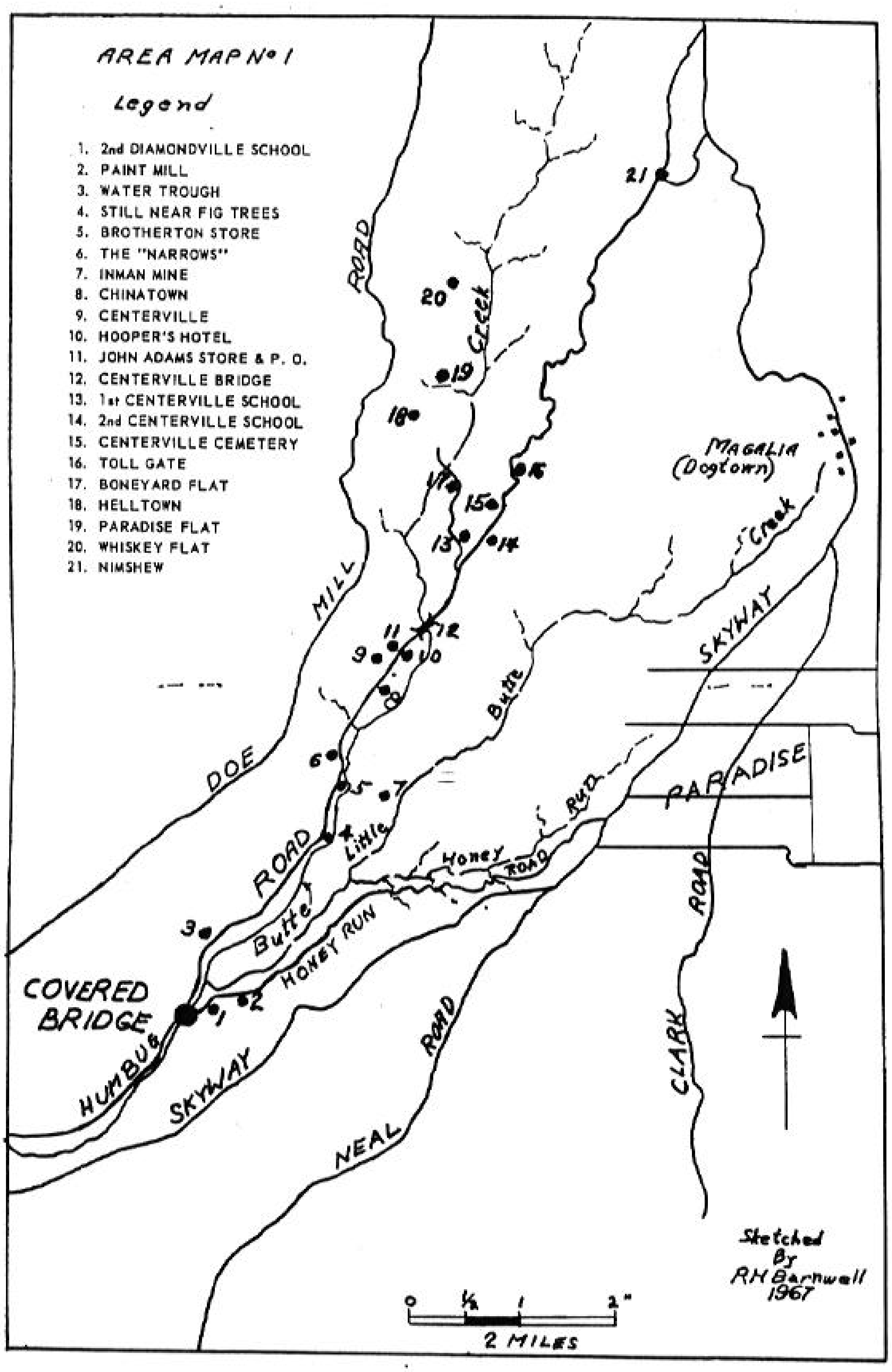


Figure 8.2 Map showing mining camps and cultural centers (Source: Barnwell, 1967)

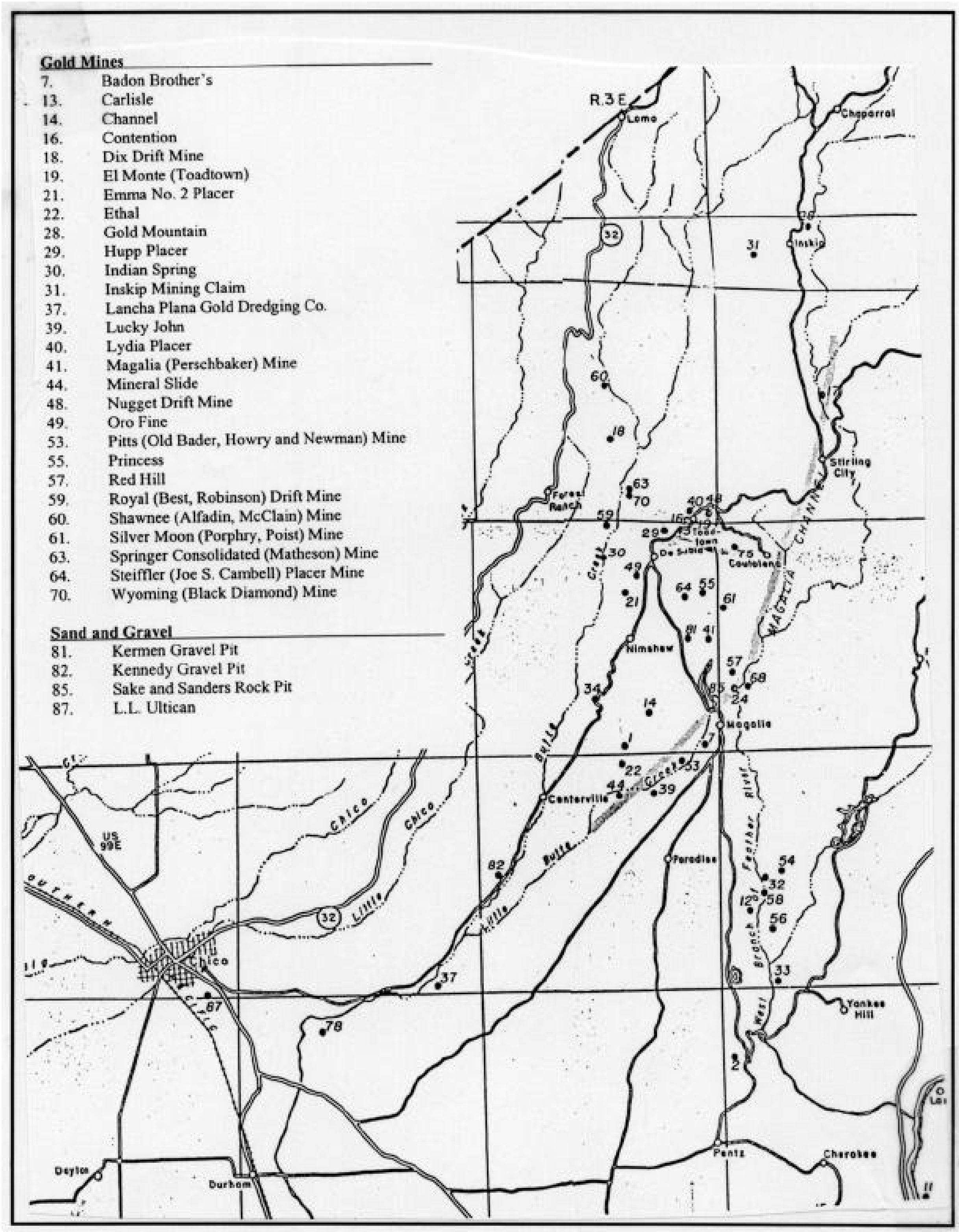


Figure 8.3 Map showing mines in the Butte Creek watershed circa 1945.
(Source: Department of Mines and Geology, 1949)

By the early 1900s dredging of the stream channels and alluvium was a common mining method on Butte Creek. The dredges either worked on the dry, exposed gravel bars or were mounted as floating barges in the water. They used large buckets to scoop gravel and release it atop a conveyor line**.** The gravel was conveyed to a hopper and shaking screens to be washed and sifted. Once the gold was removed, the remnant gravel was dumped in piles, called tailings. Electric-powered machines later replaced the original steam dredges. Various dredges operated on Big and Little Butte Creeks from 1911 to 1952 (Furr, 1968).

The construction of a large-scale system of ditches and reservoirs in the Canyon and elsewhere in the northern Mother Lode region paved the way for hydraulic mining and its near total destruction of creek ecosystems. Hydraulic mining was introduced to reach old riverbeds containing gold bearing ores, covered by ancient volcanic flows. The technique utilized the water pressure from a vertical column of water to spray and erode cliff faces. Water was stored in a holding reservoir, often miles uphill from the mining site, released into flumes and then funneled into vertical pipes, or penstocks. Holding reservoirs were built to supply water during the summer and to regulate the flow of water into the penstocks. Water streamed out of a nozzle, or monitor, at great velocity against the canyon walls (McGie, 1956). Due to the steep slopes in the foothill sections of Butte County, it was possible to have a monitor with a nine-inch diameter project a stream of water 400 feet.

Cherokee Flat Blue Gravel Mining Company was one of the first operations to work Butte Creek with hydraulic monitors south of Centerville in the 1870s. The Red Gravel Mining Company began to operate its massive, gravity-driven equipment near Centerville not long thereafter. At the peak of hydraulic mining, the Spring Valley Gold Mine Company, near Cherokee, used 18 monitors and pulled 40 million gallons of water a day through flumes and ditches from as far as Snag Lake, some 30 miles from the mine site (Hanford, 1993). Water demand increased with the development of large-scale mining technologies. Changes to water-flow measurement units accompanied the mining demands. The miner's inch became an inadequate unit of measurement for flow rates, and was replaced by cubic feet per second. Reservoir water was measured in acre-feet, the amount of water to cover one acre of land one foot deep.

With an increase of water use came the increase of gravel and sediment byproducts. Gravel and sediment debris was dumped into creeks to flow downstream to the valley below. Farmers complained to their legislators about the flooding and excessive silting of the rivers caused by mining operations. The passage of the restrictive Caminetti Act in 1883 and then the Sawyer Decision in 1884, issued an injunction against all hydraulic mining in California rivers (Mansfield 1918, Hardwick and Holtgrieve, 1996). This effectively halted the complete destruction of the Butte Creek Watershed by hydraulic mining companies.

After this act was passed, gold mining activities in the Canyon waned but did not stop completely. In the 1890's, a small operation using water from the old Spring Valley Mining Company and Hendricks Mining Company ditches continued the search for gold near what was then called Toadtown (near the Poumarat Quartz Mine and Mill). Other mining companies continued their efforts north of the small town of Lovelock and along Big Butte Creek at Centerville (Colman, 1960; Colman, 1972). High intensity mining in Helltown ended shortly thereafter and within a couple years the town all but disappeared.

The miners that remained in the area began a simpler form of mining referred to as drift or shaft mining. Shafts were dug into the sides of the ridges to reach the ancient riverbed deposits**.** Gravel was extracted by shovel, loaded into rail carts and transported to be washed by the water of the creek. Drift mining seriously weakened the integrity of the ridge-sides and also left piles of gravel, mud, and loose vegetation up and down the creekside.

Geologists mapped a tertiary riverbed that was named the Magalia Channel. A 54-pound nugget was found in this channel, called the Dogtown Nugget, which remains one of the five largest found in the world. The Magalia channel often extends a few hundred feet beneath the surface. The Magalia mine was over 300 feet deep, out of which miners removed 5800 cubic feet of gravel, yielding $6.4 million worth of gold. The miners hauled a mile of rock 300 feet to the surface to reach the buried gold (McGie, 1956).

Hydroelectric Development

The power demands of shaft mining pushed the development of hydroelectricity. Prior to the 1880's the flat paddle water wheel was the most common way of producing hydroelectric power. In the eastern United States where the rivers drop an average of 10-20 feet per mile, the flat paddle water wheel efficiently produced power. The rivers of the Sierra Nevada drop an average of 175 feet per mile; too much incline for falling water to effectively push and rotate the paddle wheel (Hanford, 1993). A man named Lester Pelton solved this problem.

Lester Pelton was a miner who became a millwright and carpenter in search of a better living. In 1850 he attempted to improve the efficiency of the water wheel by replacing the paddles with buckets. While running his new bucket wheel, Pelton accidentally discovered a method to rotate the wheel more efficiently. He split the spray of water into two streams from the nozzle, and hit two buckets at the same time. After perfecting his design, he went on to patent his new Pelton Wheel, which was proven by UC Berkeley scientists to have an efficiency rate of an unbelievable 87% (Mansfield, 1918). His technology proved successful in the field as well, by the mid-1880's most miners used the Pelton Wheel. The Pelton Wheel was used in the 1890's to turn newly developed electrical generators to produce power to run mining equipment.

In 1899, the Butte County Electric Power and Lighting Company was organized and began construction of the Centerville Powerhouse to supply power to the miners around the Helltown area. An existing flume, currently Lower Centerville Canal, was extended and elevated for water delivery to the powerhouse. The powerhouse was completed in May of 1900, and on May 23 the first hydroelectric lighted lamps, powered from Centerville, were turned on in downtown Chico (Rice, 1960). By August of 1901, transmission lines connected Centerville to several customers including those in Chico, Oroville and its gold dredges on the Feather River, Gridley, and Colusa. By the turn of the century mining became largely cost prohibitive, as productive gold bearing sites became more remote. These events set the stage for electrical generation to emerge as the next utilization of the flows of Butte Creek (Rice, 1960).

Eugene de Sabla, Jr. introduced electrical generation to Butte Creek Canyon. As a young man his father brought him to Arizona to work in one of his copper mines (Hanford, 1998). While in Arizona he befriended Alphonso Tregidgo, a Cornish miner who was one of the directors of the mine. In the early 1890's Tregidgo and de Sabla traveled to Grass Valley together, where Tregidgo became the superintendent in the Grass Valley mines. Tregidgo became interested in the new installments of hydroelectric plants and decided to build one on the South Yuba River large enough to provide power to the mines in the area. He employed de Sabla as vice president, launching his career in the utility business.

In 1895, the partners completed the Nevada Power Plant on the South Yuba River with the financial backing of Romulus Riggs Colgate, the grandson of the founder of the Colgate Soap and Perfume Company. De Sabla, with the continued sponsorship of Colgate, participated in the construction of the mighty Colgate Power Plant on the North Yuba River which was completed in 1899. With several projects under his belt, de Sabla grew more successful in the region and gained support from the Bay Counties Power Company, which by 1901 controlled the Nevada County Power Plant, the Colgate Plant, and the Yuba Power Company Plant on Brown's Valley Ditch (Rice, 1960).

De Sabla scouted further north into the foothills of the Sierra Nevada for potential hydroelectric plant locations to satisfy the San Francisco area's growing demand for electric power. Bay Counties Power Company had already acquired water rights on French Creek, a tributary to the Feather River. De Sabla formed the Butte County Power Company with $1,000,000 in capital stock and an authorized bond issue of $1,000,000 for construction of the plant. All stock was to be owned by Bay Counties and the bonds were to be placed in a bond firm.

A camp was established and preliminary work was underway. The land in the reservoir site had been acquired except one parcel. That parcel was owned by a personal acquaintance of de Sabla and he foresaw no problems with buying that piece. De Sabla went to French Creek to finalize the proposed construction and negotiate a deal with the property owner. By this point, the sale of the bonds had been confirmed and the final step in the process was to buy the last parcel of land. De Sabla was extremely disappointed to learn the property owner demanded $200,000 or half of Butte County Power Company's stock. Due to this unacceptable asking price, de Sabla ordered the foreman to close down all work, discharge all the men and consider the French Creek Development a dead project, as was the Butte County Power Company (Rice, 1960).

De Sabla continued his search of Butte County for another site on which to locate a project and discovered the potential in Butte Creek. He quickly formed the Valley Counties Power Company with a capital stock of $2,500,000 and an authorized bond issue of $2,500,000. The stock and bonds were to be issued in the same format as for the French Creek development, with the addition that all business of Bay Counties in Butte County would be turned over to Valley Counties. In 1903 de Sabla bought out the water systems of the Cherokee Mining Company, as well as the Centerville Powerhouse and Centerville head-dam and ditch, from Butte County Electric Power and Lighting Company (see Figure 8.4).

At this time Centerville was already delivering power to the valley communities of Chico, Gridley, and Colusa, as well as the gold dredges on the Feather River in Oroville. De Sabla primarily bought out the Cherokee Mining Company's holdings for its head-dam located on Butte Creek. This dam, known today as Butte Head Dam, diverted water into the Cherokee mining ditch, later to be renovated and named the Butte Canal (Maniery et al., 1985). De Sabla had the idea to build another power plant upstream of the Centerville Diversion Dam and double the output of the same amount of water.

A camp was established, called Camp One, at the site of Slater's Dam, the present Lake De Sabla (Rice, 1960). This location allowed for a drop of almost 1,600 feet to the creek. The next step involved locating land to drop the pipelines and build a powerhouse. During de Sabla’s initial surveying trip, his team observed the entire bank was eroded to bedrock and would require blasting out an area large enough to build the power plant. A site was blown out on the eastside of the creek and a camp was established.

De Sabla ordered the building of a road from the ridge top down to the creek (Maniery et al., 1985). Although Camp One and Slater's Dam were roughly a mile uphill, five miles of winding road were constructed to safely navigate down to the new campsite. Many other jobs were started simultaneously, such as flume rebuilding, ditch enlargement and expansion of the Centerville plant (see Figure 8.5).

Before the construction of the actual powerhouse began, a boarding house was built for the small community responsible for monitoring the site. The boarding house was built just upstream from the plant and on the same pad that was originally blasted out of the rock, positioning it strategically next to Indian Spring Ravine. Indian Spring supplied enough water to cool the transformers and generators and provide for domestic needs. Many smaller structures were built on the site (see Figure 8.6).

As construction of the powerhouse began, de Sabla decided to enlarge Slater's Dam, which then had its name officially changed to Lake De Sabla. During October of 1903 the first penstock was installed followed by another built the following year. Three generators were originally installed at De Sabla, each run by pelton wheels nine feet in diameter, followed by the installation of a fourth larger generator installed on August 22, 1904 (Rice, 1960). Two large oil tanks were also installed 70 feet up the hill. One tank provided oil to run the transformers and the other provided lubricating oil for the machinery and bearings. A head pressure of 1,531 feet was attained as the water flowed down a 36-inch penstock to a point 800 feet above the powerhouse, where it then dropped into a vertical shaft to the plant.

On October 22, 1903, the plant opened, supplying electricity to customers in Chico and the Oroville dredging districts. Surplus power was connected to other Bay County lines. By early 1905 de Sabla was delivering a current 378 miles south to Calaveras, a record for long distance transmission at the time. At first the plant was referred to as the Nimshew Powerhouse, after the small town of Nimshew a few miles from Camp One. The town’s namesake was the Nimshew tribe, now extinct, that once occupied the region down to the American River. The powerhouse’s name changed from Nimshew after de Sabla's associates decided to name the powerhouse after its founder (McGie, 1956).

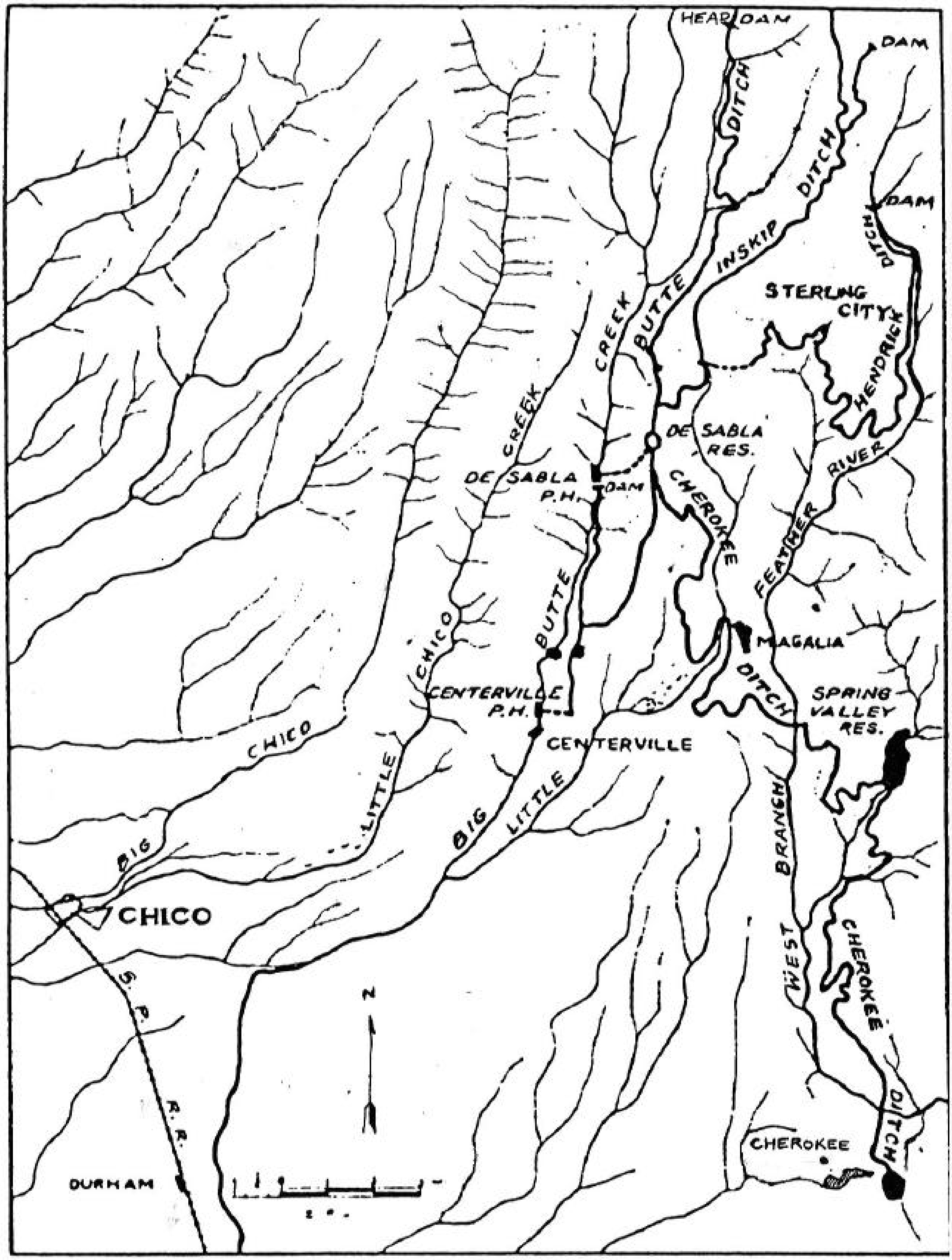


Figure 8.4 Map showing ditch system bought by Eugene deSabla (Source: Rice, 1960)

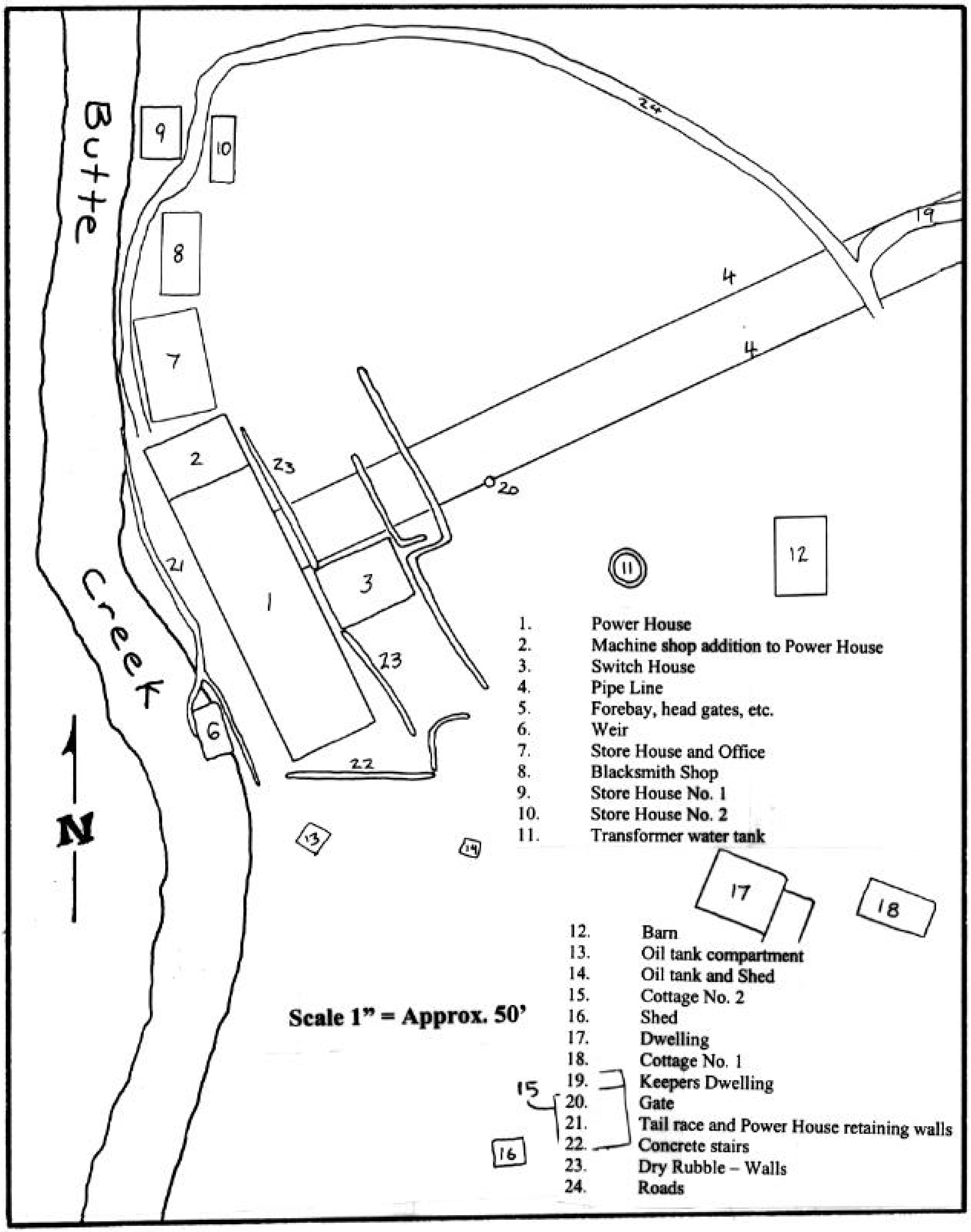


Figure 8.5 Inventory map of Centerville powerhouse (Source: Maniery et al., 1985)

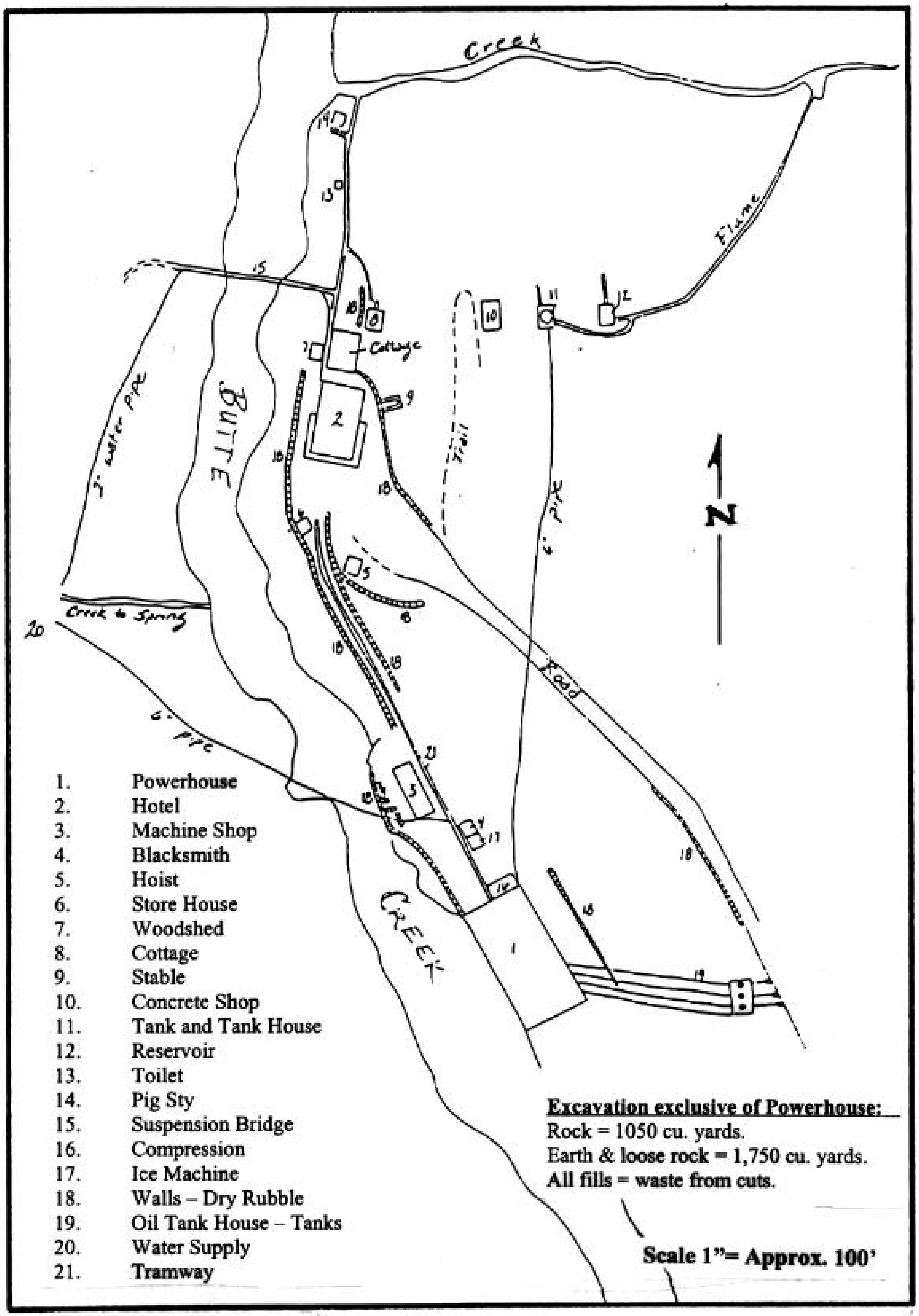


Figure 8.6 Inventory map of DeSabla powerhouse (Source: Maniery et al., 1985)

The system was in order and running within a year. Over the next couple years the crews continued to modify the canals and ditches that provided water to Lake De Sabla. Originally, Butte Canal and Upper and Lower Centerville Canals were the only sources of water to the powerhouse. Butte Canal was initially a mining water ditch built in the 1850's, and was later renovated and expanded in 1872-1873 by Cherokee Flat Mining Company, later becoming the Spring Valley Mining Company. The canal was used to bring water to hydraulic mining sites at Cherokee Flat and Helltown. De Sabla's group modified the canal to bring water to the Lake De Sabla site.

Upper and Lower Centerville Canals were also old mining ditches. Lower Centerville Canal was originally John Hupp's Mining ditch, which was used to transport water to his Red Gravel Gold Mine in Helltown. De Sabla's group modified portions of Upper Centerville Canal to transport water during low flow events directly from Lake De Sabla to Centerville Powerhouse. Shortly thereafter, de Sabla bought the Hendricks Canal for its diversion dam on the West Branch of the Feather River, originally known as Meacham's Dam and now referred to as Hendricks Head Dam, to carry more water into the system (see Figure 8.7). Portions of Hendricks Canal date back to the gold rush but the majority of the present route was built by W. C. Hendricks and Company in 1870-1872. The canal was one of the largest in the area and used to supply water to hydraulic mining operations in Morris Ravine, approximately three miles northeast of Oroville.

De Sabla’s team renovated and enlarged Hendricks Canal. The course of the canal was altered slightly to connect with Toadtown Canal. Toadtown Canal was another old Spring Valley mining ditch that imported West Branch water into Butte Canal one and a half miles above Lake De Sabla. By joining these two ditches de Sabla doubled the energy output of the two powerhouses. The acquisition and renovation of the canal system was completed by 1908 (Maniery et al., 1985). Water from Lake De Sabla currently flows through De Sabla Powerhouse, is released back to Butte Creek, and then quickly diverted by the Centerville Head Dam into eight miles of flume terminating 600 feet above Centerville powerhouse. From here the water drops into a penstock to the powerhouse and returns to Butte Creek.

After the water ditches and flumes were in working order, few alterations were made to the system until 1917, when Butte and Centerville head dams were re-built. In 1928, a 30-inch pipeline replaced the two 24 inch penstocks at Centerville. The new pipeline was made of reconditioned wrought iron siphon pipe originally installed by Spring Valley Mining Company in 1870 and 1873. In the 1950s the Hendricks/Toadtown Canal was abandoned where it passes Stirling City. An underground tunnel was constructed to bypass this section, leaving five miles of canal empty. Centerville was converted to semi-automatic operation in June of 1959. The associated buildings and unused equipment disappeared within a few years following.

Between 1900 and 1959, the Centerville and De Sabla Powerhouses played important roles in the lives of Butte Creek residents. The projects provided jobs for the men in the canyon who had not reached their dreams during the gold rush. De Sabla Powerhouse was torn down by 1963. Both were replaced by smaller semi-automatic plants built on the same respective sites. The associated buildings and community around De Sabla also disappeared.

Today the De Sabla-Centerville system is in regular use, contributing electricity to the main grid of transmission lines that reach destinations throughout the western United States. The two head dams on Butte Creek and the Hendricks Head Dam remain in working condition and continue to divert water to their respective flumes. The flumes and ditches are still in working condition, requiring occasional repairs. Except for old building pads, rock walls and few artifacts, little remains of the communities once centered on these sites. The Centerville Powerhouse is currently the oldest of 65 hydroelectric powerhouses in the entire PG&E system and its future is uncertain. Conservation concerns have led to talk of removing the Centerville Head Dam to allow for possible salmon migration farther up Butte Creek (Johnson and Kier, 1998). If the dam were removed, the Centerville site might be sold or become a historical landmark. De Sabla is run by microwave signals from the Rock Creek Plant on North Fork Feather River, and will likely continue producing hydroelectric power for many years to come.

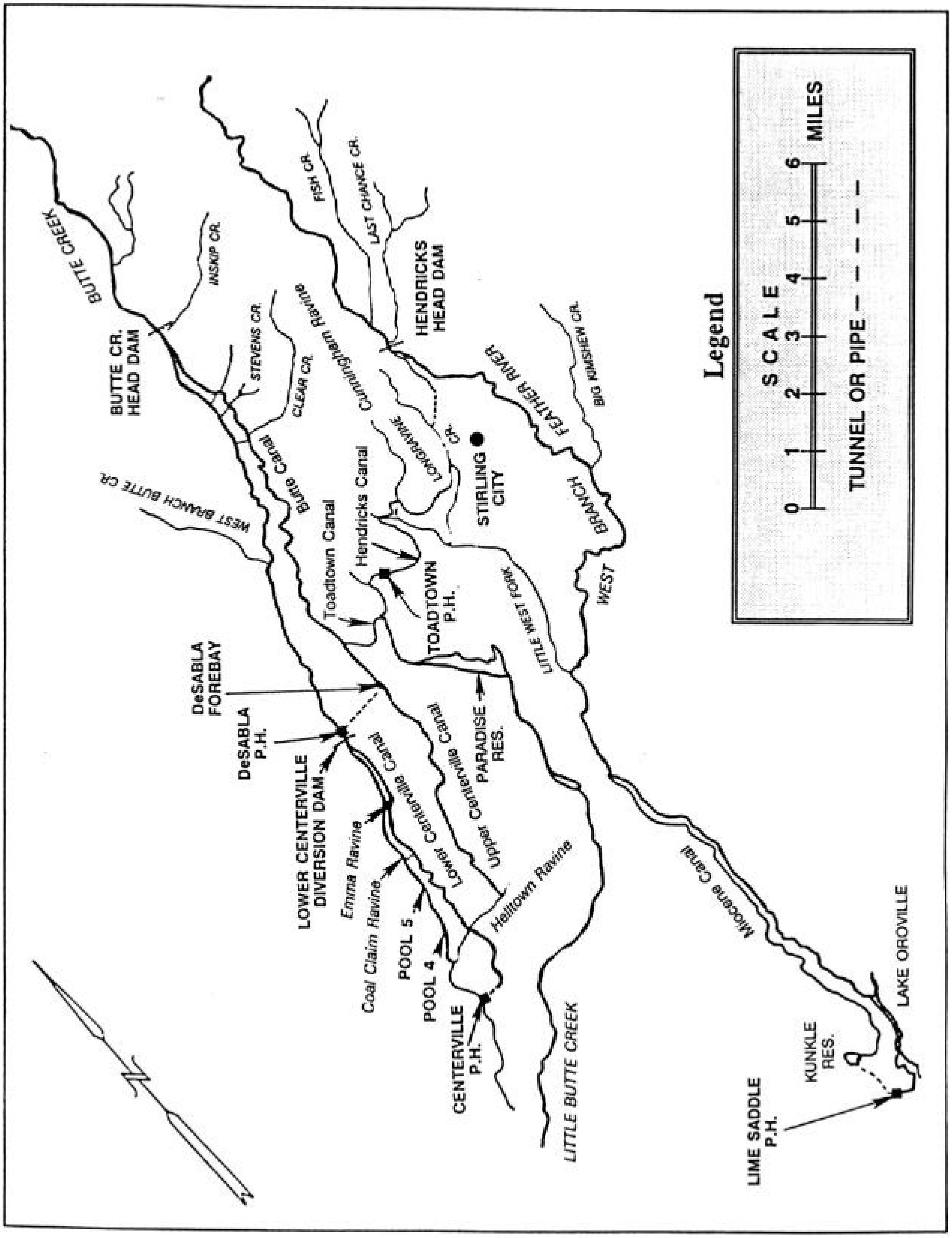


Figure 8.7 Map showing renovated ditch network for DeSabla-Centerville hydroelectric system (Source: PG&E, 1993)

For most of the 20th Century, the De Sabla-Centerville system was the only hydroelectric generation on Butte Creek. In 1991 the Forks of the Butte Power Plant was installed just upstream of the De Sabla Power Plant. The plant is owned and operated by an organization in New York called Energy Growth Group I. Their system includes a 15-foot high diversion dam located 1/4 to 1/2 of a mile downstream of the Garland Road bridge (Ponderosa Way). The dam diverts a maximum of 250 cfs into an 11 foot-wide conduit tunneled through the east side of the canyon for almost two miles (Maniery et al., 1985). The water is used to run two turbines with associated generators inside the power plant. A minimum flow must be maintained on the section of the creek where the Forks of the Butte system is located, in order to provide sufficient flows for fish and wildlife habitat. If the minimum flow can not be maintained, the plant automatically shuts down (see Geology, Basin Morphology, and Hydrologic System chapter). Due to the recency of the plant's installation, minimal flow data is available.

Agriculture History

Ranching

The earliest forms of intensive agriculture in the Butte Creek Watershed began with the influx of population that came with the Gold Rush. Animal husbandry dominated the scene and consisted of raising livestock on the large open ranges in the valley. During the 1840's and 1850's local ranchers raised range cattle, sheep, and hogs. They quickly learned that during the summer dry season there was very little feed available for the cattle and sheep in the valley. After realizing there were plentiful grazing lands in the mountain meadows to the east, the first local cattle drives began. Ranchers from Chico and the surrounding areas would gather their cattle together in the spring and drive them up the Campbell Trail, which followed Cohasset Ridge, to Butte Meadows. The drives consisted of several hundred to several thousand head of cattle and lasted from seven to ten days, depending on the number and type of cattle being driven (Roney, 1997). The cows and calves traveled the slowest and were taken on the first trip. A "dry herd" of steers and heifers followed with the bulls being driven separately to avoid conflicts.

Butte Meadows became a popular gathering place, with its corrals provided to sort out the herds by brands. Many families kept traditional grazing grounds on privately owned or leased land, while others let their cattle disperse from the corrals to graze freely for the summer. Fences lined the hotels, cabins and stores along Humboldt Road to keep cattle on the drive trail. The sheep herds were often grazed alongside the cattle and managed in similar ways (Roney, 1997). In September and October, the herds were again rounded up in the Butte Meadows corrals to be sorted and driven back to the valley. The Meadows are still grazed, but the cattle drives ceased in the 1950's, giving way to trucks for transporting the livestock (Roney, 1997). At present, there are almost 85,000 acres within the watershed that are utilized as grazing lands, making up about 17% of the total land coverage.

Original Crops

The first crop to be successfully cultivated in the Sacramento Valley was wheat. The first wheat was planted by John Sutter at his fort, near the American River. Word of his success spread throughout the valley. Up to this point people of the valley generally believed that the only good land for farming was along the creeks and rivers. The introduction of wheat dispelled this myth as it was found that it would thrive in the open plains of the valley. The wheat grown was of an extremely hearty strain and could endure the clay soils found throughout the valley plain. The first centers for wheat production in Butte County were around Hamilton and Bidwell's Arroyo Seco Ranch in 1853 (McGie, 1982). By 1854, the farmers were providing enough grain to meet domestic needs but had no market for the surplus. In 1861, the valley's wheat industry got its big break as France and England experienced shortages of wheat, partially due to the Civil War reducing shipments from the Northern United States. The wheat strain, being so hearty, was able to endure the 4-5 month sea voyages to the new markets (Hardwick and Holtgrieve, 1996). During this period the original Mexican land grants were beginning to be sub-divided and miners were moving out of the mountains to try their luck at farming. These events marked the transition from mining to agriculture as the main industry in the valley/foothill region. By 1865 farmers were experimenting with other grain crops such as barley, oats, and hay, along with the first attempts at fruit crops such as apples, peaches, oranges, and grapes for wine.

The man leading the way in wheat production was Dr. Hugh Glenn, a dentist who came in search of gold, and later began buying land along the Sacramento River in the present Glenn County (Mansfield, 1918). He was the first to experiment with the adobe soils away from the river and was extremely successful. In 1882 he owned 55,000 acres producing wheat. Wheat became the backbone of the valley economy, growing from 200,000 acres in 1866 to over 1 million acres in 1882 (McGie, 1982). Conflicts began to emerge between the livestock ranchers and the wheat farmers and early orchardists. It was becoming a problem to keep the livestock from wandering into the fields and orchards and causing damage to crops. The problem escalated until, in 1872, a law was passed that required ranchers to build fences around their range lands to keep their livestock out of neighboring crop fields (McGowan, 1967). Traditional ways of harvesting were quickly found to be inefficient and during the 1870's and 1880's, plows, threshers and other labor saving devices were brought into use. These improvements boosted the wheat production in the state to levels rivaling any area in the world. After the 1880's, wheat steadily became less profitable due to soil exhaustion and increased national and world production. Growers continued until 1903 due to money invested in machinery and use of land that would only grow shallow-rooted crops.

Irrigation

With the decline in wheat production vast acreages became available for other crops but the need for more water had to be addressed. From the 1850's to 1870's specialty crops, mostly fruits and vegetables, were in production but were much more difficult to grow and market than the hardier grains. In 1887, the Wright Act was passed which made it legal for farmers with land not located on a river to organize irrigation districts and bond their property to develop the necessary facilities (McGee, 1980). As the first local irrigation systems developed it became possible to grow more successful vine, row, and orchard crops. Grapes, used for wine, were the first successful fruit to prosper from the new small scale irrigation systems. Henry Gerke, a German born miner who became a farmer, was the first to cultivate and export wines from the area. He became one of the largest land holders in the valley and with his success founded the town of Vina (Mansfield, 1918).

Ground water as a source for irrigation lagged behind surface water in the Sacramento Valley. The early settlers of the valley used ground water for domestic use and stock supplies. It was not until 1879 that a well was dug for irrigation purposes. This 7 meter deep well was dug on the Blowers Ranch near Woodland. Its success caused an increase in drilling to tap the new source of water for irrigation. Development continued to be relatively slow due to the high cost of drilling equipment and in most areas there was sufficient surface water supplies. As drilling equipment improved and prices dropped, the use of wells proliferated. Also large farm plots were being divided into smaller 10 to 20 acre plots that had no existing surface water canals accessing the land. This made drilling wells more economically preferable on these lands. The first reliable study done on ground water use in the Sacramento Valley was a USGS report (Bryan, 1923). This report reveals that in 1913 approximately 41,000 acres of land in the Sacramento Valley was irrigated by ground water from 1,664 wells. A DWR report from 1929 found that just over 500,000 acres in the valley were irrigated about 205,000 acres utilized ground water (Olmsted and Davis, 1961). By 1970 approximately 29 percent of water used for irrigation in the Sacramento Valley was coming from wells.

The first commercial attempts at orchard crops were citrus plants around the Thermalito and Palermo areas. With the cessation of hydraulic mining in 1884 the old mining ditches became an integral part of the emerging irrigation canal systems. In the late 1880's, Thermalito and Palermo districts were receiving water through old mining ditches including the Miocene ditch (McGowan, 1967). The first citrus crops did well and irrigated orchard lands began to expand. As fruit farming became a larger industry the need to preserve the surplus for transportation was encountered. In 1882 the first fruit cannery was established and many more were built in the following years along the railroads and rivers, especially near the Marysville-Yuba City area (McGee, 1980). Oranges dominated the areas first receiving irrigation water and were a relatively successful crop up until the 1930's when market conditions changed, reducing the value of the crop. Then in 1932 there was a harsh, deep freeze that killed over half of the trees in the valley and they were never replanted. Today citrus is only produced commercially on a relatively small scale in Butte and Glenn Counties (McGie, 1982).

Other orchard crops, such as olives and almonds, were found to be successful along the foothills utilizing the new irrigation methods. Olives thrived alongside the citrus trees in the Thermalito and Palermo areas near Oroville. Down further on the valley floor, Durham grew to become one of the main almond growing regions in the valley. Almonds were first planted there in 1875 by Judge Pratt, the former owner of the Aguas Frias Rancho (Mansfield, 1918). The first commercial orchards were planted in 1895 and did so well that by 1909 the Durham Almond Growers Association was formed. It was not long before Durham's almonds were noticed by the rest of the state and in 1913 they became associated with the California Almond Growers Association. By 1940 the Chico-Durham area was producing enough almonds to make them the most important tree crop in Butte County (McGee, 1980).

In 1900 two men, Duncan C. McCallum and Thomas Fleming, became partners and constructed an irrigation canal to better supply the Gridley and Biggs areas. In 1905 they secured enough support around the Gridley area to begin construction of a canal. On June 9, 1905, Butte County Canal was completed. It was 14 miles long, 30 feet wide and cost $200,000 (McGee, 1980). The canal, which later became known as Sutter-Butte Canal, led to increased land values around Gridley and many new people moved to the area. The value of the crops being produced in the area also increased many times.

The advancement of irrigation also prompted the growth of dairy/alfalfa farms in the valley. With sufficient water reaching the valley floor, farmers could grow enough alfalfa on their land to feed their dairy cattle. This also resulted in the establishment of cooperative creameries, with the first large one being built in Gridley (McGowan, 1967).

With more water being brought across the valley through canals, a new crop came on the scene. In 1908, William Grant interested the United States Department of Agriculture in the benefits of growing rice in Butte County. W.W. Mackie recommended that experiments be made to determine the best strains of rice to grow. It was determined that 275 different varieties would be planted on the land of the Balfour-Guthrie Company, which was just west of Biggs (Hardwick and Holtgrieve, 1996). In 1912, varieties were chosen and commercial planting began. The first commercial crop of 1,000 acres was planted near present day Richvale. By 1918, there were 30,000 acres of rice being grown in Butte County (McGee, 1980). Since then, rice has grown to become the dominant crop in the Northern Sacramento Valley. Today, within the Butte Creek Watershed, rice fields cover almost 159,000 acres, or about 31% of the land coverage.

McCallum and two new partners continued to push the advancement of irrigation by securing water rights and a right of way off Hamlin Slough in 1908. They began surveying the area but no work was ever done. The rights were then passed to a financial group in San Francisco, who sold it to the Great Western Power Company. Great Western went on to organize a subsidiary company known as the Western Canal Company. In 1915, the first section of the Western Canal was completed and in May of that year the Feather River was diverted into the canal to irrigate 20,000 acres of rice and 10,000 acres of fruit orchards (McGee, 1980). The general layout of the present canal was finished by 1917, with the siphons under Cottonwood and Dry Creeks and the dams on Butte Creek being completed. In 1930, PG&E bought the Great Western Power Company with the canal as part of the transaction (McGie, 1982). Since then, other modifications have been made as demands for water for rice have increased. In the late 1980's the system was purchased from PG&E and was formed into the Western Canal Water District (WCWD). The most recent change is the newly constructed siphon under Butte Creek finalized in the fall of 1997 (see Geology, Basin Morphology, Hydrologic System chapter).

With the system of irrigation canals and ditches in place, local groups began to organize irrigation and water districts. In 1916, the Paradise Irrigation District was formed, followed by the Glenn-Colusa Irrigation District in 1920. In 1930 the Richvale Irrigation District was organized and by 1942 the Biggs-West Gridley Water District had its beginning. Durham created its own irrigation district in 1948, and in 1952, the Butte Water District was formed to serve the Gridley and East Biggs areas. The land served by these districts varied greatly, from just 93 acres for the Durham Irrigation District to 121,592 acres under the Glenn-Colusa Irrigation District. There were many other water and irrigation districts that were formed and disappeared or were absorbed by other districts.

A section of particular interest regarding mining, and later agriculture, is the Cherokee Canal Strip. This unique, human-made landform is like no other. One of the resulting effects of hydraulic mining was the deposition of large amount of debris that washed down the creeks to settle out on the valley floor. David Gage and Louis Glass, partners who owned the Spring Valley Mining Company, already owned 2,300 acres of land along Dry Creek that was to be used as a dump canal for their mine (Mathys, 1973). To help solve the farmers' concerns, Spring Valley erected a brush dam to hold back debris. Silt and water still passed through but was contained between six-foot levees. As more silt accumulated more levees were built to contain the sediment, which became known as "slickens". Hydraulic mining practices were outlawed in 1884 but due to Spring Valley's investment in protecting farm lands they continued to mine. By 1887 the Spring Valley Mine was closed partly due to the huge expense of containing the debris. Glass and Gage both moved on but Gage continued to officially own what was referred to as the Cherokee Strip (Mathys, 1973).

In 1900 Sacramento Northern Railway wished to gain a right of way to cross the "slickens". Gage went to look at the land and found a six-foot high strip of soil devoid of rock. Cottonwoods and willows grew so thickly that it was difficult to get through them. But what really caught Gage's eye was a vast amount of burr clover. Burr clover was considered to be the best cattle fattener around, so Gage decided to try his luck raising cattle. The Gage family built a house and began the Gage Brothers Ramada Ranch. By 1912 they were running a very successful cattle ranch as noted in the Chico Daily Enterprise from June 3, 1912:

> A trainload of the fattest and biggest steers that will be shipped out of California this year, according to buyers, are being loaded on the cars today in Chico. Over 200 of the steers are four and five years old, many weighing 1,600 to 1,700 pounds. The steers were fattened by Gage Brothers on their slickens ranch, a sediment formed by the impounding of debris from the Cherokee mines and peculiarly adapted to the growing of burr clover, a fodder esteemed by cattleman as next to corn for 'finishing' beef cattle.

The high cost of raising cattle made the Gage ranch a short-lived enterprise. In 1915, one of the brothers, Edward became interested in orchards. He had land cleared, and in 1916 planted, 500 acres with almonds and prunes which grew successfully (Mathys, 1973). A few years later the Western Canal was built across the lower end of the strip. This set up the eventual introduction of rice on this very well drained soil, where it has prospered ever since. Today, the Cherokee Canal is used as an irrigation canal, drainage ditch, and flood protection for the surrounding agricultural lands.

At present, agricultural lands cover about 65% of the area in the Butte Creek Watershed. Rice covers the most area, followed by grazing lands, orchards, and field and row crops. There continues to be an extensive system of canals and ditches that are used to irrigate and drain the agricultural lands. For more information about the plumbing of the watershed refer to the Hydrology chapter of this document.

Levee History

Up until the 1950's, the only levees on Butte Creek were locally built agricultural levees that local interests constructed to keep high flows from destroying their lands. The first levees were built in the 1890's and were about 6 feet high and extended from about one mile upstream of the Chico-Oroville Road downstream about 14 miles (War Department, 1940). On December 22, 1944, Congress passed the Flood Control Act (the Act), which referred to the Sacramento River and its major and minor tributaries. This legislation authorized construction of levees and channel enlargement of upper Butte Creek. According to the Act, upper Butte Creek refers to the area from and including the Little Chico Creek Diversion downstream 18 miles to a spot southwest of Nelson and Richvale. The project was placed under the authority of the U.S. Army Corps of Engineers, Sacramento District.

The Corps divided the project into two parts. In 1952, the first part of the project was completed. It consisted of levee construction and channel improvement from Highway 99 downstream 8.7 miles. The project included the improvement of locally constructed levees to comply with project standards, as well as building new levees where local ones did not exist. The project standards called for levees on both sides of the creek to have a 12-foot crown width, slopes of a ratio of 2:1 on the landside and 3:1 on the riverside, and a minimum 30 foot riverside berm. It also allowed for channel enlargement to the extent necessary to obtain the needed material for construction of the levees. Downstream from the end of the levee project, flood flows enter the Butte Basin and levee construction and channel improvements were not deemed necessary. In 1957-1958, part two of the project was completed. First a concrete diversion structure was built connecting Little Chico Creek to Butte Creek. The second part of the project covered the area from the beginning of the Little Chico Creek Diversion downstream 9.3 miles. On the diversion channel intermittent levees were built on the right bank with heights ranging from 7 to 13 feet. On Butte Creek the left bank levee is 7.2 miles long and the right bank levee is 7.1 miles long. These also have side slopes of 2:1 on the landside and 3:1 on the riverside. A minimum 30 foot berm was also provided with the levees ranging from 7 to 14 feet in height and having a 12 foot crown, allowing for a patrol road. Refer to Levee and FEMA Zone Map for locations of levees (see Map Appendix).

After the construction of the levees the Little Chico Creek Diversion was engineered to hold 4,500 cfs with no freeboard. Butte Creek, downstream from the diversion channel to where Sacramento Northern Railway crosses the creek, was constructed to contain 40,000 cfs with no freeboard. From the Sacramento Northern Railway crossing downstream to the end of the levees the capacity is estimated at 27,000 cfs with a 3 foot freeboard.

The construction of the diversion channel and levees was designed to provide flood protection to Chico from flood flows on Little Chico Creek. They also provide flood protection to Durham, as well as, 45,000 acres of agricultural land with related buildings and homes, Highway 99E, several county highways, and three railroads (Gaines, 1997).

Currently the levees are maintained by the State Reclamation Board. They issue permits for all actions that influence the levees, from a simple sign being posted to installing pipelines that cross the levee. Unfortunately, the Reclamation Board does not keep a consolidated log book of the permits that they issue so it is not possible to show all the projects that have taken place on the levees since they were built. The Reclamation Board also performs a yearly integrity assessment of the levees and oversees maintenance issues. Again, they do not have adequate records of their assessments to provide the information to the public (Padilla, 1997).

Vegetation Change

Significant impact on the vegetation of the Butte Creek Watershed was caused in large part by destructive mining techniques, population growth, and agricultural and livestock production. Introduced annuals gradually replaced native perennials, in part, due to historic development of the watershed (Davy, 1902, Heady, 1977, Keter, 1995). J.E. Perkins reported in 1864 that:

> Less than ten years ago, the traveler, would ride for days through wild oats tall enough to tie across his saddle, now dwindled down to stunted growth six to ten inches with wide reaches of utterly barren land (in Keter, 1995).

These changes, beginning with the introduction of wild oats and possibly red stemmed filaree by early Spanish in the Sacramento Valley, may have become well established by the time of the Gold Rush (Davy, 1902). The destruction of natural ecosystems in Butte Creek's downstream region was accelerated by the introduction of large number of livestock and feral pigs after 1865. Small barley grasses may have first entered the study area in the wool of sheep, as did the seeds of other exotic species (annual grasses and shrubs).

NOTE For The Following Chapter On Fire:

Preparation of this chapter is ongoing. What follows is background information on fire hazard and fire history in the Butte Creek Watershed.

Topics of emergency response to fires and analysis of future needs for watershed fire protection are being prepared and will be distributed as soon as possible.

Chapter 9

Fire History and Management

Situation

The distribution of wildfire threat to the watershed is determined by the hazard (all the things that make a fire burn relatively more or less intensely and spread relatively more or less quickly), the risk of a fire ignition, and the values that might be damaged by fire.

Hazard

Flame length represents the energy released per foot at the flaming front per second. The flame length determines the difficulty and danger to fire fighters of controlling the fire (other things equal), the damage the fire will do to trees, soils, and other forest components, and the fire's potential to ignite structures at a given distance. Flame length is a measure of the potential destructiveness of a wildfire. Flame length is the one best measure of fire hazard.

A second measure of fire hazard is rate of spread. Although a rapidly spreading fire in grass may do little resource damage, it's perimeter will grow rapidly, increasing suppression costs, potential losses, and making escape more difficult. Rate of spread is a measure of the fire's threat to human life.

The Butte Creek Watershed above Highway 99 can be divided into three major vegetation types: grass and oaks, chaparral, and timber. Within the timber zone, the forest grades from a pine dominated, mixed conifer forest at the lower elevations to fir dominated mixed conifers in the upper reaches. Most of the brush is old and highly flammable. The mixed conifer forests are, for the most part, crowded with dense accumulations of suppressed reproduction and down, dead woody material in the understory and on the forest floor. The forest crown is typically closed with sufficient bulk density[1] to support crown fires. Outside the wildland-urban intermix[2] residential areas, surface fuels are continuous over large areas interrupted only rarely by non-flammable materials. Fire ladder[3] is well developed so that the vertical arrangement of fuels links the surface with the crowns of trees.

Typically the forested portion of the watershed is represented well by fuel model 10[4]. The brush areas are represented best by fuel model 4. The grass and oak-grass woodlands by fuel model 1. These fuel models were used along with slope and weather data to estimate flame lengths and rate of spread for a fire that might

[1] Bulk density is the weight per unit volume of a fuel.

[2] The wildland-urban intermix is that area where structures are under and among wildland vegetation and wildland resource uses such as logging and grazing are intermixed with more urban land uses such as residential properties and retail centers.

[3] Fire ladder exists when sufficient flammable vegetation fills the space between the surface of the forest floor and the crowns of the overstory trees to permit fire to climb from the surface into the tree tops where torching or crown fire may occur.

[4] Fuel models are described in US Forest Service, Intermountain Forest and Range Experiment Station. (1982) *Aids to Determining Fuel Models for Estimating Fire Behavior*. (General Technical Report INT-122). Ogden, Utah: Hal E. Anderson.

be typical of one burning during the height of the fire season.[5] Flame lengths were plotted to create a fire hazard map of the watershed.

In addition to the native fuels, a significant part of the watershed is in the wildland-urban intermix where structures are built into and among the native forest vegetation. These developments represent high values but also an important increase in the fuel available to a wildland fire and the potential for dangerous fire behavior. In the wildland-urban intermix, surface fuels continuity tends to be broken up by roads, irrigated gardens and lawns, and other less flammable materials. The crowns, however, tend to be continuous and sufficiently dense to sustain crown fires. The vertical arrangement of fuels in the wildland-urban intermix-- both native vegetation and structures -- plus the heavy fuel loading imposed by structures, vehicles, fire wood piles, gas tanks and the like mean that fire will very likely be in the tree crowns very quickly. For purposes of the analysis, the wildland-urban intermix in the forested areas was assigned fuel model 10 and in the brush fuel model 4.

Risk

The best measure of the probability of ignition is the recent history of ignitions for an area modified to take into account changes in human behaviors that will increase or decrease potential ignitions for a specific area. At the time or writing of this report, ignition history is incomplete for the watershed. A good second alternative is to locate where human activity is concentrated. There the probability of ignitions is high. Where there Is little human activity, ignition probabilities are relatively lower although lightning strikes are not associated with human activity and they do represent a significant proportion of ignitions in the watershed.

For purposes of the analysis, residential densities were mapped for the watershed. High fire risk was assigned to high density areas and relatively lower risk of ignition was assigned to areas of fewer residents. In addition, heavily traveled roadways and heavily used recreation areas were assigned high risks of ignition. Power lines, less used roadways, and lesser used recreation resources were assigned relatively lower risk. Areas where wood cutting and industrial forest uses are common were assigned a moderate level of risk.

Values

The distribution of value in the watershed is difficult to do if only one variable must be defined. Values range from market values such as the assessed value of homes and the worth of timber to non-market values such as environmental aesthetics, wildlife, and recreation. They range from the highly intangible but certainly very high value of human lives and safety from injury to the very tangible worth of inventories in wildland-urban intermix retail businesses. Combining these different measures of value is difficult.

Instead, it is recognized that values tend to be concentrated where people live. Human life, property and even the less tangible values associated with landscape aesthetics have higher values in and around settlements. Heavily used recreation resource settings similarly rate highly on value. But high resource values such as timber and water catchment for down stream use are examples of two important watershed values not necessarily linked to population densities.

For purposes of this analysis, areas of the watershed are classified as relatively high, medium, or low value. However, the best approach to assessing the threat of wildfire is to select the values of interest, map their

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[5] Weather and fuel conditions used were those existing at the time of the Maidu Fire which occurred in Butte Creek Canyon on September 22, 1992.

Time = 1400
Temperature = 95°F.
Relative Humidity = 21
Wind Speed = 15 mph
Ten Hour Fuel = 4
Live Fuel = 100%
A cross-slope wind vector of 45° was assumed

distribution, determine their limitations to exposure to fire intensities, and compare that distribution to the flame length hazard map. Trying to combine a great many different values with different susceptibility to fire and different degrees of quantification into one value variable will prove to be of only limited usefulness. The assessments of threats to values are easy to make once a hazard map has been prepared as long as the susceptibility to fire of each relevant value is known. Information on susceptibility to fire can be found for many forest plants on the Fire Effects Information System[6] available on the world wide web. Research is underway by the US Forest Service to determine the susceptibility of structures to different fire intensities. Recent studies by the Forest Service have determined the minimum acceptable separation between fire fighters in safety zones and flames of different intensities[7]. These same data can be applied to resident safety.

Results

Results of the wildfire threat assessment are presented by areas of the watershed with similar conditions of risk, value, and hazard. These areas are

The grass dominated slopes below Paradise and south and east of the canyon

The Paradise wildland-urban intermix along Paradise Ridge from the south border of the town to Paradise Reservoir and from the rim of Butte Creek canyon to the rim of the West Branch Feather River canyon

The bottom of the Butte Creek canyon up to approximately a mile below the confluence of Butte Creek and West Branch Butte Creek where brush converts to timber in the canyon bottom.

The wildland-urban intermix along Highway 32 above and below Forest Ranch and on Doe Mill Ridge.

The timbered lands of the upper part of the watershed.

The Grass Dominated Slopes

Between Highway 99 and the southern edge of the town of Paradise, Paradise Ridge is wide and slopes relatively gently (less than 30 %) to the south and west. The slope is cut by numerous steep-sided ravines tending southwest. The ridge between the ravines is covered mostly with grass and oaks. The ravines are filled with brush.

Risk. The grass is easily ignited. The principal risks of fire starts in the area are from vehicles using the Skyway, Clark Road, Neal Road, and Highway 99. Risk along these routes is considered to be high. Additional risk is posed by homes located along the rim of the canyon west of the Skyway and the businesses at the edge of Chico. Again this risk is high. High fire risk results from activity associated with the Neal Road land fill. Moderate risk is associated with the high voltage transmission lines that cut across the bottom of the slope. Risk throughout the rest of this unit is low.

Values. Values within the subdivision along the canyon rim are very high as a result of expensive properties and the presence of human life both of which are susceptible to loss by fire. The remainder of the area has very little of value that can be damaged by fire. Grazing and browse values may be destroyed for a year but grasses are well adapted to frequent fire and growth will return with the rains. The chaparral will also be renewed by fire, increasing its value for wildlife and cattle. Aesthetic values will be reduced until rains re-green the area. Losses to fires on the grassy slopes and in the ravines will be minor.

However, fires in the grass and especially the brush filled ravines pose serious threats to homes and businesses in Paradise. Fires starting in the grass have excellent potential for burning into the outskirts of the Town of Paradise where potential for losses is very high.

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[6] The Fire Effects Information System can be reached at [http://www.fs.fed.us/database/feis/]
[7] Butler, B. W. & Cohen, J. D. (1998). Firefighter Safety Zones: A Theoretical Model Based on Radiative Heating. *International Journal of Wildland Fire, 8*, 73-77.

Hazard. Fuel model 1 was used to predict fire behavior for the grass and fuel model 4 to predict fire behavior in brush. Fires starting in the grass will spread up-slope and with the wind toward Paradise. Under weather conditions typical of the height of the fire season, grass fires will spread at speeds approaching six miles per hour. (5.7 mph on slope on the level, 5.8 mph on 20 percent slopes, and 6.1 mph on 40 percent slopes.) Flame lengths will be approximately 10.7 feet.

The brush will burn with flame lengths exceeding 47 feet and will spread at about five and one half miles per hour.

Fuels on the south through west facing slopes will be preheated by hot summer sunshine reaching peak flammability between noon and 4:00 p.m. The prevailing winds are from the south and are augmented by up-slope winds developing as the valley heats. Winds will be stronger in the ravines. When the slope and winds line up with hot fuels, fires can be explosive

Fires starting along Highway 99, Neal Road, and Clark Road will spread rapidly up-slope with the wind. Fires will be very intense in the brush filled ravines and on the slopes. Control at the head of the fire will be difficult especially in brush. Attacking the head of a fire of this intensity in brush is likely to be ineffective and is certainly dangerous. Aircraft applying retardant may be effective, especially in grass. There are no significant natural breaks in the fuels between the bottom of the slope and Paradise from which to attack the fire.

At the top of the slope, just at the border of the Town of Paradise, grass fires will ignite dense brush which, in turn, will ignite the surface and ladder fuels under the pines. Fire in the ravines has the potential of pushing into the heart of Paradise.

The Paradise Wildland Urban Intermix

The Paradise wildland-urban intermix covers the relatively flat-topped Paradise Ridge between Butte Creek canyon and the West Branch Feather River canyon from about where the timber starts to Paradise Reservoir. The area can be divided into the south area from the southern town border of Paradise to the Magalia Reservoir, the Paradise Pines and vicinity, and Nimshew. Descriptions of the fire threat in these areas applies also to the smaller clusters of structures elsewhere in the middle elevations of the watershed.

Risk. Risk of ignitions within the wildland-urban intermix is very high. potential sources of ignition include structure fires, construction work, landscape maintenance activities (equipment fires), children experimenting with fire, vehicles, door yard burning, smoking, barbecues, arson, and many others. The concentration of people using fire for all kinds of purposes makes vegetation ignitions likely.

Values. A large number of very high values are located in this area. First among these is human life. The numbers of people living in the wildland-urban intermix is large and concentrated. The threat to life is exacerbated by the large numbers of elderly and disabled persons including a hospital and care facilities. Many people will have considerable difficulty evacuating in the event of a major fire.

Property values are also very high in the wildland-urban intermix. Homes, businesses (and their contents), automobiles, trailers, motor homes; equipment, utilities, government buildings, and a large number of the expensive cultural developments associated with a small city are threatened by fire.

The landscape and climate are principal reasons people have chosen to live in Paradise and the other communities of the watershed's wildland-urban intermix. Were the forest removed, there is no doubt that the value of the land for residential purposes would be greatly reduced and the local economy would decline materially as fewer people chose to live there and recreational use diminished.

Natural resource values including potential timber values, water quality, and wildlife habitat are threatened by intense wildfire within the wildland-urban intermix. Certain cultural resources would also be damaged or destroyed.

Hazard. The lowest elevations of the wildland-urban intermix and portions of the canyon rim, especially on the point between Honey Run and Butte Creek are chaparral mixed with structures. Fuel model 4 applies to these locations. The remainder of the wildland-urban intermix is better represented by fuel model 10.

Chaparral on the southern edge of the wildland-urban intermix grows on relatively gently slopes typically less than 20 % Flame lengths there are predicted to be 47.3 feet. Rates of spread will be about 5.4 miles per hour.

On the Butte Creek side, slopes leading up to structures on the rim are much steeper, typically 40 to 80 percent with some 100 percent or more. Flame lengths here will range from 47 to 52 feet or more. Rates of spread will range from 5.5 mph to 6.7 mph. Fire intensity and rate of spread along the west facing slopes of Butte Creek canyon will be increased in the afternoons by solar heated fuels and increasing up-canyon winds. That will be particularly true on the south and southwest facing slopes of the west tending draws that cut into the escarpment. Structures are built at the head of many of these draws and are in particular danger.

Along the east perimeter of the wildland-urban intermix the slopes are timbered, the timber containing a considerable component of highly flammable live oak. In the lowest reaches of the wildland-urban intermix, brush covers the slopes. These slopes will burn with flame lengths similar to those of the west side of the wildland-urban intermix except that the east slope is not as exposed to direct solar radiation. Fuels will not be hot after mid-morning. Any benefits of less intense burning are largely lost because many homes along the east perimeter are built on the slopes and are virtually in the canopy of the live oaks.

The wide top of the ridge is in timber with heavy accumulations of suppressed understory vegetation and well developed fire ladder. While the surface fuels are broken up by roads and other non-flammable openings, the crowns are closed and of sufficient bulk density to support crown fires. In addition, structures, vehicles, fire wood piles, and fuel storage add to the potential intensity of surface fires. Burning structures often produce large numbers of brands and convection columns that easily carry them aloft. This greatly increases the potential for spotting and the consequent rapid leap-frog of the fire through the wildland-urban intermix and spread to surrounding wildlands.

Fuel model 10 does not adequately describe the conditions of the Paradise wildland-urban intermix but is the best available model. Surface rates of spread are probably over estimated because roads and other breaks will slow it down and fire intensities are probably underestimated. Flame lengths are predicted to be around 12.5 feet within the forest covered wildland-urban intermix. Rates of spread are predicted to be about 0.6 miles per hour. However, the flames will impinge directly among the lower branches of most of the forest cover. Torching and crowning is very likely in which case flame lengths and rate of spread will increase dramatically.

Scorch heights will exceed 90 feet. The scorch height is the distance above the ground in which all vegetation is killed. A 90 foot scorch height would result in the death of virtually all trees and understory vegetation leaving the ridge barren much as happened in the Fountain Fire that burned in similar fuel and terrain east of Redding.

There are portions of the lower Paradise wildland-urban intermix that were once in agriculture or for other reasons are now covered sparsely with timber and where grass will be the principal fuel carrying the fire. Rates of spread and flame lengths in these areas will be similar to that in the grass dominated areas below Paradise. Because grasses in these areas are intermingled with brush and urban fuels fire effects may be more pronounced. Fire will certainly spread more quickly through these areas than in the timber.

Within the Town of Paradise, draws of Clear Creek, Dry Creek, and Little Dry Creek and head water tributaries produce fingers of unbroken, dense surface fuels in conjunction with steeper slopes. The risk from children experimenting with fire is high in these pockets of fuel and the potential for fires to become well established before being detected is higher.

Under existing conditions within the Paradise wildland-urban intermix wildfire is likely to start. Under the right weather conditions common in late summer, such fires have excellent potential to become large and destructive. Even a small fire by wildland measures will result in exceptional losses in a densely settled area including, very likely, the loss of life.

Fires starting in the wildland-urban intermix are likely to be found and reported quickly. Fire fighter response times are relatively short. The many breaks in the surface fuels provided by roads and other non-flammable areas will help slow the rate of spread as long as the fire stays on the ground. Terrain in the wildland-urban intermix is not particularly steep except in some of the ravines and along the rims of the canyons; steep slopes typically will not contribute to fire spread.

These advantages are offset by the fact that fire fighters must deal with evacuation of residents from the danger area. Accumulations of dense, suppressed vegetation under the forest crown and well developed and wide spread fire ladder will often allow fires to build to dangerous intensities forcing fire fighters to immediately go on the defensive protecting structures instead of attacking the spreading fire itself. If the fire burns into the settled area from outside, the number of spot fires starting in the community might easily exceed the ability of fire fighters to deal with them under existing fuel conditions.

Butte Creek Bottoms

This area encompasses the bottom of the Butte Creek canyon and the slopes on each side from the outskirts of Chico to the timber beginning approximately one mile downstream from the confluence of Butte Creek and West Branch Butte Creek.

Risk. Risk of ignitions in the canyon bottom is high due to the combination of recreational traffic along Humbug Road, the prevalence of party activity along Honey Run Road, and the number of homes along Humbug Road and in the small settlements in the canyon.

Values are high where homes are located. Cultural resource values may be threatened by fire at the covered bridge and at historic mining locations in the canyon. Riparian vegetation could be damaged by intense fire. Aesthetic values can be damaged especially in riparian areas. The slopes of the canyon are covered with grasses, oaks, and brush. Fire in this vegetation will cause short term aesthetic damage but have little impact after one year.

Hazard. Lower reaches of the area are represented by fuel model 1. The bottom of the canyon and the slopes north and east of Chico are relatively flat. Canyon walls are steep, however. Slopes in the bottoms are typically less than 20% but slopes become steeper quickly toward the canyon walls. In the lower reaches of the canyon, slopes increase up to 80%. Higher in the canyon, slopes increase from the flats in the bottom to more than 100% in places.

Grass is the fuel that will carry fire on both the canyon bottom and walls up to about the junction of Honey Run Road and Humbug Road. Some brush is found along the canyon walls and the creek bottoms have riparian vegetation. Grass fires burning into accumulations of berry bushes and grape vines will become locally more intense. Accumulations of vegetation, downed wood and fire ladder in the riparian areas will intensify fire and killing or top killing many trees.

Rates of spread in the bottom of the canyon will be approximately 5.7 mph increasing to more than 6.5 mph as the slopes become steeper toward the canyon walls. Flame lengths will range from about 10.7 feet to more than 11.5 feet.

In the upper portion of the area, chaparral will burn with flame lengths of approximately 47 feet in the bottom of the canyon and more than 52 feet on slopes of 100% or more. Rates of spread will increase from 5.3 mph in the canyon bottom to 6.7 mph or more near the tops of the canyon sides.

The most important values in this portion of the canyon are concentrated in the bottom along the creek and Humbug Road. Fire threat is reduced somewhat by that fact. Homes in the bottom may still be threatened by fire burning down slope or by fires started down canyon. The threat from down canyon will increase as canyon winds increase later in the day. Orientation of the canyon to the south means solar heating will raise the temperatures of fuels and dry them out. East facing slopes will be somewhat less flammable than west facing slopes.

The danger of fires starting in the canyon bottom to values there is not trivial. However, the greatest threat is that posed to structures and other values along the canyon rims and timber and watershed values up canyon by the high risk of ignition and potential for rapid spread and high intensity combustion.

Highway 32 Wildland-Urban Intermix

A fire protection plan was prepared by Bob Cermack for the community of Forest Ranch. The plan addresses the wildland fire threat. Copies can be viewed at the California Department of Forestry and Fire Protection, Butte Unit, Oroville, CA.

This area includes the outskirts of Chico south of Highway 32, the Little Chico Creek drainage, Doe Mill Ridge, and extends north to the narrows between the West Branch Butte Creek and Big Chico Creek.

The fire threat is similar to that faced by the Paradise wildland-urban intermix. The ridge top between Big Chico Creek and Little Chico Creek and West Branch Butte Creek is narrower and there are fewer structures.

Risk. Between the outskirts of Chico and 12 Mile House on Highway 32, the principal risk is from travel along Highway 32. Residential areas on the outskirts of Chico present a high risk of ignitions. Recreational uses of Bidwell Park in the Big Chico Creek watershed may ignite fires that spot into the little Chico creek watershed and threaten Doe Mill Ridge and Forest Ranch.

Above 12 Mile House, risk of ignition is very high among the concentrations of residential structures and moderate from occasional small scale timber harvest activities.

Values. Below 12 Mile House and on Doe Mill Ridge, scattered structures and human life create areas of very high values that can be seriously damaged by wildfire. Most of the landscape is in grass and brush, however, which will be little damaged by fire so is classified as low value. Vegetation and landscape aesthetics damage by fire will be relatively small and will recover within a few years. Therefore the values in this area, with the exception of the structures, human lives, and associated property are rated low.

Hazard. Above 12 Mile House, the landscape changes to forest cover. Conditions there are similar to those in the Paradise wildland-urban intermix. Homes along the canyon edges and at the head of draws of tributaries to Little Chico Creek are exposed to potentially intense and damaging fire. This is especially true on the Butte Creek side at 12 Mile House where brush below the homes can be expected to produce flame lengths in excess of 47 feet. The brush blends into pine dominated timber with dense understory of suppressed reproduction and wide spread fire ladder. Fire behavior and potential damage to the landscape and threat to lives and property are similar to that described for the Paradise wildland-urban intermix.

The Timbered Upper Watershed

The remainder of the watershed is largely timbered. Although there are scattered concentrations of structures, notably at Butte Meadows, and isolated home sites most of the land is managed for natural resource values, principally wood products.

Risk. The risk along Highway 32 and the road from Paradise to Sterling City is moderate. Other risks may be locally high while timber harvesting is occurring in a particular area or during hunting season. In general the risk of ignitions in this area is low to moderate. Lightning probably presents a risk of ignition higher than that posed by human activity.

The greatest risk of fire in this area is fire spreading from a start in the wildland-urban intermix and escaping to the wildlands. That risk is high.

Values. Timber and wildland values are the principal values in this area. Especially at mid-elevations, timber is an important resource with high economic values. Timber values are susceptible to serious damage by wildfire. The potential for loss to a large wildfire is very high as is clearly demonstrated by the losses experienced in the Fountain Fire which burned over very similar terrain and fuels.

In a major conflagration, losses of structures at Butte Meadows and other clusters of homes and isolated structures is likely to be high. The scattered nature of these properties and their integration into the wildland fuels make defense difficult.

Hazard. Nearly all of the timbered portion of the watershed is classified as fuel model 10. It is mixed conifer forest dominated by pine in the lower elevations and by fir in the higher elevations. Relatively small areas are in wet meadows, young plantations, or have been thinned from below. However, by far most of the forest is characterized by dense stands of trees with heavy accumulations of suppressed understory vegetation and dead woody fuels. The watershed was heavily logged at the end of the last century and beginning of the 20th century. As a consequence, there is very little if any vertical separation between surface fuels and tree crowns. Crown closure approaches 100% over most of the upper watershed.

Slopes in the upper watershed are generally less than 40%, most less than 20%, except some north-facing slopes of the south side of Butte Creek up stream from Butte Meadows. Below Butte Meadows the Butte Creek canyons are relatively narrow. Sides of the canyon are steep. The broken, steep country dominates the east side of the upper watershed below Butte Creek Meadows. The west side is dominated by wide flat ridges separating West Branch Butte Creek from Butte Creek.

Fires burning in the broken steep country will burn with flame lengths between 12.5 and 14 feet. Rates of spread will between 6 mph and about 8 mph when the fire burns on the surface. However, crown fires are likely because there is little separation between the surface fuels and the canopy and crown closure approaches 100% over most of the watershed. Crown fires will be very destructive and may be very large under weather conditions such as those during the Fountain Fire and the 49er Fire.

Conclusions

The wildfire threat is very high in the wildland-urban intermix areas of the Paradise Ridge and along Highway 32 on the western margin of the watershed. In those areas, the risk of ignitions if very high, the values that may be lost, including human life, are very high, and the hazard predicts potentially very destructive fire behavior. The bottom of the Butte Creek canyon contains high values and the risk of ignition is high. However, the topography means that intense fire is much less likely in the canyon bottoms. The danger there is not trivial but is much less than it is on the ridge top, especially at the canyon rim. Indeed, the greatest danger in the canyon bottom is that fires that start there will rush to the canyon rim and destroy homes and landscapes there.

The upper part of the watershed is in timber. The hazard is high, especially in the steep, broken terrain. Timber values are high and there are scattered clusters of structures and individual homes. Risk is relatively low. An important danger is that fires that start in the wildland-urban intermix will spread to the wildlands and develop into a large destructive fire on the order of the Fountain Fire dominated by crown fires. In that case, destruction of timber values and both tangible and intangible watershed values will be very great.

The potential for loss is relatively low in the grass lands south of Paradise and Forest Ranch. Fires are likely here because the risk is high especially along the roads. However, the grass and chaparral are well adapted to fire and will generally recover by the next year or so. The danger in this area is that it lies up wind and down slope from the wildland-urban intermix. Fast moving and intense fires are likely to carry flames into the southern subdivisions of Paradise.

Chapter 10

Scenic and Recreation Resources

Introduction

The purpose of the Recreational Opportunities Inventory for the Existing Conditions Report is to examine the present conditions of recreational sites, facilities and activities within the Butte Creek Watershed boundaries. The inventory identifies the locations of facilities and activities on a corresponding map and matrix.

This inventory provides valuable information to stakeholders such as residents, landowners, water users, recreational users and local, state and federal agencies. Because there is a close relationship between public and private land use in this area, it is important to clearly define recreational areas, facilities, and activities in order to have a complete existing conditions report of the entire watershed area.

There are no set standards or rules regarding the issues and topics that should be included in a recreational opportunity inventory. Because every watershed has different opportunities and goals, it is important to identify the Issues and Concerns of the region.

The topics that are addressed in this project reflect information gathered from existing management reports and studies, interviews, and field investigations. Although there are a wide range of topics that could be included in this inventory, this study focused on the issues that were found to be of greatest concern to its users (see Issues and Concerns chapter, # 1).

Related Studies

This inventory is a compilation of information that has been gathered from various agencies, stakeholders, interest groups and organizations, and recreational users. It is unique in that it combines multiple sources of information into one document.

This inventory began with a collection of secondary data and related studies (see list of related studies found at the end of this chapter). There were numerous sources of information that had to be reviewed in order to prepare a complete and comprehensive study that encompassed a wide range of issues. These sources included state and federal documents, local and city documents, and existing studies:

- USFS Lassen National Forest *Land and Resource Management Plan*, 1992
- BLM *Forks of the Butte Creek Recreation Area Management Plan*, 1990
- Butte Creek Watershed Conservancy *Addressing Public Recreational Access on Butte Creek, CA, 19*97
- Butte County *Draft Butte County General Plan Energy, Natural Resources, and Recreational Element, 19*91
- Town Paradise *Paradise General Plan*, 1982
- DWR *Butte and Sutter Basin's Water Data Atlas, 19*94
- Durham Recreation and Park District *Masterplan, 19*92

Each of these documents provided information concerning existing facilities and sites, recreational activities, existing conditions, character of the landscape, resource availability, and current management strategies.

These documents were found to be the most informative and useful. They provided the information necessary to compile a list of recreational activities and identify the sites where these activities occur.

General Overview of Land Uses and Land Ownership

For the purposes of this report the Butte Creek Watershed is separated into three major regions. These include: 1) the upper watershed - Butte Meadows mountain zone, 2) the foothill canyon zone - below Butte Meadows to the canyon's end at the Skyway bridge, and 3) the valley and Butte Basin zone - from below the Skyway bridge to the Sutter Buttes.

Butte Meadows Basin Zone

A majority of the land within the Butte Meadows Basin Zone of the Butte Creek Watershed is managed for public use. Butte Meadows is located adjacent to the Lassen National Forest which is managed by the USFS Almanor Ranger District. The Forest offers year-round recreational opportunities including: camping, hunting, fishing, hiking, horseback riding, sightseeing, picnicking, snowmobiling, cross-country skiing, and off-road vehicle use. Also located on national forest land are two residence tracts in Butte Meadows and Jonesville that are leased by special permit.

Privately owned land constitutes the remaining portion of the this zone. Small subdivisions, generally used for vacation homes, are located throughout Butte Meadows with small resorts providing services to residents and visitors.

Butte Creek Canyon Zone

This zone contains land that is managed at the federal and local jurisdictions. Federal land consists of areas managed by the BLM including the Forks of the Butte Creek Recreation Area and the Upper Ridge Wilderness Area. Activities in this area include: backpacking, biking, camping, mineral collection, nature viewing, fishing, hiking, horseback riding, kayaking and tubing, picnicking, and swimming.

The Town of Paradise Recreation and Parks District manages parks and trails that fall within the watershed boundaries. Furthermore, private organizations within the town offer recreational opportunities at the Paradise Reservoir and DeSabla Lake.

The remaining land within this zone is semi-public, private and commercial recreational facilities. These facilities include: museums, golf facilities, and bridges.

Valley and Butte Basin Zone

Land ownership within the Valley and Butte Basin Zone is primarily private. Public facilities within this zone are managed by the USFS, DFG, and the USFWS.

Overview of Recreation Opportunities

Developed Recreation Use

Developed recreation refers to opportunities presented by sites that are built and managed to enhance specific types of outdoor recreation, and to provide for varied degrees of resource protection. Examples of developed recreation sites in the Butte Creek Watershed include the USFS Cherry Hill campground above Butte

Meadows, and the Honey Run Covered Bridge. Established trails are also considered developed recreation sites, though they may traverse essentially undeveloped wildlands.

Developed Recreation Sites

A facilities matrix (see Appendix O) provides the details of facilities at developed recreation sites within the watershed. Additional description of selected areas continues below.

Butte Meadows Mountain Zone

Pacific Crest Trail: Managed by the USFS (Lassen NF), the Pacific Crest trail crosses the upper ridge of the Butte Creek Watershed from Humboldt Summit to Humbug Summit, and then exits the watershed to the east of Snow Mountain. Elevations range from 6,000 to 7,000 feet. Use is primarily seasonal (late spring, summer, fall) and is limited to hiking and equestrian passage.

Butte Creek Trail: Managed by the USFS (Lassen NF), the Butte Creek Trail follows Butte Creek from Jonesville to Butte Creek House on Humbug Road, in an elevation range of 5,000 to 5,800 feet. Uses include hiking, horseback-riding, fishing and mountain biking.

Colby Mountain Lookout: Managed by the USFS, Colby Mountain Lookout (6,200 feet) is accessible to vehicular traffic and is popular with cyclists in summer, and skiers and snowmobilers in winter. The lookout commands exceptional views of the upper Butte Creek Watershed and the Deer Creek Watershed.

Butte Meadows and Cherry Hill Campgrounds: Managed by the University Foundation of California State University, Chico under permit by the USFS. Butte Meadows (4,300 feet, 13 sites) and Cherry Hill (4,700 feet, 25 sites) campgrounds offer seasonal late spring to fall use. The campgrounds include tables, fire rings with grilling grates, potable water, and vault toilets.

Jonesville Snowmobile Park (Winter OHV Area): Managed by the USFS, the Jonesville Snowmobile Park (5,000 feet) provides a sizable parking area designed for pull-through trailer parking. The park also provides parking for the nearby Colby Meadows Cross-Country Ski Area. Facilities include vault toilets. Use is primarily winter, though the parking area and restrooms are also used in summer months by hikers, fishers, cyclists and equestrians.

Private developed sites in the Butte Meadows area: The Butte Meadows area is a popular location for vacation homes. Most vacation homes are on private land, though the USFS manages two tracts of permit recreational residences in Butte Meadows (12), and in Jonesville (16). Three small resorts operate in the Butte Meadows area - The Bambi Inn, The Outpost, and the Tank House.

Foothill Canyon Zone

A notable characteristic of the Foothill Canyon Zone is its lack of developed recreational sites, and the predominance of private land (mostly owned by Sierra Pacific Industries). In the canyon's upper reaches between Centerville and Butte Meadows, only the BLM - managed Forks of Butte Creek Recreation Area (1,200 to 3,200 feet) is designated for recreational access. Primary access to Forks of Butte is via Doe Mill Road between the Skyway and Butte Creek, and by Doe Mill Road and Garland Road which continues through to Highway 32 above Forest Ranch. Developed sites in the Forks of Butte are limited to the Doe Mill Road bridge across Butte Creek, and to the Black Prince Trail which runs from the Doe Mill Road Bridge downstream to the DeSabla Powerhouse Road below the Forks of Butte Hydroelectric Project. The trail is maintained by the Butte Creek Trails Council. Further details on the Forks of Butte Recreation Area are contained in the BLM Forks of Butte Recreation Area Plan (1990).

The Paradise - Magalia area, which covers a section of the watershed's southeast ridge, offers several developed recreation sites and trails within the watershed. Prominent among these are the Upper Ridge Nature Preserve on BLM land, operated by the Upper Ridge Wilderness Area Group, and Bille Park, operated by the

Paradise Area Park and Recreation District. These areas are best detailed in the Town of Paradise General Plan (1982).

Lower Foothill Canyon Zone - Centerville to Skyway

The lower stretches of Butte Creek Canyon are primarily in private ownership, and there is little developed recreational access. Notable sites include the Centerville Museum on Humbug Road (640 feet) above what once was referred to as the "Steel Bridge", and the Honey Run Covered Bridge area (347 feet) at the junction of Honey Run and Humbug roads. Both sites have historical significance, and provide opportunities for a variety of recreational activities.

Valley and Butte Basin Zone

The Valley and Butte Basin Zone of the watershed are characteristically quite different from the canyon and upper reaches of the watershed. Here too, developed recreational opportunities along the creek are minimal. Land ownership in the valley section is also primarily private. However, there are a variety of public developed sites within the valley section of the watershed. Elevations in this area are 200 feet and below.

USFS Genetic Resource Program: Located off of Morrow and Cramer Lane in south Chico, the USFS (Mendocino NF) Genetic Resource Program facility (approximately 209 acres) provides an interpretive site, nature trail, and picnicking opportunities. Recreational use levels are low.

Butte Creek Canyon Ecological Reserve: Located adjacent to Highway 99 at the end of Southgate Lane in south Chico, this 285 acre reserve is managed by DFG. Closed to vehicular access, the reserve is used primarily by anglers, waders, sunbathers, and for nature study.

Durham Recreation and Park District: The Durham Recreation and Park District spans Butte Creek in the Durham area. Developed community park sites and trails provide a variety of recreational opportunities. Further details on the Durham Recreation and Park District are available in the Durham Recreation and Park District Master Plan (1992).

Sacramento River National Wildlife Refuge: The Llano Seco Unit of the Sacramento River National Wildlife Refuge, located on 7 Mile Lane southwest of Dayton, is managed by the U.S. Fish and Wildlife Service (USFWS). The refuge provides an interpretive site with parking, observation stands, and trails. Primary use is seasonal birdwatching and nature study.

Upper Butte Basin Wildlife Area: Three units comprise the Upper Butte Basin Wildlife Area, managed by the California State Department of Fish and Game (DFG), 1) the Llano Seco Unit off of 7 Mile Lane (note this DFG unit is separate from the USFWS managed Llano Seco Unit of the Sacramento River National Wildlife Refuge just to the north) 2) the Howard Slough Unit off of road ZZ and Highway 162, and 3) the Little Dry Creek Unit off of Colusa Highway. Each of these units provide access and parking. Recreational opportunities include seasonal birdwatching, nature study, and hunting.

Gray Lodge Wildlife Area: The Gray Lodge Wildlife Area, west of Gridley off of Pennington Road, is managed by DFG. Gray Lodge provides a variety of recreational opportunities including seasonal hunting, nature study, birdwatching, fishing, hiking, picnicking, and bicycling. Gray Lodge includes an interpretive site, nature trails, hunters' check station, potable water, and restrooms.

Butte Sink: More than 45 private hunting clubs are located in the valley and Butte Sink sections of the lower Butte Creek Watershed. These areas are managed for agricultural production as well as hunting, or managed exclusively as game reserves, primarily for waterfowl, and for the benefit of club members. The Butte Sink Waterfowl Association is a non-profit association representing the interests of member clubs in the Butte Sink area.

Dispersed Recreation Use

Dispersed recreation refers to opportunities presented by areas that are not developed specifically for recreational use. Dispersed recreational activity occurs over a broad landscape, and is not confined as it often is in developed sites. Examples of dispersed recreation include angling, cycling, hiking in undeveloped areas, and picnicking or camping in undeveloped areas. Examples of dispersed recreation use in the Butte Creek Watershed include parking along Honey Run Road to gain access to Butte Creek for tubing, and pulling off the Skyway heading west from Paradise to take in a clifftop view of the Butte Creek Canyon. The key concept to consider in dispersed recreation is access. Therefore, roads and trails provide the foundation of access upon which dispersed recreation is dependent.

Dispersed Recreation Areas

Dispersed recreation is, by definition, not restricted to specific sites. Rather, dispersed recreation is better described as patterns of use in generally defined areas and landscapes. The three major zones within the watershed: Butte Meadows Mountain, Foothill Canyon, and Valley Butte Sink, help to describe recreational opportunities that are of a dispersed nature. Further, the systems of roads and trails within the watershed help define the major corridors along which dispersed recreation occurs.

Butte Meadows Mountain Zone

Accessible roads and trails that structure the patterns of dispersed recreation in the Butte Meadows Mountain Zone include: Butte Meadows Road (paved from junction with Highway 32 to Jonesville; Skyway between Inskip and Butte Meadows; Forest Roads to Colby Mountain, Humboldt Summit, Humbug Summit, and Snow Mountain; Pacific Crest Trail; and Butte Creek Trail. Attractions in this area that draw seasonal recreationists include Butte, Willow, Scotts John, Jones, Colby, and Bolt Creeks; Humbug Summit and Cold Springs; Summit Lake; and Humboldt Summit. Activities in these dispersed areas are noted in the Activities Matrix (see Appendix P).

Foothill Canyon Zone

Accessible roads and trails that structure the patterns of dispersed recreation in the Foothill Canyon Zone include: Doe Mill Road; Butte Creek Trail; Nimshew - Centerville Road; DeSabla Powerhouse Road; Helltown Road; Humbug Road (paved); Honey Run Road (paved); and Skyway (paved). Major attractions in the Foothill Canyon Zone include access to Butte Creek's waters, scenic vistas, and the roads themselves. Typical of dispersed use in the Foothill Canyon Zone are activities such as hiking along the Centerville Flume, "putting in" kayaks and tubes at the former Steel Bridge, and cycling the roads that lace the area. Unlike the Butte Meadows Mountain Zone of the watershed, land ownership in the Foothill Canyon Zone is primarily private, setting the stage for conflicts over dispersed recreational use that at times constitutes trespass. Activities in these dispersed areas are noted in the Activities Matrix (see Appendix P).

Valley and Butte Basin Zone

Accessible roads and trails that structure the patterns of dispersed recreation in the Valley and Butte Basin Zone include: numerous county roads (paved); Highway 162; an extensive network of unpaved roads, public and private; and levee-top roads that are selectively accessible. Attractions in this area include wildlife, fish, generally uncrowded roadways, and access to water. Typical recreation activities include hunting, nature study, cycling, and driving for pleasure. As in the Foothill Canyon Zone, land ownership in the Valley and Butte Sink Zone is predominantly private. Dispersed use tends to follow developed road access, though trespass by recreationists is a common occurrence. Legal access becomes a conflict in the Butte Sink, when floodwaters create what some believe to be "navigable waterways", open to public access. Owners and members of private clubs inundated by these seasonal waters take exception to the navigable waterways concept under these circumstances, and consider such access to be trespass. Activities in these dispersed areas are noted in the Activities Matrix (see Appendix P).

Anecdotal Use Reports

Phone interviews were conducted to obtain further input as to the current conditions of the recreational opportunities within the watershed. Federal. State, and local residents and organizations provided valuable information for this portion of the existing conditions report.

- Butte Creek Trails Council provided information regarding the Butte Creek Trail located in the Forks of the Butte Creek Recreation Area. Information included: trail accessibility, conditions of trail after the 1997 flood, types of recreational uses, and involvement of the council concerning the maintenance and preservation of the trail.
- BLM Redding Resource Area representative expanded on the information obtained about the Forks of the Butte Creek Recreation Area and the Upper Ridge Wilderness Area. Additional information was provided about gold collection or mining activities at the Forks of Butte Creek area.
- Almanor Ranger District provided maps and information about the types of facilities available at the Butte Meadows and Cherry Hill camping areas as well as residential tracts within the area.
- Chico Velo Biking Club provided maps indicating routes and trails that the club uses within the watershed.
- Honey Run Covered Bridge Association provided information about ownership, activities, and conditions of the bridge and visitor area after the 1997 flood.
- Among the issues described by the Chico Area Flyfishers, littering was one of their primary concerns. Furthermore, the club feels that the creek is "fished-out" and they no longer fish within this area as a group. Suggestions of this organization included: a catch-and-release program and replanting of fish.
- Paddleheads is a kayaking club whose members use the creek regularly. The information provided indicated the most popular runs used on the creek. Access to the creek is limited and many times kayakers hike and cross over private property to reach the creek.
- A California Department of Fish and Game warden discussed popular places to fish within the watershed.

Recreation Opportunities Matrixes

The purpose of this section is to define and outline the information contained in the Recreational Opportunities Matrixes (see Appendices Q and R).

The matrixes serve as a quick reference for site identification and existing recreational uses. Based on secondary data collection, interviews, map identification and field investigations two recreational opportunities matrixes were prepared: (1) facilities matrix and (2) activities matrix. Each matrix lists all of the recreational sites within the watershed as well as the corresponding map identification number.

Facilities Matrix

The facilities matrix identifies the types of developed or constructed facilities that are located at that particular site. During field investigations each site was examined for existing facilities. The matrix indicates if each of the sites provides the following facilities:

- public facility - located on public land such as a national forest
- private facility - located on private land
- BBQ pits or grills - often associated with campsites
- bridge - provides access across the creek
- campsites - areas designated for camping

- interpretive site - signs, kiosk, visitor center or informational bulletin boards
- lease cabins - associated with national forest land, known as residence tracts
- legitimate access - legal access either by road or trail
- parking - areas where users can park vehicles
- picnic tables - areas designated for picnicking
- potable water - drinking water and faucets
- roads (paved) - legitimate access
- roads (unpaved) - legitimate access
- signs - indicating recreation area
- store/lodge/restaurant - services provided to users
- toilets - pit or flush restrooms
- trails (maintained) - legitimate access maintained by a public agency
- trails (not maintained) - legitimate access not maintained

Activities Matrix

The Activities Matrix identifies the various types of recreational opportunities that can be found at a particular site. The activities that occur at a site were identified by signs, interviews, and secondary data. It should be noted that each site is not limited to the types of activities indicated on the matrix. It is possible that recreational users may partake in other forms of recreation. The matrix identifies the types of activities that were commonly identified to occur at that particular site.

- Backpacking
- Biking On road/off road
- Camping
- Collecting
- Cross-country skiing
- Fishing
- Golf
- Hang-gliding
- Hiking/jogging
- Horseback riding
- Hunting
- Kayaking
- Mining/panning
- Motorcycling/ORV Off-road/on-road
- Nature study/birding
- Picnicking
- Rock-climbing
- Shooting/plinking
- Sightseeing/driving
- Snow-shoeing
- Snow-mobiling
- Sunbathing
- Swimming/wading
- Tubing

Mapping

Included in this study is a Recreational Opportunities Map. The matrixes include a column indicating the sites' Map Identification Number. This number indicates the sites' location on the corresponding map.
The sites' identification on the map indicates any of the following:

- the location of the site, such as a campground
- trailheads, including bicycle paths, hiking trails, or cross-country ski trails
- location where there is legitimate access, such as a portion of a trail or creek

Tubing and Whitewater Paddlesports (Canoeing, Kayaking, And Rafting)

Butte Creek is known to many Paradise and Chico-area locals as a retreat from the summer heat. This is the act of floating down the creek while sitting on top of a tire inner-tube. This activity occurs primarily during the warmer months of the year, roughly April or May through August or September. While this is not a whitewater activity per se (creek flows are low during this time of year), it is included in this section as it pertains to human's navigating the creek, and as such, the activity is dictated by the same sorts of conditions that influence the more traditional whitewater activities of kayaking, rafting, and canoeing.

Kayaking, rafting, and canoeing activities usually occur in the winter and spring (October or November through April or May, depending on water conditions). This season corresponds to the higher creek flows that are sought by these recreationalists in order to float their crafts over gravel bars, as well as to create the difficulty and hydraulics that are desired by advanced paddlers. It is this very rate of flow that makes tubing an unsafe activity in Butte Creek during the high water season.

Tubing

Tubers, as those who float the creek in tubes are called, usually float a section of the creek beginning at the upper crossing of the creek by Centerville Road (the Steel Bridge, or Bailey Bridge as it is called in its current configuration) down to the Honey Run Covered Bridge day-use area, a distance of 5.2 miles. Some tubers used to "put in" at the Centerville Powerhouse about 0.75 mile upstream of the Bailey Bridge, although the access road is now gated. Other tubers choose to float a lower section, starting at the Honey Run Covered Bridge, and ending at either the BLM land just downstream, or continuing on to the recreation area at the CDFG property above Parrott-Phelan Dam.

The float makes for a long day, and the canyon's long, late-afternoon shadows can make the creek seem especially cold, even on the hottest of summer days. The creek is shallow, slow, and a leisurely float can take three hours or more. This, along with late-in-the-day put ins, and alcohol, can lead to cold, tired, drunk, and disoriented tubers. Cold and tired, or with darkness approaching, some head through private property to gain access to Centerville Road in order to hitch a ride up to their put in, as they are unable to reach their destination. Some local residents have observed tubers harassing salmon holding in the creek. These occurrences have led to conflicts with private landowners in the past (see Issues and Concerns chapter, # 1)

The creek itself has changed considerably (see Fluvial Geomorphology chapter of this report) in the last two years (winter of 1996 through the present). These changes have brought some considerations for summer recreationalists. The high water event of January 1997 removed vegetation on both sides of the creek, widening the bed of the creek. This created a shallower creek in numerous sections during low summer flows. This created more sections where tubers must walk and carry their tubes, slowing their progress. The high waters of 1997 also created several cobble bars that have no distinct line of main flow through them. At lower flows, the water essentially runs through the cobbles, not over them, creating another portage for tubers.

The most serious creek change from the high water event of January 1997 affecting tubers was the introduction of trees and large woody debris directly in the stream channel. While the Butte County Private Industry Council sent crews through the residential portion of the canyon to remove trees and woody debris from the streambanks on many parcels of land, many such items are still to be found in the stream channel itself. These trees and snags are an integral part of healthy fish habitat (see Fisheries chapte), yet they can pose a threat to any unsuspecting tuber with his/her feet dangling in the water. Foot entrapment is a leading cause of moving-water drowning, and the need to bring this to the public's attention should not be underestimated.

Some WAC and Conservancy Board members have suggested restrictions on numbers of tubers, restrictions on parking at the Bailey (Old Steel) Bridge and other sites, and stricter enforcement of these regulations in the hope that by making it more difficult to use the creek for tubing, associated impacts will be decreased. Others in the WAC and on the Board have put forward the idea that a shuttle to and from the canyon, with staff explaining the situation regarding private property, litter, safety, and fisheries issues could alleviate the current level of impacts, especially the parking problems. The idea of educational signs at the put in and take out sites with information on float times, water temperatures, rules, and suggestions has been accepted by most.

Kayaking, Rafting, and Canoeing

The whitewater activities of kayaking, rafting, and canoeing on Butte Creek during the winter high-water season are differ tremendously from summer season tubing. First and foremost, the creek is not so much a creek as it is a small river. Whitewater paddlers (as this section will refer to kayakers, rafters and canoeists) differ from the summer tuber in that they seek the speed and power of the dynamic hydraulics that are created by high winter flows. On the whole, the paddling community is very aware of the dangers associated with navigating these sorts of conditions, and therefore are fairly well trained and equipped to deal with problems encountered on a trip down Butte Creek, just as they would be for a more isolated creek or river. Due to this and their lower numbers, whitewater paddlers on Butte Creek appear to be less of a problem than summer tubers.

Proper equipment, responsible and experienced leaders, and common sense should be used whenever participating in a whitewater activity. Butte Creek may attract recreationalists that are not prepared for what they may encounter. With the population of Chico growing along with the popularity of whitewater paddling, more beginner paddlers will be seeking out a place to try the sport. This, coupled with the fact that summer tubers see the creek as an "easy float," great for a beginner friend that may be looking for a first run, sets Butte Creek up as a prime candidate for first-time whitewater recreationalists.

Butte Creek is an excellent place for beginning through advanced whitewater enthusiasts. One of the main reasons why the creek itself is so well suited to whitewater recreation is the varied degrees of difficulty found on the creek and listed later in this section. Another reason the creek is a good place to learn and enjoy whitewater is that there is already a decent number of public and private groups or individuals certified and highly qualified as instructors and guides. Conservancy cooperation with local paddling groups, such as the Chico Paddleheads, Adventure Outings at CSU, Chico, and private individual instructors will assure that first time paddlers are instructed properly in safety, basic river navigation and boat maneuvering, as well as respect for private property and natural resources. These organizations also serve as an information source for out-of-town paddlers searching for runs that suit their ability levels.

Whitewater Difficulty Classifications And Butte Creek Ratings

International Scale Of River Difficulty

The following is the American version of a rating system used to compare river difficulty throughout the world. It was taken from the American Whitewater Affiliation homepage, located at: www.awa.org. This system is not exact; rivers do not always fit easily into one category, and regional or individual interpretations may cause misunderstandings. It is no substitute for an accurate first-hand description of a run by experienced guides or recreational river runners.

Paddlers attempting difficult runs in an unfamiliar area should act cautiously until they get a feel for the way the scale is interpreted locally. River difficulty may change each year due to fluctuations in water level, downed trees, geological disturbances, or bad weather, as has Butte Creek, especially over the past two years. Stay alert for unexpected problems!

As river difficulty increases, the danger to swimming paddlers becomes more severe. As rapids become longer and more continuous, the challenge increases. There is a difference between running an occasional Class IV rapid and dealing with an entire river of this category (ie the section just above the Steel Bridge down versus the section from Chimney Rock down). Allow an extra margin of safety between skills and river ratings when the water is cold or if the river itself is remote and inaccessible.

The Six Difficulty Classes:
Class I: Easy. Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

Class II: Novice. Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed.

Class III: Intermediate. Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. Scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims.

Class IV: Advanced. Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require ``must" moves above dangerous hazards. Scouting is necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong Eskimo roll is highly recommended.

Class V: Expert. Extremely long, obstructed, or very violent rapids which expose a paddler to above average endangerment. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex, demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end ofthe scale, several of these factors may be combined. Scouting is mandatory but often difficult. Swims are dangerous, and rescue is difficult even for experts. A very reliable Eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential for survival.

Class VI: Extreme. One grade more difficult than Class V. These runs often exemplify the extremes of difficulty, unpredictability and danger. The consequences of errors are very severe and rescue may be impossible. For teams of experts only, at favorable water levels, after close personal inspection and taking all precautions. This class does not represent drops thought to be unrunnable, but may include rapids which are only occasionally run.

Note: "+'s" and "-'s" may be added to the above ratings to give further refinement in classifying a run. For example, a rapid may be given the designation of "Class IV-" rather than just a "Class III" if, for instance, the hazards for a swimmer may make self rescue difficult, requiring group assistance.

Butte Creek: Classes Of Difficulty

Butte Creek is interesting in that the farther you go upstream, the more difficult the creek becomes. Lower sections of the creek are perfect for beginners in an instructional setting. The middle portions of the creek are great for intermediate and advanced paddlers, with the upper portions of the creek a place for advanced and expert paddlers only. It should be kept in mind that if the creek is above the 3,500 to 4,000 cfs range, it is considered to be at flood stage, and all of the following ratings should be disregarded. As the creek level approaches this range, it is becoming increasingly difficult with the corresponding rise in water level. When the creek is at or above flood stage, flow through streamside vegetation and trees is a common occurrence. These tree branches and large vegetation are known as "strainers," being named for their ability to catch a paddler or swimmer and strain them like spaghetti, with the water going right over the unlucky paddler's head. There are no "eddies" or resting spots in the creek, as the pools are now places of high velocity flow.

Doe Mill Road to De Sabla and Forks of the Butte Powerhouses Class VI
This section of creek is influenced heavily by the serpentine and metavolcanic basement rocks of the Sierra Nevada Basement Complex (see the Geology, Basin Morphology and Hydrologic System section of this report). The creek falls an average 215 feet per mile for the approximately three and one-half miles down to the powerhouses, yet has sections that fall at over 400 feet per mile. Many dangerous waterfalls and rocky rapids lie in this reach. It is in a very steep canyon, and although a trail (the BLM's Black Prince Mine Trail) follows high above the creek for a portion of the run, the run is quite isolated and portage of difficult rapids may be close to impossible once in the gorge. An informal survey of the local paddling community found that this section has most likely not been attempted by whitewater enthusiasts.

De Sabla Powerhouse to Chimney Rock Class V
While the upper mile or so of this run is still quite steep (well over 160 feet per mile), the gradient lessens as the run progresses, corresponding to changes in geology. This geology change also allows for the canyon to open up more. The creek is not in an inner gorge, and portages are easier. There are still many large drops, at least one substantial waterfall, and many rocky rapids. This reach is run by at most about two dozen kayakers in a year with favorable water conditions.

Chimney Rock to Helltown Class IV
Although it offers some excellent scenery with a reduced difficulty level, with nearly a two hour hike to the put-in, this section is not run very much. More often, kayakers will run the next section downstream, described below.

Helltown to Centerville Powerhouse Class III+; IV-
No public access and a one mile hike to the put-in discourages rafts. This section starts in the hard, dark colored slates of the Sierra Nevada Basement Complex, but quickly the transition is made to the sandstones of the Chico Formation. The canyon becomes much wider, and the creek is able to establish a floodplain in some areas, making for a creek with some sand and cobble substrate, rather than the bedrock seen upstream.

Centerville Powerhouse to the Honey Run Covered Bridge Class III
This is the classic introduction run for Butte Creek. The scenery, although there are homes along much of the run, is excellent. The creek is not excessively "pushy" or steep through this reach, although boaters may encounter strainers that require skillful maneuvering. There are several good "play spots" for more advanced boaters.

Honey Run Covered Bridge to the Parrott-Phelan Diversion Dam Class II
This is a great run to instruct first-timers on. The creek is essentially a braided, sand and gravel stream at this point, with no major rapids. Although there are some spots where the main flow may go into strainers, this is a great place for beginners to practice the basics of ferrying and catching eddies.

Visual Resources - Viewsheds

The Butte Creek Watershed is generally attractive for its visual resources. The watershed's three zones offer distinctive landscape forms, and are developed in ways best characterized by the nature of the landscapes, and the ownership of the lands. The Butte Meadows Mountain Zone is predominantly forested highlands managed by the USFS. Land uses fall under the USFS general principles of multiple-use management, and landscapes are characterized by a forested environment managed for a variety of resource values including forest products, water quality, wildlife, and aesthetics. The Foothill Canyon Zone is predominantly in private ownership, and is characterized by a managed forest environment changing to a chaparral and grassland landscape as the canyon descends in elevation. Land uses include forest husbandry, hydroelectric generation, grazing, and rural residential development. The Valley Butte Sink Zone is where Butte Creek wanders into the landscape of the Sacramento Valley Region, characterized by flat agricultural and wetlands, and punctuated in the south by the profile of the Sutter Buttes.

No single managerial entity governs the lands and resources within the Butte Creek Watershed. Therefore, visual resources management can only be implemented as a cooperative and often voluntary exercise between land jurisdictions. The USFS and BLM, both agencies that practice visual resource management, have holdings in the watershed. The Lassen National Forest manages a good part of the Butte Meadows Mountain Zone, and the Forks of Butte Creek Recreation Area is the major ownership by BLM within the Foothill Canyon Zone of the watershed. The visual resource management systems employed by these agencies can provide a general groundwork for assessing the visual resources of the Butte Creek Watershed.

Visual Resources Management (VRM)

The USFS has recently revised its visual resources management system to what is now called the Scenery Management System. The BLM is currently working on a revised visual resource management system. The existing BLM and former USFS visual resource assessment systems are closely related and should be easily understood for the purposes of this inventory.

Visual Resource Inventory Components

A visual resource inventory is conducted by 1) evaluating the nature of the landscape for scenic attractiveness, and categorizing areas in one of three classes based on landscape characteristics; 2) determining the sensitivity of these areas based on levels and types of recreational use, and on regional interest in the visual quality of the landscape; and 3) determining the visual distance and observability of objects in the landscape. Each of these three components is divided into three classes as follows:

- Variety Class: Class A = Distinctive
Class B = Common
Class C = Minimal
- Sensitivity Level: Level 1 = Highest Sensitivity
Level 2 = Average Sensitivity
Level 3 = Lowest Sensitivity
- Distance Zones: fg = Foreground
mg = Middleground
bg = Background

Variety Class Descriptors
Class A Distinctive

Landform: Over 60 percent slopes which are dissected, uneven, sharp exposed ridges, or large dominant features.

Rock Form: Features stand out on landform. Unusual or outstanding, avalanche chutes, talus slopes, outcrops, etc.

Vegetation: High degree of patterns in vegetation. Large old-growth timber. Unusual or outstanding diversity in plant species.

Water Forms,
Lakes 50 acres or larger. Those smaller than 50 acres with one or more of the following: 1) unusual or outstanding shoreline configuration, 2) reflects major features, 3) islands, 4) class A shoreline vegetation or rock forms.

Water Forms,

Streams: Drainage with numerous or changing flow characteristics, falls, rapids, pools and meanders or large volume.

Class B Common

Landform: 30-60 percent slopes which are moderately dissected or rolling.

Rock Form: Features obvious but do not stand out. Common but not outstanding avalanche chutes, talus slopes, boulders and rock outcrops.

Vegetation: Continuous vegetative cover with interspersed patterns. Mature but not outstanding old growth. Common diversity in plant species.

Water Forms,
Lakes: 5 to 50 acres. Some shoreline irregularity. Minor reflections only. Class B shoreline vegetation.

Water Forms,
Streams: Drainage, with common meanderings and flow characteristics.

Class C Minimal

Landform: 0-30 percent slopes which have little variety. No dissection and no dominant features.

Rock Form: Small to non-existent features. No avalanche chutes, talus slopes, boulders and outcrops.

Vegetation: Continuous cover with little or no pattern. No understory, overstory or ground cover.

Water Forms,
Lakes: Less than 5 acres. No irregularity or reflection.

Water Forms,
Streams: Intermittent streams or small perennial streams with no fluctuation in flow or falls, rapids, or meanderings.

Sensitivity Level Descriptors

Sensitivity ratings of Level 1 (highest sensitivity), Level 2 (average sensitivity), and Level 3 (lowest sensitivity), are a measure of public concern for scenic quality. Ratings are based on evaluation of the following indicators of public concern:

Type of Users: Visual sensitivity will vary with the type of users. Recreational sightseers may be highly sensitive to any changes in visual quality, whereas workers who pass through the area on a regular basis may not be as sensitive to change.

Amount of Use: Areas seen and used by large numbers of people are potentially more sensitive. Protection of visual values usually becomes more important as the number of viewers increases.

Public Interest: The visual quality of an area may be of concern to local, state, or national groups. Indicators of this concern are usually expressed in public meetings, letters, newspaper or magazine articles, newsletters, land-use plans, etc. Public controversy created in response to proposed activities that would change the landscape character should also be considered.

Adjacent Land Uses: This interrelationship with land uses in adjacent lands can effect the visual sensitivity of an area. For example, an area within the viewshed of a residential area may be very sensitive, whereas an area surrounded by commercially developed lands may not be visually sensitive.

Special Areas: Management objectives for special areas such as Natural Areas, Wilderness Areas or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Areas, Scenic Roads or Trails, and Areas of

Critical Environmental Concern frequently require special consideration for protection of the visual values. Management objectives for these areas may be used as a basis for assigning sensitivity levels. (Note: These are BLM land class distinctions cited above.)

Other Factors: Consider any other information such as research or studies that includes indicators of visual sensitivity.

Distance Zones Descriptors

Foreground (fg): This is the area that can be seen from each travel route where landforms and activities might be viewed in detail.

Middleground (mg): This is the area where details are not as discernible, perhaps a range of 1 to 5 miles. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape.

Background (bg): This is the remaining area which can be seen from each travel route to approximately 15 miles. Vegetation should be visible at least as patterns of light and dark. Landscapes discernible in the distance as only forms or outlines should not be included.

Visual Resource Management methods combine Variety Class with Sensitivity Level and Distance Zone ratings to establish general visual resource management objectives for land areas. These methods are used on relatively continuous lands over large areas under management of a single agency, such as the USFS or BLM. Within the Butte Creek Watershed, only the lands in the upper watershed managed by the USFS are mapped for VRM objectives. (Adopted Visual Quality Objectives Map. Lassen National Forest Land and Resource Management Plan., 1992)

For the purposes of this inventory, watershed lands will be rated for the general VRM components by zone: 1) Butte Meadows Mountain, 2) Foothill Canyon, 3) Lower Foothill Canyon, and 4) Valley and Butte Basin. Specific scenic viewshed areas will be noted. Identifying management objectives for lands within the watershed is beyond the scope of this inventory.

Butte Meadows Mountain Zone

Visual Resource Management objectives for the Butte Meadows Mountain Zone are described in the Lassen National Forest Land and Resource Management Plan. Specific areas are detailed in the plan's accompanying "Adopted Visual Quality Objectives Map" (1992). Visual Resource Inventory components for this portion of the watershed are:

- Variety Class:	B Common
- Sensitivity Level:	Level 2 Average Sensitivity, to Level 1 Highest Sensitivity
- Distance Zones:	fg Foreground along roadways and trails, mg Middleground elsewhere

Vistas: Unique vistas in the Butte Meadows Mountain Zone include open views from Colby Mountain Lookout, locations along Humboldt and Humbug Roads, and views of Butte Meadows.

Foothill Canyon Zone

The Foothill Canyon Zone below Butte Meadows is mostly private land (Sierra Pacific Industries), with some ownership under BLM (Forks of Butte Creek Recreation Area). Access to this zone is limited. The major route into the area is Doe Mill Road that bridges the creek at Forks of Butte Creek between Highway 32 and the Skyway. Visual Resource Inventory components for this portion of the watershed are:

-Variety Class:	B Common, to A Distinctive (along creek corridor)
-Sensitivity Level:	Level 3 Lowest Sensitivity, to Level 1 Highest Sensitivity (at Forks of Butte Creek Recreation Area)
- Distance Zones:	fg Foreground along roadways and trails, mg Middleground elsewhere.

Vistas: Unique vistas in the Upper Foothill Canyon Zone are concentrated along the Butte Creek corridor. Most significant of these foreground view areas is the Forks of Butte Creek Recreation Area. Middleground and some background vistas are present along Highway 32 above Forest Ranch, which looks over the West Branch of Butte Creek south of Lomo. Quality middleground and background vistas exist on the upper Skyway beyond Inskip to Butte Meadows. These views are primarily in Variety Class B Common, though sensitivity is reasonably high because of travel along these routes.

Lower Foothill Canyon Zone

The Lower Foothill Canyon Zone is the most heavily settled portion of the watershed above Durham. The area is unique for canyon views from both canyon bottom and canyon rim, as well as from the few travel routes that ascend the canyon. Access to this zone is high in the canyon bottom (Honey Run and Humbug roads) and along the south rim (Skyway). Views from the north rim along Doe Mill Road are limited by accessibility. Visual Resource Inventory components for this portion of the watershed are:

-Variety Class:	B Common, to A Distinctive (along creek corridor and bluffs
-Sensitivity Level:	Level 2 Average Sensitivity, to Level 1 Highest Sensitivity (along creek corridor and from bluffs where easily accessible
-Distance Zones:	fg Foreground along roadways, mg Middleground elsewhere, with some bg Background distances looking southwest into the north valley

Vistas: Unique vistas are a significant attraction of the Lower Foothill Canyon Zone of the Butte Creek Watershed. The area is primarily rural and rural-residential, providing a relatively pastoral appearance. The riparian creek corridor is attractive for water features and diverse vegetation. Sloping canyon walls are crowned by cliffs and bluffs, creating distinctive landforms for which the County was named. Significant rim views are present along the westbound lanes of the Skyway, where several dispersed pullouts are frequently used. Small hiking paths allow people to view the canyon away from their autos. Vistas in this area are of high sensitivity because of high levels of travel and intentional sight-seeing behavior. Rim views from Doe Mill Road are also of high quality (common to distinctive), but the remoteness of Doe Mill Road keeps visitation low and thus rates the lowest sensitivity level. From the canyon bottom, Honey Run and Humbug roads, as well as Centerville Road where it is unpaved between Centerville and Nimshew, offer distinctive views of Butte Creek and the creek's canyon. These areas are Class B Common to Class A Distinctive, and rate Level 1 Highest Sensitivity because of high levels of travel and intentional sightseeing behavior.

Valley and Butte Basin Zone

The Valley and Butte Basin Zone is characterized by flat topography with distance views of the foothills to the east, coast range to the west, and Sutter Buttes to the south. Land ownership is predominantly private, with several government managed wildlife areas. Unique views include the agricultural lands, Sutter Buttes when weather permits, and opportunities to view avian wildlife. Visual Resource Inventory components for this portion of the watershed are:

- Variety Class: C Minimal to B Common
- Sensitivity Level: Level 2 Average Sensitivity, to Level 3 Lowest Sensitivity Distance Zones: fg Foreground along roadways, mg Middleground where riparian vegetation is visible on near horizon, and bg Background distances viewing foothills, coast range, and Sutter Buttes

Vistas: Unique views are provided by the Sutter Buttes, particularly in closer proximity and during periods of clean air quality in the valley. Riparian areas add variety to the agricultural landscape. Waterfowl presence during winter months provides unique viewing opportunities. Openness in the Valley and Butte Basin Zone offers a full view of the day and nighttime skies.

Issues and Concerns Regarding Recreation (see Issues and Concerns, #1)

Stakeholder Concerns

The Butte Creek Watershed Project held its first Stakeholders meeting on February 18, 1997. At this meeting participants voiced their "issues and concerns" regarding the watershed. Each of the various topics that were discussed at this meeting was tabulated and grouped by theme. One of the topics included recreational issues. The specific issues of concern included:

- Recreational Uses: Impact on the use of Butte Creek since other creeks restricted. Users putting pressure on Butte Creek - increased traffic, inadequate parking, trespassing, trash. Solution: Alcohol checks and surprise checkpoints, garbage cans, Board of Supervisors enforce ordinances.
- Driving inappropriately is growing - drinking - flooding off road damage, parking, garbage, bathrooms.
- Uncontrolled dirt bike and off road vehicle use in the upper watershed. Causes erosion and increases sediments.
- Recreational trespass on private property.
- How can human contamination be controlled in the Butte Creek Watershed? Campers/Septics.
- Look at regional needs and availability of recreation, habitat, etc.
- Butte Creek Access: Exclusion moves problem to another location. Solution: Post signs for public access and private access, increase parking access for public access.

Resident Concerns

- Litter
- Trespassing
- Over fishing
- Cyclists and vehicle conflicts
- Private duck clubs and trespassing
- Disturbance to soil, vegetation, and water quality
- Increased traffic
- Disturbance to migratory salmon

Recreationist Concerns

- Lack of access/parking
- Cycles and vehicle conflicts
- Lack of fishing opportunities
- Conflicts between incompatible recreation activities

Conclusions

The Butte Creek Watershed presents a number of challenging issues. The watershed possesses qualities that make it enticing to recreational use: flowing water suitable for wading, swimming and whitewater floating, fish, scenery, riparian areas, trails, roads, and a generally natural or rural appearance. The proximity of the Chico urban area, and the communities of Paradise, Oroville, Biggs, Gridley, Nelson, Richvale, and Durham, present population pressures projected only to increase in the future.

Though open space is plentiful in the watershed, private land is the primary ownership pattern. With the exception of national forest lands in the upper watershed, limited BLM holdings in the foothill canyon zone, and wildlife areas in the valley, publicly accessible lands are relatively scarce, particularly in the part of the canyon nearest Chico and Paradise.

It is to be expected that recreationists will continue to seek recreational opportunities in the Butte Creek Watershed. As accessing these opportunities may frequently require crossing private lands, trespass conflicts will continue to occur. Non-trespassing recreationists will continue to crowd the few legal access points in the canyon stretches of the watershed, causing ongoing parking and traffic problems. The need for cooperative efforts leading toward mutually agreeable changes from the conditions of existing recreational resources is apparent (see Issues and Concerns chapter, # 1).

List of Related Studies for the Recreation Component of the Butte Creek Watershed Project ECR

Lassen National Forest, 1992. Land and Resource Managment Plan. U.S. Department of Agriculture, Pacific Southwest Region.

Forks of Butte Creek Recreation Area Management Plan. May 1990. U.S. Department of the Interior, Bureau of Land Management, Ukiah District, Redding Resource Area.

Paradise General Plan, 1982.

Butte and Sutter Basins Water Data Atlas. February 1994. Department of Water Resources, Northern District.

Durham Recreation and Park District Master Plan 1992 - 2007.

Chapter 11

Existing Resource Protection Measures

Resource Protection Measures

This chapter summarizes the regulatory process established to protect natural resources in the Butte Creek Watershed. The laws pertaining to the protection and enhancement of the Butte Creek Watershed, both state and federal, have been identified. Approved restoration "actions" from *the Revised Draft Anadromous Fish Restoration Plan* are listed and other significant restoration projects are summarized. Finally the non-governmental organizations involved in Butte Creek Watershed planning are identified.

Stream Project Permitting in California

Projects adjacent to streams or in a riparian corridor require certain permits from local, State or Federal agencies. The following is a summary of the agencies involved in stream project permitting, as well as agencies active in the Butte Creek Watershed planning area.

Local Agencies

All local government agencies with jurisdictional responsibilities for a streambed projects must review them under the requirements of CEQA. The main purpose of CEQA review is to identify and prevent significant potential environmental impacts from proposed projects.

City or County planning departments may have local ordinances pertaining to creeks and wetlands, and depending on the nature of the project, several other permits/exceptions/may be required as well. City or County Health Departments may be involved in stream or discharge projects if they pose a potential public health hazard.

The Cities of Chico, Paradise, Biggs and Gridley conduct project review through their planning and building departments.

In an effort to minimize environmental impacts of projects adjacent to Butte Creek, the Butte County Department of Development Services, Planning Division often makes suggestions and imposes conditions for projects in the planning review process. In addition to this review, the County has recently revised a "Watershed Protection Overlay Zone," that makes specific development provisions for projects in the Firhaven Creek, Paradise Reservoir, and Magalia Watersheds.

The Butte County Health Department requires permits for the construction, expansion and/or destruction of all sewage disposal systems. Section 19 of the County Code outlines the specifications for all sewage disposal systems including capacity and location requirements. The Butte County Health Department also requires permits for constructing drinking water wells. The specific drinking water well permit requirements can be found in Section 34 of the County Code.

The Butte County Fish and Game Commission is under supervision of the County Board of Supervisors. The Commission has created a wetland mitigation bank on Butte Creek. Purchase of credits from this mitigation bank can be used for development projects in other parts of the County.

The Butte County Agricultural Commissioner’s Office is the local enforcing agency for California State Food and Agriculture Code. The Code was enacted “for the purpose of promoting and protecting the agricultural industry of the State and for the protection of public health, safety and welfare.” Under direction of the California Department of Food and Agriculture and the California Department of Pesticide Regulation, the Agricultural Commissioner conducts regulatory service functions required by State law and enforces local agricultural ordinances. Major functions of the Agricultural Commissioner’s Office include: pest prevention, pesticide enforcement, service programs, and consumer protection. The Agricultural Commissioner is appointed by the Butte County Supervisors.

The Butte County Air Quality Management District (BCAQMD) is a state mandated local authority charged with reducing stationary sources of air pollution. The BCAQMD also has review guidelines for indirect sources which include commercial and residential development. Through the CEQA process BCAQMD planners comment on the impacts of indirect sources and offer possible mitigations. The BCAQMD is guided by a board of directors composed of the County Supervisors and two city council representatives from the five incorporated cities.

State Agencies

The California Department of Fish and Game (DFG) requires a Streambed Alteration Agreement for projects that will divert or obstruct the natural flow of water, change the bed, channel or bank of any stream, or use any material from a streambed. The SAA is a contract between the applicant and the DFG stating what can be done in the riparian zone and stream course. The DFG is interested in any work that occurs in, on, over, or under the creeks between the streambed sloping upwards to the top of the bank. The DFG is also the state law enforcement agency for the protection of fish and wildlife resources.

The California Department of Forestry and Fire Protection (CDF) is dedicated to the fire protection and stewardship of over 34 million acres of California’s privately-owned wildlands. CDF oversees the enforcement of California’s forest practice regulations. This includes review of Timber Harvest Plans (THPs) submitted by private landowners and logging companies who want to harvest trees on their property.

The California Reclamation Board cooperates with the U.S. Army Corps of Engineers in controlling flooding along the Sacramento and San Joaquin Rivers and tributaries. The Board has jurisdiction throughout the drainage basin of the Central Valley and governs the Sacramento and San Joaquin Drainage District. Their jurisdictional area extends through 14 counties and 1.7 million acres lying along the most flood prone portions of the two rivers. Approval by the Reclamation Board is required for projects or uses that encroach into rivers and waterways within federal and State authorized flood control projects, or designed floodways adopted by the Board. Board permit must be obtained before you begin any construction work.

The Board exercises jurisdiction over the levee section, the waterward area between project levees, 10-feet landward of the landward levee toe, and within designated floodways adopted by the Board.

The State Water Resources Control Board (SWRCB) administers the state’s water quality, water pollution control, and water rights functions under California’s Environmental Protection Agency. This state board provides policy and budgetary authority to the nine Regional Water Quality Control Boards, which conduct planning, permitting and enforcement activities. There are three divisions of the State Board, they are: Division of Water Rights, Division of Water Quality, and Regional Water Quality Control Boards.

Any persons or agencies intending to take water from a creek for storage or direct use on nonriparian land must first obtain a Water Rights Permit from the Division of Water Rights. To grant a Water Rights Permit, the Board considers under what conditions water will be taken and used. The goal of the Board is to assure that California’s water resources are put to maximum beneficial use and that the best interests of the public are served.

The following permits are issued from the Division of Water Quality:

General Industrial Storm Water Permit, for the discharging of industrial storm water runoff only.

General Construction Activity Storm Water Permit for any construction activity, including clearing, grading, excavation or reconstruction for storm water discharges and that result in the disturbance of at least five acres of total land area.

The following permits are issued from the Regional Water Quality Control Boards:

National Pollution Discharge Elimination System (NPDES) Permit. Issued to the owner or operator of any facility that is currently discharging, or proposing to discharge, waste into any surface waters of the state must meet state waste discharge requirements. For discharges to surface waters, these requirements become a federal National Pollution Discharge Elimination System (NPDES) Permit from the Regional Board.

Federal Clean Water Act(CWA) Section 401 Water Quality Certification. Federal CWA Section 401 requires that every applicant for a U.S. Army Corps of Engineers CWA Section 401 permit or a Rivers and Harbors Act Section 10 must request State certification from the Regional Board that the proposed activity will not violate State and Federal water quality standards. The Regional Board reviews the request for certification and may waive certification, or may recommend either certification or denial of certification to the State Board Executive Director. (Guide to Stream Project Permitting for the State of California (Pamphlet), California Association of Resource Conservation Districts)

In 1997 Governor Wilson issued an Executive Order that established the Cabinet-level Watershed Protection and Restoration Council (WPRC) charged with developing a California Watershed Protection Program. The WPRC's primary responsibility is to provide oversight and coordination to State activities related to watershed protection and enhancement, including the conservation and restoration of anadromous salmonids in the watersheds of California.

The main objective of the WPRC is to develop a watershed protection program, which includes an anadromous salmonid conservation element, that will lead to the promulgation of a 4(d) rule by the National Maribe Fisheries Service under the federal Endangered Species Act. This approach enables NMFS to exercise the flexibility under the ESA to assist and support the State in developing and implementing adequate adequate State conservation efforts, rather than establishing a whole new federal overlay of processes and requirements. The State's objective is to have NMFS certify this program as meeting the requirements of the ESA. It further seeks to have the program be a basis for meeting the goals of State and federal water quality laws. (Watershed Protection and Restoration Council: Protecting California's Anadromous Fisheries, State of California, The Working Group of the Watershed Protection and Restoration Council, July 1998)

Federal Agencies

The U.S. Army Corps of Engineers

The regulatory authority of the U.S. Army Corps of Engineers for creek projects is based on Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Section 404 of the Clean Water Act requires Corps authorization for work involving intentional or unintentional placement of fill or discharge of dredged materials into any "waters of the United States". This applies even if there is a chance the winter rains may cause erosion leading to sediment discharges into the "waters." Section 10 of the Rivers and Harbors Act requires Corps authorization for work for structures in or affecting "navigable waters". Corps jurisdiction extends up to the ordinary high water line for non-tidal waters.

U.S. Natural Resources Conservation Service

The NRCS, formerly the Soil Conservation Service, is an agency of the U.S. Department of Agriculture working with private landowners to conserve and protect soil, water, air, plants and animals. NRCS helps land users and communities approach conservation planning and implementation with an understanding of how natural resources relate to each other, and how land use activities affect natural resources. NRCS, in cooperation with Resource Conservation Districts and other local, state, and federal agencies, provides free technical information and assistance to landowners and land users upon request, to address management concerns for natural resources such as cropland and pastureland, rangeland, woodland, water resources, disturbed areas, and watersheds. NRCS also provides free soil survey information. NRCS is non-regulatory and does not provide any permits, just recommendations. Recently, NRCS was designated as the federal agency responsible for making wetland delineations/determinations on private agricultural lands. However, these delineations are made only when a written request has been submitted by the landowner or another federal agency. (Guide to Stream Project Permitting for the State of California (Pamphlet), California Association of Resource Conservation Districts)

US Fish and Wildlife Service

The USFS manages grazing permits and timber harvests on all national forest land within the Butte Creek Watershed. The current management practices of the USFS can be found in the Lassen National Forest *Land and Resource Management Plan* (LRMP).

Bureau of Land Management

The Bureau of Land Management (BLM) is the permitting agency for recreational mining in the Butte Creek Watershed. A permit is required for mineral collection that involves the use of a dredge, vacuum, pump, any motorized devise, rocker box, or sluice box. There are 30 recreational mining sites located in the Butte Creek Canyon. (Instructions for Obtaining a Recreational Mineral Collection Permit, Forks of Butte Creek Special Management Area, US Dept. of Interior, BLM)

Relevant Environmental Laws

Much of the following information comes from *Environmental Laws, Regulations, and Policies Pertaining to the Protection and Enhancement of Natural Resources in the Deer Creek Watershed,* Compiled by the Habitat Restoration Group for the Deer Creek Watershed Action Committee.

Federal Legislation

Rivers and Harbors Act of 1899

The Rivers and Harbors Act of 1989 was originally established to protect interstate commerce in navigable waters. The Rivers and Harbors Act is the basic act for controlling works or activities in navigable waters of the United States. These are waters with sufficient capacity to transport products of the country. The Chief of Engineers and the Secretary of the Army must approve all plans and specifications for the placement of structures or other works, pursuant to Sections 9 and 10 of the Rivers and Harbors Act of 1989.

Under the 1899 Act, the District Engineer must subject a proposed project to a “public interest review” having two aspects. The first includes a review of such factors such as economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, water quality, etc. This evaluation allows for considerable discretion on the part of the COE. The second component of the review is more restrictive and requires that the proposed project be “water dependent” and that no feasible alternative sites exist.

This statute, intended to protect water quality, fish and wildlife, prohibits the discharge of materials into a navigable water without a permit from the U.S. Army, excepting liquid waste flowing from streets or sewers, and discharges from certain dredging activities and from water craft. Discharges derived from agricultural runoff, are not included in the Refuse Act Permit Program. Those dischargers that do not require a permit must show that “applicable water quality standards” can be met, or that discharge can be brought into compliance with these standards within a specific period of time. The pertinent standards are those adopted by the State Water Quality Control Board in its Basin Plan. If a Section 404 permit is also needed, the COE must follow regulations issues by the EPA as well as its own regulations. Since Zabel v. Tabb, the COE has had the authority to not issue a permit based on ecological reasons, even though the activity would not interfere with navigation, flood control, or the production of power.

Section 9 of the Rivers and Harbors Act requires an applicant to obtain a permit to construct a dike or dam in navigable waters of the Unites States.

Section 10 of the Rivers and Harbors Act prohibits the obstruction or alteration of navigable waters of the U.S. without a permit from the COE. Under Section 10, the Corps regulates projects or construction of structures that could interfere with navigation. Structures that require permits include piers, breakwaters, bulkheads, revetments, power lines, and aids to navigation. Activities that require permits include dredging, stream channelization, excavation, and filling.

Section 13 of the Rivers and Harbors Act provides that the Chief of Engineers and the Secretary of the Army may permit the discharge of refuse or material of any kind into navigable waters if anchorage and navigation will not be adversely affected. Without a permit such a discharge is prohibited.

National Flood Insurance Act of 1968

The National Flood Insurance Act of 1968 instituted the National Flood Insurance Program (NFIP). The Act established parallel responsibilities among Federal, State, and local governments by ensuring the availability of Federal flood insurance while attempting to reduce the exposure to flood hazard risks though regulatory action at local and State levels. Participating communities must adopt and enforce floodplain management regulations governing aspects of development in flood hazard areas such as location, density of development, height of construction above flood elevations, and construction materials. Residents and businesses in participating communities can then purchase Federal flood insurance against flood loss.

Determination of whether or not a specific property is eligible for flood insurance is made through floodplain mapping. Those areas within the 100-year flood boundary are shown as “Special Flood Hazard Areas” SFHA’s on Flood Insurance Rate Maps (FIRM’s) produced by the Federal Emergency Management Agency (FEMA) and are considered automatically eligible. FIRM’s can be amended or revised to either increase or decrease the SFHA’s due to changes such as flood control project or upstream land changes likely to affect the volume and timing of floodwaters.

If a presidentially declared disaster due to flood occurs in a non-participating community, no Federal financial assistance can be provided for the permanent repair or reconstruction on insurable buildings in SFHA’s. However, eligible applicants may receive other forms of disaster assistance that are not related to permanent repair and reconstruction of buildings.

Federal Water Pollution Control Act of 1972

The Clean Water Act (CWA) is the common name for the Federal Water Pollution Control Act. The primary goal of the CWA is to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” This CWA outlined in a national goal that all discharge of pollutants into navigable waters be eliminated by 1985, and an interim goal to be achieved by 1983: the use of “best available technology economically achievable” to obtain water quality at a level adequate to protect fish, shellfish, wildlife and human recreational activities. The CWA establishes a very broad framework of planning, research, financial assistance, and permit systems to further the national objective and goals. These include creation of a process for reviewing and adopting water quality standards and establishment of regulatory permit processes to control discharges into surface water to reduce pollution of receiving waters.

The SWRCB is responsible for implementing the provisions of the Act, under the supervision of the EPA.

National Environmental Policy Act of 1969 and 1977

The National Environmental Policy Act (NEPA) directs all agencies of the Federal government to address the environmental consequences of their proposed actions. Federal agencies must prepare environmental impact statements (EIS) on major Federal actions that could significantly affect the quality of the human environment. Major Federal actions may include construction projects, permits, licenses, loans, and other subsidies.

The intent of the EIS is to disclose to the general public and to the agencies undertaking the proposed action or those responsible for resource management, the probable long- and short-term impacts of the proposal as well as consideration of less environmentally damaging alternatives to the recommended course of action. NEPA review must consider direct, indirect, and cumulative effects as well as alternatives to the proposed actions. Federal regulations for preparation of an EIS establish an early opportunity for public involvement as Federal agencies are required to conduct a "scoping" process to identify and outline the issues to be addressed in an EIS. Once a Draft EIS is prepared, it is circulated for comment by the general public and by Federal, State, and local agencies. A Final EIS is issued after submitted comments have been considered by the agency preparing the EIS.

Often an Environmental Assessment (EA) is prepared by a federal agency prior to undertaking a major action. An EA is often the first document prepared and it provides sufficient analysis as to whether an EIS or a "finding of no significant impact" is needed. The EA document process is more streamlined and allows for opportunity for mitigation to be built into the project description. (Jain, et al., 1993).

Watershed Protection and Flood Protection Act of 1985

The Watershed Protection and Flood Prevention Act of 1985, established the Watershed Protection Program through which the Natural Resource Conservation Service (formerly SCS) provides financial and technical assistance to local organizations in planning and implementing watershed projects. The purposes of the Watershed Protection Program include flood prevention, agricultural water management, recreation, municipal, and industrial water supply, and fish and wildlife development.

Eligible organization include Indian tries, State or local governments, soil or water conservation districts, flood prevention or control districts, nonprofit water users' associations, and similar organizations that can carry out and maintain improvement projects.

The 1990 Farm Bill (i.e., Food, Agriculture, Conservation, and Trade Act of 1990) amended the watershed protection program to allow cost sharing (Federal funding of 50 percent or more) for acquiring perpetual wetlands or floodplain easements for conservation of flood prevention. Other projects can indirectly benefit wetlands.

The Watershed Protection Program applies only to projects located in watersheds of less than 250,000 acres.

Endangered Species Act of 1973, 1978, and 1982

The Endangered Species Act (ESA), first enacted in 1973, prohibits any action that could harm, harass, or further endanger Federally designated endangered or threatened plant or animal species or the associated critical habitat. The purposes of the ESA are, in part, "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered and threatened species…"

This Act establishes a national and international program for the protection of plant and animal species threatened with extinction. The ESA is jointly administered by the Secretaries of the Interior and Commerce, through the U.S. Fish and Wildlife Service (FWS) for terrestrial and freshwater species and the National Marine Fisheries Service (NMFS) for marine species. The Secretaries of Interior and Commerce are authorized to designate (list) those species which are "endangered" or "threatened" with extinction and delineate specific habitat areas deemed critical for their survival and recovery. An endangered species is "any species which is in danger of extinction throughout all or significant portion of its range." The Secretaries are instructed to develop plans outlining the necessary steps required to bring about the recovery and eventual de-listing of the species, including acquisition of habitat.

The ESA also specifies that whenever Federal Agencies propose to authorize, carry out, or approve an activity which may adversely affect a listed species and/or its critical habitat, the project proponent must consult with the appropriate service. Specifically, the ESA requires Federal agencies, in consultation with the FWS and/or NMFS, to ensure that their actions do not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of these species. The appropriate service is required to engage in a formal consultation with the Federal agency project proponent, and to issue a "Biological Opinion," determining project could jeopardize the species or adversely affect coastal habitat. The Biological Opinion must include any mitigation measures necessary to reduce or eliminate impacts to the species. The Federal agency is prohibited from granting a permit if such determination is made.

In some circumstances, Federal agencies conducting activities which may adversely affect a listed species may receive permits, known as "incidental take statements", from the appropriate service for activities that may incidentally affect the listed species. Similarly, the FWS and NMFS may issues "incidental take permits" to private parties and State and local governments (i.e., individuals, developers, cities, counties) provided that an acceptable Habitat Conservation Plan (HCP) has been developed and submitted to the appropriate service with the appropriate environmental documentation according to the National Environmental Policy Act.

Habitat Conservation Plans (HCPs) aim to protect endangered or threatened species and their habitat by designating appropriate conservation measures for habitat maintenance and enhancement to be used during the process of land development. These plans also identify preserve areas where land is to be protected to mitigate for the loss of habitat elsewhere within the species' range, and must include funding for the conservation program. The FWS encourages large scale, cooperative HCPs to avoid fragmented, piecemeal conservation efforts, as well as to streamline permit processing for individual project applications.

Anadromous Fish Conservation Act of 1965

The Anadromous Fish Conservation Act of 1965 authorizes the Secretary of the Interior to cooperate with the States in conserving, developing, and enhancing the nation's Anadromous fish. The Act authorizes research and investigations and construction and maintenance of hatcheries and of structures to improve feeding and spawning conditions, and to facilitate the free migration of fish. These measures are cost-shared with the States and with other non-Federal interests.

Central Valley Project Improvement Act of 1992

The Central Valley Project Improvement Act (CVPIA) of 1992 has the following purposes:

…to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley of California;

to address impacts of the Central Valley Project;

to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary;

to achieve a reasonable balance among competing demands for use of Central Valley Project water, including the requirements of fish and wildlife, agricultural, municipal and industrial, and power contractors.

The CVPIA "amends the authorization of CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancements as a purpose equal to power generation. "

The CVPIA directs the Secretary of the Interior to develop and implement "a program which makes all reasonable efforts to ensure that, by the Year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the levels attained during the period of 1967 to 1991" (section 3406(b)). The program being developed to satisfy this directive is known as the Anadromous Fish Restoration Program (AFRP).

The Anadromous Fish Restoration Plan (Plan) is being developed for the AFRP. (See the actions and evaluations pertaining to the Butte Creek Watershed listed in the Plan in Restoration Projects Section)

Section 3406(b)(16) of the CVPIA directs the Secretary of the Interior to establish, in cooperation with independent entities and the State of California, a comprehensive assessment program to monitor fish and wildlife resources in the Central Valley to assess the biological results and effectiveness of programs and actions implemented pursuant to Section 3406(b). In compliance, Interior's Fish and Wildlife Service has established a program called the Comprehensive Assessment and Monitoring Program (CAMP).

State Legislation

California Environmental Quality Act of 1970

The California Environmental Quality Act of 1970 (CEQA) declares that it is the policy of the State to "ensure that the long-term protection of the environment… shall be the guiding criterion in public decisions." These decisions should be "consistent with the provision of a decent home and suitable living conditions for every Californian." CEQA requires the preparation of a formal document (an Environmental Impact Report [EIR] or Negative Declaration) that presents to decision-makers and to the public the potential environmental impacts of a proposed project. Mitigation measures for each significant impact must be addressed in the environmental document. Projects which come under CEQA review include public, as well as private projects which require approval by a State or local agency. Each State and local agency must adopt procedures to implement CEQA consistent with CEQA and the Guidelines.

California Water Code

The California Water Code contains provisions affecting water quality, appropriations, and water quality. Division 1 of the Water Code establishes the SWRCB. Division 2 provides that the SWRCB shall consider and act upon all applications for permits to appropriate waters. The SWRCB is required to consider water quality factors in granting a water right. Division 3 addresses dams and reservoirs; Division 5 pertains to flood control; Division 6 controls conservation, development, and utilization of the State water resources; Division 7, commonly referred to as the Porter-Cologne Water Quality Control Act. Covers water quality protection and management; and Divisions 11 through 21 provide for the organization, operation, and financing of municipal, County, and local water-oriented agencies.

State Forest Practices Act of 1974

The State Forest Practices Act of 1974 is intended to utilize, restore, and protect the forest resources, recreational opportunities, and aesthetic enjoyment of State timberlands, while providing watershed protection and maintaining fisheries and wildlife. The Act outlines specific resource conservation standards. The Board is required to divide the State into districts, which are subsequently represented by Technical Advisory Committees that advise the Board. The Act establishes a permit process, with penalties for violations of the permit or Act.

Groundwater Management Act of 1992 (AB-3030)

The Groundwater Management Act of 1992 (AB-3030) lists 12 components that may be included in a groundwater management plan. Each component would play some role in evaluating or operating a groundwater basin so that groundwater can be managed to maximize the total water supply while protecting groundwater quality.

The 12 components listed in Section 10753.7 of the Groundwater Management Act (AB-3030) form a basic list of data collection and operation of facilities that may be undertaken by an agency operating under this act. A groundwater management plan may include components relating to all of the following:

- The control of saline intrusion
- Identification and management of wellhead protection areas and recharge areas.
- Regulation of the migration of contaminated groundwater.
- The administration of a well abandonment and well destruction program.

- Mitigation of conditions of overdraft.
- Replenishment of groundwater extracted by water producers.
- Monitoring of groundwater levels and storage.
- Facilitating conjunctive use operations.
- Identification of well construction policies.
- The construction and operation by the District of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- The development of relationships with State and Federal regulatory agencies.

The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

Efficient Water Management Practices Act of 1990 (AB 3616)

California Assembly Bill 3616 became law in 1990 and established an Advisory Committee to promote efficient agricultural management practices in California. The Advisory Committee is developing the means to undertake cooperative efforts to identify and promote such practices. Currently, a Memorandum of Understanding is being drafted which identifies and defines practices to achieve efficient agricultural water management by water suppliers, including 18 specific practices. Members of the Advisory Committee include representatives from agricultural districts, environmental and public interest organizations, the California Department of Water Resources, and the Bureau of Reclamation's Mid-Pacific Regional Water Conservation Office. (Water Conservation in the State of California, Mid-Pacific Region, Web Page: [http://ogee.hydlab.do.usbr.gov/rwc/mp/mp_cal.html])

Decree No. 18917, Superior Court of the State of California (1942- Adjudicated Rights)

On June 22, 1942 the Superior Court of California, in and for Butte County, determined rights in and to the use of the waters of that portion of the Butte Creek and its tributaries situated above the Western Dam, near Nelson, in Butte County, California. This judgement and decree names claimants rights to divert water from specific points along the Butte Creek Stream system.

(Decree No. 19817, Superior Court of the State of California, *In the matter of the determination of the rights of the various claimants to the waters of that portion of Butte Creek and its tributaries situate above the Western Dam near Nelson, in Butte County, California*.)

California Riparian Habitat Conservation Act of 1992

The California Riparian Habitat Conservation Act established the California Riparian Habitat Conservation Program administered through the Wildlife Conservation Board of the State Department of Fish and Game. The purpose and goal of the program is "to protect, preserve, and restore riparian habitats throughout the State by the acquisition of interests and rights in real property and waters to the extent deemed necessary to carry out the purposes of the program."

The preservation and enhancement of riparian habitat shall be a primary concern of the Wildlife Conservation Board and the Department, and of all State agencies whose activities impact riparian habitat. The board, pursuant to this chapter, shall approve projects to acquire, preserve, restore, and enhance riparian habitat throughout the State, and coordinates its activities undertaken pursuant to this program with other resources protection activities of the board and other State agencies.

In order to accomplish the objectives, the Wildlife Conservation Board may authorize the department to do all of the following:

Acquire interests in real property and water rights through gift, purchase, lease, easement, and transfer or exchange of easements, development rights or credits, and other interests in real property.

- Coordinate its activities under the program with any governmental program for surplus real property sales in the State.
- Award grants and loans to local agencies, State agencies, Federal agencies, and nonprofit organizations for the purposes of this program.
- Exercise any authority and comply with requirements contained in Sections 1348 and 1350, as appropriate, to preserve and enhance riparian habitat.

Streambed or Lake Alteration Agreement (Fish and Game Code 1601/603)

Any person, public agency, or public utility proposing an activity that substantially diverts, alters, or obstructs the natural flow of substantially changes the bed, channel, or banks of any river, stream, or lake must give notice to the California Department of Fish and Game (DFG) under Sections 1601 (public project) and 1603 (private project) of the California Fish and Game Code. All waterways of the State, including intermittent streams, are subject to DFGs jurisdiction. Plans of such projects must be submitted to the DFG for evaluation of impacts to aquatic and wildlife resources. Based on their impact evaluation, DFG will propose modifications to the project in order to mitigate the impacts. If agreement on conditions for a lake and streambed alteration agreement can not be reached between DFG and the project proponent, Section 602 provides for binding arbitration by a panel to formulate the agreement. Such projects can not commence until DFG has determined that adverse impacts to the resources will not result or until adequate mitigation measures are incorporated into the project. If DFG does not grant or deny approval of a project within 30 days of notification, the applicant may proceed with the work.

A Lake/Streambed Alteration cannot be used to authorize the take of a State or Federally-listed threatened or endangered species. If a proposed project may result in the take of a threatened or endangered species, the project proponent must consult with the Department and negotiate a separate “Endangered Species Management Agreement” pursuant to FGC Section 2081 prior to negotiating a Streambed Management Agreement. State lead agencies must consult pursuant to FGC Sections 2090 and 2091. For those lake and streambed agreements affecting wetlands, proposed activities must comply with the DFGs 1990 wetland protection guidelines which prefer alternatives that avoid impacts to wetlands.

Fish and Game Code 5650—Water Pollution

The California State Fish and Game Code states that it is unlawful to deposit in, permit to pass into, or place where it can pass into waters of the State of California any of the following:

- any petroleum, acid, coal or oil tar, lampblack, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material substance.
- any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill or factory of any kind.
- any sawdust, shavings, slabs, edgings.
- any factory refuse, lime or slag.
- any cocculus indicus.
- any substance or material deleterious to fish, plant life or bird life.

Fish and Game Code 1606- Plans for Timber Harvesting

The California State Fish and Game Code requires that plans for timber harvesting must include the following:

- the volume, type, and equipment to be used in removing or displacing any one or combination of soil, sand, gravel or boulders.
- the volume of water, intended use, and equipment to be used in any water diversion or impoundment, if applicable.
- the equipment to be used in road or bridge construction.
- the type and density of vegetation to be affected and an estimate of the area involved.
- a diagram or sketch of the location of the operation which clearly indicates the stream or other water and access from a named public road. Locked gates shall be indicated. The compass direction must be shown.
- a description of the period of time the operation will be carried out.

State Lands Commission Public Trust Doctrine

In California, sovereign rights and responsibilities of the State which are traditionally associated with real property ownership have been delegated to the State Lands Commission (SLC). The Public Trust Doctrine, as it affects these rights, is designed to protect the rights of the public to use watercourses for commerce, navigation, fisheries, recreation, open space, preservation of ecological units in their natural state, and similar uses for which those lands are uniquely suited. Under this doctrine, title to tidelands and lands under navigable water are held in trust by the State for the benefit of the public. Acquired rights in navigable streams, lakes, and tidelands, are subject to the trust and assert no vested right in a manner harmful to the public trust. The Public Trust Doctrine requires the SWRCB to "balance" the potential value of a proposed or existing diversion with the impact on the trust resources. Fish and wildlife are public trust resources in the custodial care of DFG.

The State Lands Commission has exclusive jurisdiction over all ungranted tidelands and submerged lands owned in the State and the beds of navigable waterways, such as rivers, sloughs, and lakes. The State's ownership of these lands includes lands lying below the ordinary high-water mark of tidal waterways and below the ordinary low-water mark of non-tidal waterways. The area between the ordinary high- and low water marks on non-tidal waterways is subject to a "public trust easement". This easement is also under SLC jurisdiction.

Determining the location of the boundary separating private lands from State lands is often a complex and difficult task because of natural changes, such as erosion or accretion, and human changes, such as dredging, filling, and diking.

The SLC reviews projects affecting tidal and non-tidal waterways for consistency with the "public trust doctrine". This doctrine restricts the kinds of uses for which State lands may be utilized. Permitted uses typically include public uses of waterways for navigation, commerce, fisheries, recreation, and environmental protection. Generally, the SLC analyzes proposed uses of a project and determines whether the proposed use will be consistent with the public trust doctrine and what the proper balance of those uses should be.

The California Endangered Species Act of 1984

The California Endangered Species Act (CESA) recognizes the importance of endangered and threatened fish, wildlife and plant species and their habitats for their ecological, educational, historical, recreational, economic, aesthetic, and scientific values. The Act declares the conservation, protection, and enhancement of these species and their habitats to be of Statewide concern. Codes 2052-2098 are provisions intended to meet the goal of endangered and threatened species protection.

The taking of any endangered, threatened, or rare plant and/or animal species in the State is prohibited by the CESA unless the take is specifically permitted by DFG for scientific education or management purposes. In addition, CESA requires that State agencies not jeopardize the continued existence of any listed species either through projects undertaken by the agency or as a result of permits or agreements issued by the agency. To effectuate this requirement, State lead agencies are required to adopt feasible alternatives or mitigation measures to minimize adverse impacts. Consultation is optional for non-State lead agencies or project proponents. CESA requires DFG to provide guidelines for informal consultation. The purpose of informal consultation is to identify endangered species concerns to the project proponent or lead agency as early as possible. The CESA also details the procedures for listing the species and protects species which are candidates for listing.

Natural Community Conservation Act of 1991

The Natural Community Conservation Planning Act (NCCPA) is a legislative attempt to minimize increasing conflicts between urban development and endangered, threatened, proposed, candidate, and other sensitive species. The primary goals of the NCCPA are t o "conserve long-term viable populations of California's native animal and plant species and their habitats in areas large enough to ensure their continued existence, "while at the same time allowing for "compatible and appropriate" urban growth and economic development. By attempting to protect multiple species and their habitats in advance of listing, the NCCPA aims to conserve species before risks to their survival reach crisis proportions. In addition, the NCCPA is intended to avoid the difficulties (both from a species protection and an economic standpoint) that raise when a proposed or candidate species is listed after development of the species' habitat has already begun. The NCCPA does not supersede the requirements of the ESA, CESA or the NPPA, although compliance with the NCCPA may meet some of the requirements of these other endangered species laws.

Establishment of Ecological Reserves

The Establishment of Ecological Reserves (Fish and Game Code Section 1580) declares that the policy of the State is to protect threatened or endangered native plants, wildlife, or aquatic organisms or specialized habitat types, both terrestrial and aquatic, or large heterogeneous natural marine gene pools for the future use of mankind through the establishment of ecological reserves. For the purpose of establishing those ecological reserves, the department, with the approval of the commission, may obtain, accept on behalf of the State, acquire, or control, by purchase, lease, easement, gift, rental, memorandum of understanding, or otherwise, and occupy, develop, maintain, use and administer land, or land and water, or land and water rights, suitable for the purpose of establishing ecological reserves.

Senate Bill 1086

In the State approved Senate Bill 1086 which required a management plan for the Upper Sacramento River and its tributaries. The result of Senate Bill 1086 was the plan *Upper Sacramento River Fisheries and Riparian Habitat Management Plan*, submitted in 1989. The Plan identified several "investigative solutions" and several "corrective solutions." The corrective solutions included installing fish screen on diversions, improving or adding fish ladders at four dams and at Sutter Bypass locations, and habitat restoration work in lower Butte Creek.

California Department of Fish and Game

DFG, as a trustee agency, reviews projects and comments on potential impacts to fish and wildlife resources in general, and identifies potential impacts to endangered or threatened plant or animal species under the California Endangered Species Act. The Department is required to issue a written finding indicating whether a proposed finding would jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of habitat essential to the continued existence of the species. If the Department makes this "jeopardy" finding, it is then required to develop "reasonable and prudent alternatives" to conserve the endangered or threatened species.

In addition to its regulatory responsibility, the DFG has an active role in law enforcement, land management and policy decisions in the Butte Creek Watershed.

Presently there are three DFG wardens working primarily in the upper Butte Creek Watershed. These wardens are based in Oroville, Paradise and Gridley. The wardens are responsible for enforcing California Fish and Game Code including water quality issues and endangered species. Wardens regulate and monitor mining activities, streambed alterations, and diversion activities. Several grants have recently enabled the DFG to expand their law enforcement work in the Butte Creek Watershed.

In recent years DFG has developed programs designed to prevent poaching and polluting through increased public involvement. The Cal Tip Program established a toll free number where the public can call and report Fish and Game violations to DFG wardens. Similarly the Streamwatch program is an outreach effort that provides appropriate Fish and Game contact information.

DFG owns and manages several large properties in the Watershed, including Graylodge Wildlife Area, the Butte Creek Canyon Ecological Reserve, Virgin Valley, Llano Seco, and Butte Creek House. The DFG owns a total of 1,965 acres in the Butte County portion of the Butte Creek Watershed.

US Fish and Wildlife Service

Anadramous Fish Restoration Plan (see Table 11.1)

There are numerous restoration projects planned or underway in the Butte Creek Watershed. Many of the more extensive projects have been identified in the *Revised Draft Anadromous Fish Restoration Plan* (Plan). The Plan is intended as an implementation tool of the Anadromous Fish Restoration Program established by the CVPIA, directed by the Secretary of the Interior. The Plan used the following criteria in determining the reasonableness of each of the restoration actions: consideration of potential adverse economic and social impacts, public sentiment, the magnitude of benefits, the certainty that an action will achieve the projected benefits, and the authority established by existing laws and regulations.

Restoration Projects

McAmis Property

The proposed property for the site of the Butte Creek Ecological Reserve Expansion is currently owned by John McAmis. This 90+ acre parcel with approximately 4,000 feet of creek frontage that is critical riparian corridor adjacent to spawning beds and holding pool in Butte Creek. This property is contiguous with the California Department of Fish and Game Ecological Reserve (285 acres) which extends approximately 2.5 miles downstream.

This area would provide an opportunity for the investigation and development of channel and flood plain management methods to help stabilize the sediment and bedload input from the remains of gravel mining. Restoration of this natural floodplain could have tremendous implication for the enhancement of riparian plant communities that help cool the stream, filter urban runoff, capture large woody debris, and increase the water storage and groundwater recharge capabilities of lower Butte Creek. The net result would be improved habitat for spring run chinook salmon and steelhead trout as well as other native species.

Keeney Project

This project will restore 56 acres of almond orchard between the levees of Butte Creek to shaded riverine aquatic (SRA) and native riparian habitat. The restoration will include the establishment of native riparian species such as cottonwoods, oaks, willows, ash, alders and associated shrubs along nearly one mile of Butte Creek. The successful restoration will benefit fall and spring run chinook salmon, as well as other species by providing shaded riverine aquatic habitat. This shaded riverine habitat will also provide foraging, cover nesting, and roosting habitat for a variety of avian species. To date, the 56-acre parcel has been acquired in fee title, a draft restoration plan has been completed, and the former landowner has agreed to cooperate to remove the orchard and leave the existing irrigation system in place. The Center for Natural Lands Management has purchased the land and will manage the restoration efforts utilizing a nursery stock of native plants from sources local to the site to be used in the revegetation effort. Permit requirements are being evaluated and dialog with local and regulatory agencies is proceeding.

Butte Creek Siphon and Dam Removal Project

Butte Creek is one of the only four Sacramento tributaries that supports a wild spring run chinook salmon. It is also a secondary source of irrigation water for the WCWD, which serves tens of thousands of acres of rice and some orchard in addition to one wildlife refuge primarily with Feather River water brought into the basin from the Thermalito Afterbay.

The purpose of the Butte Creek Siphon and Dam Removal Project is to enhance fish passage and augment Butte Creek flows while maintaining water deliveries to current WCWD customers. The project includes the removal of four dams: two WCWD dams, McGowan Dam and McPherrin Dam. Alternative water delivery systems will be created to replace the dam delivery system. The facilities and construction associated with removing the dams and constructing the siphon and conveyance systems are summarized as follows:

- Remove two WCWD dams and McGowan and McPherrin Dam
- Construct siphon
- Remove/replace associated Main Canal and Highline Ditch structures
- Extend Highline Ditch (2,400 feet)
- Construct check structure across 1048 West Slough
- Construct pipeline from Highline Ditch to 1048 West Slough (600 feet)
- Construct/enlarge Durnel Ditch (6,250 feet)
- Construct pipelines from Durnel Ditch to Pumps 1048B and 1048E (1,500 feet)
- Enlarge a portion of existing drain on Harris property (3,700 feet)
- Construct canal extension to little Butte Creek (9,000 feet)
- Install check structures at Little Butte Creek, Main Drain, Howard Slough, and Little Dry Creek Overflow confluences with Butte Creek
- Install additional culverts on Little Butte Creek at Rabo and Johnson Crossings

Butte Creek House Restoration Project

Lying at the base of Snow Mountain in the extreme southwestern corner of the Cascade Mountains, Butte Creek House is at the headwaters of Butte Creek. Butte Creek House was acquired by DFG to preserve and enhance the site’s wet meadow complex and to benefit associated species in connection with Federal Energy Regulatory Commission (FERC) Project 803, De Sabla-Centerville Hydroelectric Project.

BCH was acquired in November 1986. Funding was jointly provided by PG&E and the Wildlife Conservation Board. Today the 110 acres of wetland meadows has been restored to a condition that closely matches its pre-disturbed state.

Table 11.1
Restoration Projects from Revised Draft Anadromous Fish Restoration Plan 1997

Action	Involved Parties	Status
Obtain additional instream flows from Parrott-Phelan Diversion.	Diverters, DFG, USFWS, USBR	
Maintain a minimum 40 cfs instream flow below Centerville Diversion Dam.	DFG, PG&E, USFWS, USBR	
Purchase existing water rights from willing sellers.	Diverters, DFG, USFWS, USBR, SWRCB	Ongoing
Build a new high water volume fish ladder at Durham Mutual Dam.	Diverters, DFG, TNC, USFWS, USBR	
Install fish screens on both diversions at Durham Mutual Dam.	Diverters, TNC, USFWS, USBR, NMFS, DFG, CDW	
Remove the Western Canal Dam and construct the Western Canal Siphon.	Western Canal Water District (WCWD), TNC, DFG, USBR, USFWS, CALFED, CUWA	Complete
Remove McPherrin and McGowan dams and provide an alternate source of water as part of the Western Canal removal and siphon construction.	Diverters, WCWD, DFG, USBR, USFWS, CALFED, CUWA	In progress.
As available, acquire water rights as a part of the Western Canal Siphon project.	WCWD, DFG, SWRCB, USBR	
Adjudicate water rights and provide water master service for the entire creek; enforce or initiate legal action on Diverters who are violating water right allocations.	Diverters, DFG, CDWR, SWRCB, USFWS, USBR	No Action
Build a new high water volume fish ladder at Adams Dam.	Diverters, DFG, USFWS, USBR	In progress
Install fish screens on both diversions at Adams Dam.	Diverters, USFWS, USBR, NMFS, VDFG, CDWR	In progress
Build a new high water volume fish ladder at Gorrill Dam.	Diverters, DFG, USFWS, USBR	In progress
Install fish screens on both diversions at Gorrill Dam.	Diverters, USFWS, USBR, NMFS, DFG, CDWR	
Install a fish screen at White Mallard Dam	Diverters, Conservancy, DFG, CDWR, NMFS, USFWS, USBR	
Eliminate chinook salmon stranding at White Mallard Duck Club outfall.	Diverters, Conservancy, DFG, USFWS, USBR	
Rebuild and maintain existing culvert and riser at Drumheller Slough outfall.	Diverters, Conservancy, DFG, USFWS, USBR	
Install screened portable pumps in Butte Creek as an alternative to the Little Dry Creek diversion.	Diverters, Conservancy, DFG, USFWS, USBR	No Action. Deemed unnecessary.
Install a fish screen at White Mallard Dam.	Diverters, USFWS, USBR, NMFS, DFG, CDWR	
Develop land use plans that create buffer zones between the creek and agricultural, urban, and industrial developments; and restore, and protect riparian and spring run chinook salmon summer-holding habitat along Butte Creek.	City and county government agencies, Conservation groups, Conservancy, DFG, USFWS, USBR	
Install fish screens and fish ladder at Parrott-Phelan Diversion Dam.	Diverters, Conservancy, DFG, USFWS, USBR	
Develop a watershed management program	Conservancy, USFWS, USBR, NMFS, DFG, CDWR	In progress. Strategy expected in Fall 1998.
Establish operational criteria for Sanborn Slough Bifurcation.	Diverters, Conservancy, DFG, USFWS, USBR	
Establish operational criteria for East Barrow pit and West Barrow pit.	Diverters, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Establish operational criteria for Nelson Slough.	Diverters, Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.

Evaluation Studies from *Revised Draft Anadromous Fish Restoration Plan 1997*

Evaluation	Involved Parties	Status
Develop and evaluate operational criteria and potential modifications to Butte Slough outfall.	Diverters, Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report,
Evaluate alternatives to build a new high water volume fish ladder at East-West Diversion Weir.	Diverters, Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #2.	Diverters, Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate operational alternatives and establish operational criteria for Sutter Bypass Weir #1	Diverters, Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate alternatives to help fish passage, including the installation of a fish screen, at Sanborn Slough Biurfication Structure.	Diverters, Conservancy, DFG, CDWR, NMFS, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate alternatives to help fish passage, including the installation of fish screens, within Sutter Bypass where necessary.	Diverters, Conservancy, DFG, CDWR, NMFS, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate the operational alternatives and establish operational criteria for Sutter Bypass Weir #5.	Diverters, Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #2.	Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #1.	Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #5.	Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report..
Evaluate alternatives to help fish passage, including the installation of a high water volume fish ladder, on Sutter Bypass Weir #3.	Conservancy, DFG, USFWS, USBR	See findings, The Lower Butte Creek Project, Final Report.
Evaluate enhancement of fish passage at a natural barrier below Centerville Diversion Dam.	Conservancy, PG&E, DFG, USFWS, USBR	
Evaluate fish passage enhancement at PG&E diversion dams and other barriers above Centerville Diversion Dam.	Conservancy, Spring run chinook Salmon Workgroup, PG&E, DFG, USFWS, USBR	
Evaluate the juvenile life history of spring run chinook salmon.	Conservancy, DFG, USFWS, USBR	Ongoing by DFG
Evaluate juvenile and adult chinook salmon stranding in Sutter Bypass and behind Tisdale, Moulton, and Colusa weirs during periods of receding flows on the upper mainstream Sacramento River.	Conservancy, DFG, USFWS, USBR	No activity

Conservation Organizations

Americorps Watershed Project

Americorps is the new National Service Initiative that employs Americans across the country. In exchange for one or two years of service Americorps members receive an educational award for college or vocational training.

The Americorps Watershed Project combines an integrated, hands-on science curriculum with an innovative implementation model based on school\community collaboration. Kindergarten students adopt a local watershed (In this case the Butte Creek Watershed) and use it as a focal point for their science curriculum through twelfth grade, doing at least three service-learning projects each year. Adult volunteers from a broad range of organizations in the community work closely with the students, lending their expertise in the planning and implementation of the service-learning projects.

A coordinator has been hired for the development of education and service projects in the Butte Creek Watershed. The coordinator has the following roles and responsibilities:

- Coordinate the efforts of schools and communities
- Work with teachers and students in developing service learning curriculum
- Coordinate field trips and demonstrations
- Work with classes on various service and restoration projects
- Assist with evaluation and documentation of projects

Butte Creek Watershed Conservancy

The Butte Creek Watershed Conservancy (Conservancy) is a nonprofit organization that was formed in September 1995 to encourage watershed-wide cooperation and communication between residents, landowners, water users, recreational users, and the local, state, and federal agencies working in it. Interest in the watershed arose because federal agencies expressed various interests in it such as wild and scenic river status, endangered species, flood hazard, water management and others. Much of the original interest arose because of the desire of local residents to restore spring run chinook salmon populations in Butte Creek. Although these fish were once the most abundant race in the Sacramento-San Joaquin system, Butte Creek is one of the last remaining tributaries that supports these fish. Efforts to improve fish passage began in discussions over a decade ago, but due to limited funding, has proceeded slowly.

Recognizing the need to address restoration of salmon populations, as well as other related issues such as land use, recreation, and property rights, on a watershed basis, a group of residents invited resource agency staff and other conservancies to explain the need and benefit of watershed-wide planning. Volunteers formed a steering committee which became the initial board of directors that secured a 501 c (3) non-profit educational status. The mission statement adopted by the Conservancy is: “The Butte Creek Watershed Conservancy was established to protect, restore, and enhance the cultural, economic, and ecological heritage of the Butte Creek Watershed through cooperative landowner action.” A memorandum of understanding was circulated in order to establish cooperative partners who would work together on the development of a Watershed Management Strategy. To date, more than 25 agencies and organizations have signed on as participants in this effort.

One of the main goals of the Conservancy is public education. In addition to a K-12 program (see Butte Creek Watershed Project), the Conservancy has held an annual “Spring Run chinook Salmon” celebration, and has a booth which is set up at many of the events hosted by other organizations in the area. Conservancy publishes a quarterly newsletter designed to keep the public appraised of the events and issues impacting Butte Creek. The board of directors holds monthly meetings to conduct business and has a number of committees working on specific projects. The annual membership meetings occur on the first Thursday of March every year and provide information on the past year activities and the future plans. The Conservancy's watershed coordinator attends various meetings, conferences, and hearings for the purpose of staying informed, networking with resource professionals, and relaying information back to others in the Butte Creek Watershed.

Butte Creek Watershed Project (CSU, Chico)

In 1996 the Butte Creek Watershed Conservancy (Conservancy) established a connection with California State University, Chico (CSU Chico Research Foundation, Office of Sponsored Projects) in order to solicit and manage grants to support its efforts. The Conservancy continues to work closely with CSU Chico both with regard to obtaining and managing grants, but also with respect to compiling all of the information that has gone into this report. A group of faculty, staff, and graduate students at CSU Chico, called the Butte Creek Watershed Project (Project), has coordinated the effort needed to gather the vast amount of information on the existing conditions of the Butte Creek Watershed. In preparing this report, the Project has had input form stakeholders groups, a watershed advisory group, and a technical advisory group made up of agency representatives. After the completion of this report, the Project will continue to play an important role in filling in any data gaps and in helping to develop a watershed management strategy for Butte Creek.

The Conservancy and the Project have also worked together to establish a K-12 education program. The primary objective of this program is to make watershed and anadromous fish curriculum available to those schools that lie within the Butte Creek Watershed boundaries, to involve school children in riparian restoration projects, and to involve teachers and their students in public outreach at local watershed related events. The program is made up of 8 core teachers from 8 schools within the Paradise, Chico, and Durham Unified school districts. This group of 8 core teachers will be expanded to 16, making the curriculum available to as many K-12 students as possible.

Butte County Wetland Conservation Bank

The Butte County Wetland Conservation Bank was created by the Butte County Fish and Game Commission for purposes of providing prime habitat as mitigation required by some Fish and Game Code Section 1600-1603 mitigation agreements. It is a cooperative venture designed to help small developers mitigate environmental damage while replenishing riparian habitat and improving the Butte Creek fishery. The Center for Natural Lands Management (CNLM), a nonprofit conservation group, and the Butte County Fish and game Commission worked together to purchase a 56-acre almond orchard on Stanford Lane on Butte Creek. Funds for the land acquisition was paid through the U.S. Fish and Wildlife Service's Anadromous Fish Restoration Project. Ten acres of the site are technically classified as the "mitigation bank" for developers. Builders of projects in other parts of Butte County can buy "credits" towards mitigating the effect of their development. That money will offset the restoration and ongoing management costs of the remaining 46 acres, which are set aside as a "conservation project".

The CNLM will be implementing a management plan in 1998 for this newly acquired land. As the result of concerns by neighboring farmers that an abandoned orchard would result in increased pests in surrounding orchards, the CNLM has removed the almond trees that were present on the site. The CNLM is also working closely with a consultant to develop a wetland restoration plan for the land. Since this site has very little existing riparian vegetation, the restoration of riparian habitat along the creek will be invaluable in terms of providing shade and habitat for steelhead, chinook salmon, migratory waterfowl, and other wildlife.

Butte Environmental Council

The Butte Environmental Council (BEC) is a nonprofit organization that is aimed at environmental education and advocacy.

In addition to its quarterly newsletter and information web page, BEC hosts an annual Endangered Species Faire, in Chico, which serves as a vehicle for public education on environmental issues, including the preservation of riparian habitat and anadromous fishes.

Butte Trail Council

The Butte Trail Council was formed in the mid-1980's when there was talk of building a 200 foot dam and reservoir in the region of the Butte Creek Watershed known as the Forks of the Butte. This is a region where the Sierra Nevada and Cascade Ranges meet and result in a unique assemblage of plants and animals. A group of concerned citizens who felt that this would have too much impact on the resources of the area formed and fought the project. They were able to reduce the project to a 16-foot high diversion, now known as the Forks of Butte Hydroelectric Project. As mitigation the Butte Trails Council proposed funding to be set aside to maintain a trail near the project. The trail is located on BLM land and the Butte Trail Council has worked closely with the BLM and California Conservation Crews over the years to maintain it.

Cherokee Watershed Group

The Cherokee Watershed group is a grassroots organization recently formed to address issues within the Cherokee watershed. The Cherokee watershed is located within the Butte Creek Watershed. The stated mission of the Cherokee watershed is to protect, enhance, and provide for a sustainable watershed without risking its historical, ecological, and economic balance and management for future growth consistent with these goals.

Little Chico Creek Watershed Project

Little Chico Creek is a subwatershed of the Butte Creek Watershed. The Little Chico Creek Watershed Project was organized in order to address specific concerns of the Little Chico Creek Watershed.

Northern California Water Association

The Northern California Water Association (NCWA) was formed in 1992 to provide agricultural water districts, farmers and landowners a united regional voice on California water policy. NCWA seeks to protect the regions' water rights and supplies by working with Congress, the State Legislature, and with State and Federal agencies. NCWA's directors and staff are committed to constructive leadership in the pursuit of solutions to California's water problems. NCWA's stated mission is to promote the economic, social and environmental viability of Northern California by enhancing and preserving the water rights and supplies of members. NCWA today represents approximately 65 agricultural water suppliers and individual farmers who irrigate about 850,000 acres of Northern California farmland.

Parks and Preserves Foundation

The Parks and Preserves Foundation is a 501 (C)(3) nonprofit dedicated to preserving land in Northern California for new parks and nature preserves. The Foundation preserves land in four ways:

Direct Ownership- Parks and Preserves Foundation purchases, inherits, and accept donations of lands for preservation as parks or natural areas.

Conservation Easements- Parks and Preserves assists property owners who would like to place deed restrictions on their properties to limit the future development or destruction of important natural or historic areas. These voluntary deed restrictions are also known as Conservation Easements. Parks and Preserves specializes in the drafting, holding and monitoring of conservation easements.

Cooperation- Parks and Preserves cooperates with a wide variety of organizations and government agencies involved with planning, land acquisition and management of new parks and nature preserves.

Mitigation- Developers are often required to mitigate the impact of their projects by preserving land on-sites or off-site. Parks and Preserves assists in the implementation of mitigation measures.

Protect Our Watershed

Protect Our Watershed (POW) is a grassroots environmental organization located in Paradise and the Upper Ridge near Magalia. The purpose of POW is to educate and disseminate information about all environmentally sensitive projects on or in the area known as "The Ridge."

POW was formed in the summer of 1990 in response to a threat to the environmental resources surrounding the Magalia Reservoir. Initially the primary emphasis of POW was on logging within the watershed and its effect of logging on the quality of the water in the reservoirs. Since then the scope of concern has been broadened to include all factors affecting water quality including: development, septic systems, fertilizers, and road building.

Sacramento River Preservation Trust

The Sacramento River Preservation Trust is a nonprofit, tax-exempt organization that was formed in 1984 to protect and restore the Sacramento River and its tributaries and to ensure protection of steelhead and chinook salmon populations. The Trust has promoted local involvement in environmental issues and many of its activities have resulted in benefits to the Butte Creek Watershed and its anadromous fish populations. In particular, the Trust has encouraged the screening of agricultural diversions both on the Sacramento River and all of its tributaries.

Spring Run Chinook Salmon Work-Group

The spring run chinook salmon Work Group was founded by a variety of interested individuals including the Pacific Coast Federation of Fishermen's Association and the Sea Grant Extension Program in October 1992. The purpose of the Work Group was to discuss actions that could be taken to avoid listing the spring run chinook salmon as an endangered species. Funding for this continuing effort has been provided by Sea Grant, DFG Salmon Stamp Program, National Fish and Wildlife Foundation, and the U.C. Cooperative Extension.

The group has a diverse membership that holds 10 to 11 meetings a year. During the course of the Work Group existence, approximately 300 individuals have attended a meeting(s) and receive a monthly newsletter/meeting announcement. At the first meeting of the Work Group, there was consensus on this general goal: "Restore Sacramento River system native spring run chinook salmon runs and their habitat."

The group developed an action plan and identified options for restoration action. Early in this planning process, the Work Group identified watershed planning for habitat protection and restoration in Butte, Mill, and Deer creek as its highest priority. Meetings in the local area of these convened. It was soon realized that locally based watershed conservancies would be the best lead groups to take on the tasks of watershed planning. As the conservancies began to take the lead, the spring run Work Group shifted its emphasis to expanding the range of spring run salmon into watersheds where it had become scarce or extinct such as Battle and Clear creeks. The Work Group is now primarily focused on providing technical outreach and informational exchange.

ISSUES AND CONCERNS AS RELATED TO EXISTING CONDITIONS

Introduction

The stakeholders who participated in the scoping process, through six four hour meetings, identified over 100 issues that were of concern to landowners, educators, conservationists, farmers, foresters, recreationists, and agency representatives. These issues were categorized into fourteen groups, and from these, the Watershed Advisory Committee (WAC) defined the top ten issues and concerns for the watershed. *Please note that the numbers in parentheses after each issue/concern correspond to the order in which issues were raised. They are in no way intended to indicate rank or priority.* These concerns were further refined for consensus on exact wording. The top ten issues are as follows:

1. Increased population over the last ten years in the canyon and surrounding areas, as well as future growth, has increased recreational pressures in the watershed without an increased infrastructure to accommodate the use. (Note: infrastructure has not kept up with the increase in population, i.e. the number of wardens.)
2. The decline of the fisheries mainly due to water diversions and lack of screening has resulted in Endangered Species Candidate listing for the spring run Chinook salmon leading to restrictions on Sport fishing and elimination of salmon and trout fishing, and could lead to further watershed-wide restrictions for multiple uses: agriculture, timber management, recreation, urban development, and property rights.
3. The current fuel load in the watershed is at an unacceptable level due to natural response and man-made interventions.
4. Inadequate timber management regulations and practices have potential impact on water quality.
5. Improper road construction, design and maintenance intercepts and redirects runoff, causing erosion and road blowouts and may damage the watershed.
6. Ground water recharge capabilities need to be considered, and recharge areas are not identified and may need increased protection.
7. The quantity and quality of domestic water supplies need to be understood and protected.
8. Urban run-off, due to increased urbanization, contributes to water quality degradation.
9. Flooding in the Butte Creek watershed is natural and unavoidable, therefore any past and future building (to include roads, bridges, levees, etc. as well as structures) on the floodplain must be compatible with flooding in an environmentally conscious and sustainable manner.
10. Need to educate on appropriate management practices for the above 9 items.

By category, the issues sort out a very similar but broader perspective of the concerns.

1. Flooding
2. Dams
3. Woody Debris
4. Recreation
5. Creeks and Riparian Zones

6. Urban Issues
7. Mining
8. Fire
9. Agriculture
10. Hydroelectric Production
11. Fish and /Wildlife
12. Roads
13. Water Quality
14. Review Items

A general discussion of issues other than the top ten follows an analysis of these fourteen categories. There are many significant concerns that for one reason or another, such as wording, did not filter to the top of the list in the process of prioritizing. These issues are, none the less, important and must be considered, refined, and prioritized for future reference. Also, the list should be considered open ended to include new issues as they may occur or to delete problems that may have been resolved. Conditions change, episodic events happen: this means that management of the watershed will be constantly evolving. Annual review of issues seems prudent considering the diversity and complexity of the watershed. Adaptive management techniques and policy implementation measures based on these issues will be included in the management strategy.

In describing issues, the current status of activities related to these concerns is discussed. In some cases, related issues are included to ensure clarity in the analysis of the situation for the benefit of stakeholders and watershed advisory committee members. Finally, all of the initial issues and concerns will be considered in developing a strategy for management of the watershed. They are here discussed by category, and in some cases, by specific issues. There is no attempt to prioritize issues beyond the initial top ten list, but as these are addressed, other issues as they appear (from the WAC or from agencies) will be incorporated into this document in annual revisions.

Top Ten Issues and Concerns

> *1. Increased population over the last ten years in the canyon and surrounding areas, as well as future growth, has increased recreational pressures in the watershed without an increased infrastructure to accommodate the use. (Note: infrastructure has not kept up with the increase in population, i.e. the number of wardens, parking availability.)*

This issue has clearly been a concern for many years by residents, resource agencies, and law enforcement agencies. The focus of much of the concern is the lower canyon area frequented by tubers, swimmers, kayakers, bicyclists, auto tourists, fishers (prior to the closure of this section to fishing), and other recreationists. The only developed public sites in the canyon are the Honey Run Covered Bridge and the Centerville School and Museum. There are many undeveloped creek access areas, some private and some public, but with no definition of boundaries between private and public land. This has led to degradation of these undeveloped areas and numerous conflicts with private property owners. The increase of population in the canyon, Paradise, and the Chico urban areas has exacerbated the problems. Restrictions on recreation in Bidwell Park in Chico and on the Sacramento River, specifically parking and alcohol regulations, have also contributed to increased pressure on Butte Creek.

Recreational facilities are located throughout the watershed: Butte Meadows, Forks of the Butte, Paradise, and the valley refuges, but there is no comprehensive management or consideration for the impacts of unregulated recreation. Recent efforts by the Butte Creek Watershed Conservancy, Centerville Recreation and Historical Association, Honey Run Covered Bridge Association, Butte Creek Volunteer Fire Department, 4-H, and Paradise Parks and Recreation District have led to the formation of a Butte Creek Canyon Recreation Advisory Committee which has established priorities for addressing the problem. With support from outside funding sources, it is possible that several parcels of land can be purchased or leased to allow for the development of low use, low impact, and focused recreation areas. There is a general consensus among the Recreation

Advisory Committee that attracting more recreationists has a serious downside, i.e. traffic, trash, trespassing, etc. However, the need to manage for proper parking, trash facilities and public restrooms drives the effort.

2. The decline of the fisheries mainly due to water diversions and lack of screening has resulted in an Endangered Species Candidate listing for the Spring Run Chinook salmon leading to restrictions on sport fishing and elimination of salmon and trout fishing, and could lead to further watershed-wide restrictions for multiple uses: agriculture, timber management, recreation, urban development, and property rights.

One of the most debated issues in the stakeholder scoping process was the reason for the decline of the Butte Creek fishery. The biological opinions vary, but clearly indicate that a combination of factors has prompted the serious declines of the last three decades. Outside the watershed, the losses to predation during out migration, direct losses of juveniles at the State and Federal pumps in the south Delta, and commercial and sport fisheries catch are all significant factors. Before the State Water Project pumps became operational, salmon populations were more stable (see fishery section). These added losses in the system probably reduced the base population to a level where other perturbations have left anadromous fish unable to reproduce with sufficient surplus to overcome all the combined losses. Within the watershed boundaries, the most serious detriment identified for the juvenile salmon is the diversions of water for agriculture and wildlife refuges. Up until December of 1995, all diversions were unscreened and estimates of losses of 40% or more at each diversion indicate serious impacts. (Hill, 1996) Flow levels during the out migration have a significant effect, as in dry years most of the flow may be diverted out of the creek before it reaches the Sacramento River, which causes high water temperatures and concentration of potential contaminants. Flow agreements between CDFG and Parrott-Phelan Irrigation District will help the situation. The very recent Resource Renewal Institute sale of a small water right for fish will help (check with Water Division, Butte County). In addition, CDFG has a bypass flow agreement with WCWD, Elma Ryan and Jim McAllister which is part of current legal actions to relocate WCWD's diversion to the Gorrill dam. CDFG has requested the Butte County Superior Court that this agreement be included in any order approving the relocation of said diversion. High flow years allow for many of the fish to be swept by the diversions and beyond harm's way within the watershed.

The diversions have a second significant impact on the salmon by blocking migration of adults on the way to cold holding waters in the canyon reach. This affects the adults three ways: physical damage from hitting the diversion structures and ladders; reduced flow and increased water temperature; and subjecting the fish to poachers following their migration upstream (Taylor, Bishop, personal communication, 1996). The reduced numbers of returning adults has led to the candidacy status for spring run under California Endangered Species Act. In addition, the National Marine Fisheries Service has issued orders to list spring run, fall run and late-fall run Chinook and steelhead trout as threatened in the Sacramento Valley mainstem and tributaries under the Federal Endangered Species Act. The impact of these listings have been softened by the dedicated efforts of a broad array of agencies and private interests, but only to the degree that populations remain stable in the short term and at least double in the long term. The many efforts in the Butte Creek watershed, dam removal, ladders for dams, screens for diversions, and significant planning efforts, demonstrate the interest and concern of the stakeholders to work together cooperatively to restore these populations.

3. The current fire fuel load is at an unacceptable level due to human-made interventions and natural responses to the interventions.

Throughout the Sierra Nevada and other mountains, fire has become an increasing concern. Fire was once a major ecological process in the Sierra Nevada that exerted profound influences on the evolution of Sierra ecosystems (Sierra Nevada Ecosystem Project, Vol. 1, Chapter 4, pg.70). Human settlement in fire prone areas and resource management philosophy has combined to establish a fire policy based on suppression. In areas where fire frequency is high, suppression has, in many cases, contributed to extensive growth of low level fuel plants such as manzanita, ceanothus, live oak, and several non-natives. Species composition of many plant communities has been altered by a variety of natural and human caused interventions with little understanding of the relationships between species composition, fire frequency, and intensity. It is recognized that dense stands of fir and other species often have tremendous amounts of ladder fuel material that contribute to fire intensity. Fir is also a shallow rooted tree that tends to dry out the immediate rooting zone, inhibiting other volunteer species and producing a more fire prone microenvironment.

Reducing the fuel load is a relatively new fire management treatment because the high labor cost to remove understory fuels did not seem to be justified. However, evaluation of the costs of losses in the urbanized zones of the foothill scrub and mountain forest communities has demonstrated that prevention is becoming more cost effective. The efforts of this project to identify areas of high value, risk and danger, compile a GIS map, and make the information available to fire specialists throughout the watershed, will provide the basis for a guide to fuels reduction and fire management that will have tremendous value (see fire history and management chapter). This planning will address the findings of the Sierra Nevada Ecosystem Project report: (1) avoid further community development in flammable wildlands without mitigating fuel hazards, (2) establish defensible space/fuel reduction zones, buffering communities and certain wildlands, (3) identify other resource-threatening intolerable fuel hazards and prescribe mitigation treatment, (4) support a return of managed fire and prescribed wildfire, where practicable, to specific forest areas to provide the natural ecological functions believed necessary for ecosystem health and sustainability, and (5) advocate strong prevention and suppression capability. (Sierra Nevada Ecosystem Project Report Summary, page 17, 1997) This combination of management strategies is already being implemented under various programs. In particular, the Fire Safe Council, a statewide program with the California Department of Forestry, timber management plans with Lassen National Forest in the upper watershed, and private management programs are all seeking to find better strategies to manage fire in the ecosystem. The Butte Creek Watershed Project will facilitate the coordination of these programs.

4. Inadequate timber management regulations and practices have potential impact on water quality.

Many small land holdings in the upper watershed have been targeted by timber operators to harvest small blocks due, in part, to high lumber prices and restrictions on logging on public lands. The notable "three acre exemptions" in Butte County gave many operators incentive to market timber removal to small landowners who could make significant returns from just a couple of large trees. Previous lack of regulation for these small acreage's led to many less than desirable consequences, particularly erosion and sedimentation which affect water quality. This situation has changed, specifically within the Watershed Protection Zones above Paradise and Magalia reservoirs, (see issue #7) and other areas, due to tighter restrictions on these exemptions. There are now "three acre exemption conversions" to allow for changing land use from timber to other uses, presumably development. There is also a new state law, AB49, which allows for tree removal for fire protection.

The California Forest Practices Act was updated in 1973 and has broad authority over timber harvest operations. The enforcement of the regulations is difficult at best considering the vast expanses of timberlands over which it has jurisdiction. There is significant controversy related to its enforcement and it will continue to be suspect and subject to frequent challenge by various groups. Most private lands have less stringent regulations as compared to public land. The conversion of the forests from what they were when European settlers arrived has been dramatic. Late seral stage forests are all but gone and second and third growth forests are the rule. The forest are none the less highly productive in terms of total board feet, but changed in ways that, among other things, have contributed to degradation of water quality. Probably the most significant timber management practice affecting water quality is road building, which is discussed, in the next issue.

5. Improper road construction, design and maintenance, intercepts and redirects runoff, causing erosion and road blowouts and may damage the watershed.

Road building in the foothills and mountains has been determined to be a source of sediment pollution and regulation of this activity has been sketchy in most cases (Sierra Nevada Ecosystem Project Summary, page 8, 1997). Major lawsuits are being litigated on the North Coast of California over Total Maximum Daily Load allocation for sediment pollution as defined under the Clean Water Act of 1973. This has prompted serious efforts to identify and control sources of sediment, primarily roads. Major sediment reduction projects are currently in progress on the Trinity River, Redwood Creek, and the Garcia River. Almost no information is available on the contribution of unpaved roads to sedimentation in Butte Creek. There is estimated to be over 400 miles of unpaved roads in the upper watershed of Butte Creek and, with the exception of the main road system that is well designed and relatively stable, these roads could be the largest single contributor to sedimentation in the watershed.

As a result of this project, the first survey of unpaved forest roads will be completed this year under a CALFED grant. The survey will identify the soils and areas of highest potential erosion in three sub-watersheds, Bull, Varey, and Scotts John Creeks, and provide for recommendations to mitigate sedimentation. In other project areas, such as Redwood Creek on the coast and Grass Valley Creek on the Trinity River, various road maintenance treatments have been shown to greatly reduce erosion.

6. Recharge areas are not identified and may need increased protection.

The status of groundwater in the Butte Creek basin is among the most debated issues of concern to humans inside and outside the watershed. Water supply to surface water domestic systems, wells, surface water agriculture, and wildlife uses are all related to groundwater recharge throughout the watershed through the normal hydrologic cycle. Precipitation, springs, local creeks, subsurface connection to the foothills and mountains, applied water, canal losses and the Thermalito Afterbay all contribute to the recharge of the groundwater in the upper Butte Creek Basin. The California Department of Water Resources and the HCI groundwater model identify recharge areas. The focus of the DWR delineation and the model is the areas of recharge on the edge of the valley and in the basin proper. Significant recharge is likely in other areas, such as the foothills and through fractures from the mountain regions, but directly identifying the connections and the quantity is difficult. Human disturbances are increasingly affecting the hydrologic cycle by reducing infiltration of rain and snow into the soil and groundwater.

This reduction of infiltration happens in two significant ways. The first is the covering of the land surface with impermeable materials such as buildings and pavement. The second type of groundwater recharge reduction is the interception and concentration of overland surface flow that would normally infiltrate and percolate through permeable sections of the landscape. Various other human activities are affecting groundwater recharge by retaining, diverting, and spreading water over various surfaces for domestic, agriculture, and wildlife water systems. These activities collectively have a positive effect on groundwater recharge. Considering the value of water in the statewide arena, any activities that might reduce infiltration and recharge of the Butte Basin aquifer seems ill advised.

Recharge from over-irrigation of agricultural lands is highly variable across the basin. Soil types, methods and timing of application, and connection to groundwater table affect the quantity and quality of this recharge. For economic reasons, most irrigators strive to apply only the precise amounts of water necessary for plant growth plus evaporation, efficiency losses and occasionally, intentional leaching to remove built-up salts. Excess application has the potential to pollute the shallow groundwater aquifer with soluble nutrients and pesticides. Recharge potential in the immediate floodplain of the creek is not clearly quantified and the potential to increase recharge in these highly permeable areas with channel management techniques needs to be seriously considered.

7. The quantity and quality of domestic water supplies need to be understood and protected.

Available quantities of water for domestic supplies are fairly well understood and protection measures are utilized in most areas (see water chapters). The development of the ridge communities of Paradise, Magalia, Paradise Pines, and surrounding urban development has changed the nature of water use in this area from primarily agriculture to primarily urban. The existing systems were not designed to meet the needs of a rapidly growing urban area and are noticeably strained by the demand. An estimated 25-30% of the treated water for Paradise is lost to leaks in the system (Pers. com., Felte, 1995). Repairs are ongoing but are costly and slow. Other sources of water, such as wells, have been discussed by Paradise Irrigation District (PID) but pumping costs are high. Diversion of West Branch Feather River water passing through the Hendrick's canal purchased from PG&E has helped PID in dry years. Permanent access would require that PID negotiate a consumptive right and PG&E or future owners would have to be willing to reduce their power production. The future needs of Paradise and surrounding communities that depend on surface water are not great and could easily be accommodated with between two to five thousand acre/feet from the West Branch diversion. The vast majority of the rest of the watershed is dependent on well water for domestic use and quantities are generally adequate with varying quality (see water supply chapter). Wells are deeper and less dependable in the ridge and foothill areas. Valley wells are generally adequate with the exception of dry years and/or years of heavy pumping for agricultural use.

Ensuring water quality for domestic use is expensive, particularly for PID. The natural and human induced turbidity of the runoff in the watershed above Magalia and Paradise reservoirs forced the construction of a treatment plant in the late 1980's. Preventing further increases in sedimentation from development activity runoff is a very cost-effective measure for the areas above the reservoirs. Recent surveys by PID have indicated that increased protections are needed in the wet season and new development should be allowed only with proven erosion control measures. The Butte County Board of Supervisors approved updating the Watershed Protection Zone regulations above the Magalia and Paradise reservoirs and incorporating the regulations into the zoning ordinances in June 1998. It had previously been a resolution, which led to confusion and duplication of efforts. Protection of groundwater supplies from surface and infiltrated contaminants is monitored fairly well. Proposals have been submitted by the Butte County Water Division to increase and improve groundwater monitoring for contaminants.

8. Urban run-off due to increased urbanization contributes to water quality degradation.

The catchment area above the Paradise and Magalia reservoirs has been designated as a sensitive watershed in an effort to reduce pollution of the domestic water system from toxic pollutants and sediments being introduced from increasing urbanization of this area. In fact, this is a problem in several areas, not just Paradise. The south side of Chico is increasingly encroaching on Little Chico Creek, which enters Butte Creek via the bypass on the upper end and through Angel Slough which drains agricultural and refuge lands, Little Chico Creek and the Edgar Slough/Comanche Creek diversion canal. Much of Chico south of 20th Street is now being storm sewered to drain into this canal. A floodwater retention pond was constructed between East Park Avenue and Paseo Campeneros to mitigate this increase in runoff. Residents of Little Chico Creek at a meeting (June 18, 1998) who stated that flooding is an increasing problem recently discussed this problem in the lower parts of the watershed. It was also mentioned that the peak of the flow arrives in the lower creek much sooner that it did previously. This is characteristic of urbanization and the resulting covering of the land with impermeable surfaces. Little Butte Creek was especially hard hit in the 1997 flood and the paving of Paradise may be a contributing factor.

9. Flooding in the Butte Creek watershed is natural and unavoidable, therefore any past and future building (to include roads, bridges, levees, etc. as well as structures) on the floodplain must be compatible with flooding in an environmentally conscious and sustainable manner.

The flood of '96-'97 served as a harsh reminder that in any watershed the potential problems from episodic storm conditions are immense, diverse, and particularly widespread. California's climate is noted for the episodic events, eliciting memories much more readily than memories of pleasurable climatic events. The hydrology section of this report has identified the situation in the Butte Creek Watershed relative to floods and it is clear that residents and users of Butte Creek will be dealing with similar events in the near future. Current traditional flood protection and control projects may, in fact, have a negative effect on floodplain function. It behooves everyone to discuss and plan early and often for these events in the future. Alternative management techniques may need to be employed. The habitat needs of humans and the wildlife that depend on this watershed and the riparian ecosystem must be carefully managed. Management recommendations that consider the best scientific information on habitat needs, protection and restoration, and the fluvial geomorphology of the creek must be developed within the parameters of the episodic nature of Butte Creek floods. Most importantly, human land use practices that may be contributing and exacerbating flood events must be carefully analyzed. This analysis will allow for the development of practices that are compatible with human needs within the laws and regulations designed to minimize impacts on the environment. A study of the fluvial geomorphology of the alluvial portions of Butte Creek, from above Helltown to Highway 162, will be conducted in 1998 by a team of private hydrologic consultants, Matt Kondolf, Ph.D., and John Williams, Ph.D. This report will provide valuable recommendations on the management balance necessary to protect people and the function of valuable riparian habitat and function.

10. There is a need to educate the public about appropriate management practices for the above 9 items.

With the recognition and prioritization of issues affecting the watershed, development of protection, restoration, and enhancement plans for specific areas is the logical next step. This was obviously recognized by the WAC and the stakeholders and many efforts already discussed and others to come will be initiated to try to best manage the diverse resources and uses thereof in the Butte Creek watershed.

A brief discussion of significant issues by category will hopefully provide some direction in looking beyond the top ten for the development of the management strategy. The numbers in parentheses refer to the order that they were brought up in the stakeholder meetings. The asterisks refer to items, which are included in more than one category.

1. *Flooding*

What's good to control? Some creek things are beneficial, others not (too costly). (1)

Final plan needs to address flooding. (56)

Peak flow flooding really ate into roads and culverts. (76)

Culverts plugged - Ponderosa Way and Bridges undersized for floods (all bridges). (57)

A review of other watershed projects show that while fire hazards are addressed, flood hazards are not. Can we include flooding as one of the "existing conditions"? (84)

Flood damage recently. -Solution: CDFG 1600's permitting can be flexible-want to work with landowners. Short term processes available. Staff will help. (44)

This category is discussed in general in Problem #9. Some of the issues are better understood at this point. Two of the topics related to peak flows and erosion are addressed to some degree in # 8 and #5 respectively.

2. *Dams*

By whom and how are reservoirs maintained? (59)

Okie Dam: What is best way to deal w/ problems associated with it? (6)

Desabla (Paradise and Magalia) Reservoir: Danger to downstream. Who maintains? Safety? What about future - upgrading? (26)

Increase levee protection in lower reaches of creek. (30)

Status of dams - look at them. (51)

Diversion dams - dangerous but people tube over them are and get caught. Solution: Need methods to get out - Safety. (70)

Safety issues at diversion dams is a valid concern and is not necessarily being addressed in the design of the new fish ladders and screens for the four main diversions, Parrott-Phelan, Durham Mutual, Adams, and Gorrill. Flood control is not part of operations of the dams in Paradise. There are discussions of upgrading the dams managed by Paradise Irrigation District but it does not seem likely that flood control capabilities will be a part of the upgrade. Increased flood control with levees in the lower watershed is a concern and should be more specifically defined relative to CALFED ecosystem restoration which calls for setback levees and reconnected riparian corridors.

3. *Woody Debris*

Debris: contributes to channel debris rerouting. (12)

Woody debris is habitat for fish, valuable. Solution: DFG: Educate folks on benefits/problems of debris: There are win/wins (i.e., woody debris for habitat, that isn't a hazard). (13)

Post harvest woody debris and licensed timber operators: Solution: Licensed timber operators should carry bond based on reputation and include road damage. (21)

What's happening now for danger Final Solution: Creek needs clearing. (45)

Put folks to work (i.e. off welfare, etc) to help clean debris. (35)

Flood brought debris into creek - very dangerous to tubing and kayakers. (66)*

Unusually high amount of debris in creek now - also cutting at bank. (67)

Woody debris important for water quality can also protect streambanks. Solution: Need balance (73)

Kayak/Tubers: hazard. Solution: Clear debris/reduce recreational use. (11)*

Woody debris is an asset for aquatic organisms and a problem for creek access for landowners and clogging problems for dams and bridges. Several bridges suffered damage from debris clogs in the 1997 flood and a monumental effort was undertaken to cut, burn, or otherwise dispose of potentially threatening large woody debris (LWD). This effort mobilized material that probably would have otherwise decayed in place, releasing nutrients to the surrounding areas. Much of this mobilized material ended up clogging fish ladders, necessitating extra efforts to maintain clear fish passage at these structures. LWD by nature enters the stream in relatively high flow events, most often episodic events that have numerous landslides and creek course changes. The change in course of Butte Creek at Parrott-Phelan dam alone took out five acres of forest in a matter of minutes. This is most likely the material that caused the greatest damage to the bridges but is virtually impossible to prevent. Bridges are an expensive item to repair or replace. Most modern bridges are designed for passing debris and several Butte Creek bridges are not up to these design standards.

4. *Recreation*

Recreational Uses: Impact on use of creek since other creek restricted. Users putting pressure on Butte Creek - increased traffic inadequate parking, trespassing, trash. (4) (83)

Recreational Use: - Solution: Alcohol checks and surprise checkpoints, garbage cans, Board of Supervisors enforce ordinances. (8)

Driving inappropriately is growing - drinking - flooding off road damage, parking, garbage, bathrooms. (53)

Uncontrolled dirt bike and off road vehicle use in the upper watershed. Causes erosion and increases sediments. (78)

Campers/Septic. (94)*

Look at regional needs and availability of recreation, habitat, and etc. (54)

Butte Creek Access: Exclusion moves problem to another location. Solution: Post signs for public access and private access, increase parking access for public access. (18)

Many of these items are summarized in Issue #1. Better management of recreation, primarily in the Canyon area is important. There is, however, a growing problem in other parts of the watershed with many of these same concerns. Trespass and the resulting damage from vehicles and left-behind garbage is a problem throughout the watershed. Lack of restroom facilities and unmanaged off-road vehicle use can degrade water quality.

5. *Creeks and Riparian*

Repairs and Maintenance of Creek - Solution: Contingency plan for landowners/ homeowners - who to contact during emergencies. (5)

Creek boundary: Is creek going to meander? Is it going to be kept in current channel? (29)

Give creek more room. (39)

City setback zones for urban creek areas a problem - Solution: Use this project to address. (3)*

Sedimentation causes problem contributes to fish passage problems, and hits carry capacity. (47)

Butte County and PIC received $600,000 for 4 crews to clean. (71)*

What plans are being made to re-establish the creek to it's original banks on Little Butte Creek? (95)

Riparian systems are dynamic. (69)

Riparian and buffer looked at panacea - but doesn't work if uplands don't manage. (72)

Setbacks for riparian (WLPZ & THP) is not adequate (up and down). (49)

Riparian Forest: Very little in valley portion of creek. Solution: Educate landowners about management of (all landowners). (27)

Riparian Forest devastated. - Solution: Riparian restoration where appropriate. (7)

Most of these concerns are discussed in various other top ten discussions such as flooding, #9, urban runoff, #8 and water quality, #7. Management of the riparian corridor is important, as it is a priority habitat for the CALFED Ecosystem Restoration Program Plan. The corridor on Butte Creek is severely impacted by development both from urban and agricultural projects. Levees protect much of this zone, but the hundred-year floodplain extends beyond the levees and covers much of the land within 300 feet thereof throughout the valley. Plans to increase the amount of "shaded riparian aquatic" habitat are currently underway with projects such as the McAmis property acquisition in the lower canyon and the Keeney property acquisition in Durham. Allowing the creek to meander in the lower portions is being considered, however, hard point constraints such as dams and bridges must be considered. There are certainly opportunities to give the creek more room, which could in turn increase Shaded Riverine Aquatic habitat and the associated benefits, of recharge, slowing floodwaters, and capturing LWD.

6. *Urban Issues*

How can Human contamination be controlled in the Butte Creek Watershed?

Uncontrolled pets (dogs and cats) of homeowners in the upper watershed. (Detrimental to songbirds and other wildlife). (79)

Fishing and regulations effect on residents. (63)

Illegal water diversions for lawns by urban folks. (68)

How to have shaded corridors and still protect property behind them. (61)

Look at trespass problems. (52)

What is urbanization doing to flooding +/or watershed? (46)

Money for private landowners - roads and erosion control. (42)*

Effects of all septic tanks on creek. (28)

Land use: What are limits of urban growth, responsibilities of landowners. (25)

City setback zones for urban creek areas a problem - Solution: Use this project to address. (3)*

Restrict building in flood plains in future plans. (60)

How to control human contamination in water from homeless campers. Liability issues, too. (10)

Abandoned cars, appliances in upper watershed. (9)

Illegal dumping in the watershed yard waste, tires, refrigerators, etc. (82)

Urban related issues from a growing population cover the spectrum. Individually, these issues are relatively minor. They need to be recognized none the less for the current and potential impacts. Clean up and preventing illegal dumping is significant and is not being addressed effectively by the County or other groups. Regular creek and canyon cleanups occur but do not cleanup too many of the major dumping areas on Honey Run Rd. and Centerville Rd. Illegal diversion of the creek and contamination by human waste either directly from campers, mostly illegal, or from sub-standard or failed septic systems specifically can degrade water quality and pose health concerns. Focused recreation areas with toilet facilities, such as the Covered Bridge, and functioning riparian buffers will minimize these problems.

7. *Mining*

Reparation tax for all existing mines. (34)

Still feel the effects of old mining operations - some homes of old tailings - unstable. (64)

Look at mining operations. (75)

Mining is now much less of a factor in Butte Creek than a few decades ago, although the legacy of the ‘49'ers, the dredgers of the late 1800's and early 1900's, and the gravel operations of more recent decades, remains. Much of the cobble in the creek was introduced by miners working the creek bed and the banks. This bedload can be a problem when a wave of material moves through an already flooding area. This can raise the peak elevation of floodwaters in a particular area and cause channel changes that are difficult to predict. Areas developed on old tailing piles near the creek seem to be most vulnerable to bank erosion and have proven costly to maintain. The upcoming fluvial geomorphology study will help to define the extent of the problem. Other mining operations appear to be vulnerable to erosion, which can lead to sedimentation of the creek. Dredger mining can negatively affect fish habitat. It is only permitted in certain areas above the anadromous fish habitat.

8. *Fire*

Collectively need to protect airport for fire protection in watershed. Solution: California enter into agreement with Federal fire protection service. (16)

Airport access for fire tankers is currently moving. Solution: Move access to Oroville. (17)

Fire Issues need to be proactive in fuel loads management in urban areas. Solution: In plan address how to manage debris. (19)

Butte Creek Canyon dangerous for fires due to limited access to get in (volunteers). Solution: Fire management plan in Butte Creek Watershed Project. (20)

Use appropriate level of controlled burns. (55)

How do we collectively protect the Watershed from losing fire protection? i.e., Chico Airport CDF and Federal Air Tankers). (86)

Issue # 3 addresses most of these issue in that a fire management model is part of the ECR (see Fire chapter). This will lead to a management plan that can be implemented by the responsible agencies and landowners to manage vegetation and wildfire to reduce the risk of catastrophic fires and the resultant degradation of water quality.

9. *Agriculture*

BLM needs scrutiny on management of rangelands. (74)

Come to agreement w/ cattlemen about grazing in riparian habitat. (32)*

Include agricultural practices, etc., in plan. (23)

Timber harvest issue in a conservancy -(87)

Terminate all timber operations by extending the current exclusion time frame to Sept-May. (14)

Grazing has not been identified as a top issue but nevertheless, grazing management can be very effective at protecting water quality, increasing water infiltration, and water holding capacity in soils. In some cases in drier areas on the west side of the valley, exclusionary fencing, rotational grazing, reintroduction of native grasses and control burning has actually reestablished perennial streams. The obvious increase in water storage and yield is significant. Best management practices for most crops are promoted but problems of excess water, fertilizer and pesticide use continue to demand attention. Timber issues are discussed in Issue #4.

10. *Hydroelectric Production*

PG&E use of Butte Creek - problems associated with. (24)

Maintenance of flumes by PG&E causes effluent dumps and silt. (58)

Problems of loss of fish habitat, lack of water, impassable barriers, and sedimentation from flume cleaning operations, landslides, and flume failures combine to reduce trout and salmon populations significantly (see fisheries chapter). Operations have been modified in recent years but most of the problems still exist. Several studies have addressed the potential of the fish habitat above the Centerville Head Dam and concluded that it is suitable for approximately 500 pairs of spawning salmon. Access to this habitat is in part, hindered by the Head dam and it was recommended in 1977 by Flint and Meyer to install a fish ladder. Natural barriers are a problem also but have been easily laddered on Big Chico Creek and Deer Creek. Physically, access to this upper habitat is highly feasible with current restoration programs. However, socially and politically, the issue of introducing or reintroducing a species to a habitat where it has not been documented before, is a concern. Conflict with landowners, suction dredgers and hydroelectic operations, are certainly a problem.

11. *Fish and /Wildlife*

Fish: should have continuous monitoring efforts/studies. (37)

Wildlife use: Study. (38)

Poaching of fish and other game species in the watershed. (80)

Bear hunting in the winter on native surface roads. Damages roads and increases sediment. (81)

Recent efforts to fund extra personnel and overtime have increased the presence of DFG wardens protecting the salmon habitat. Poaching of other animals does not receive as much attention however it is still a problem. Wildlife studies are not consistently funded unless there is a perceived problem. Winter hunting travel on unpaved roads is a source of increased sedimentation.

12. *Roads*

Unrestricted winter access to native surface roads. Damages roads and increases sediment. (77)

Money for private landowners - roads and erosion control. (42)*

Roads: runoff has effects on peak flows. (41)

Drainage ditches not maintained, etc. Who has control of the excess water? (90)

These issues are summarized in issue #5.

13. *Water Quality*

USGS: Pollutants entering Sac River from sheds. (88)

USGS and DWR are monitoring the waters of Butte Creek with much greater scrutiny (see water quality chapter). Increasing awareness of the factors that have contributed to the overall decline of the health of the Bay-Delta and its ecosystem is helping promote voluntary efforts to monitor and clean up waterways. Developing functioning riparian ecosystem can have a significant impact on buffering non-point source pollutants from the creeks and waterways.

14. *Review Items (Helpful Hints, Miscellaneous, and Questions)*

Extend confidentiality of archeological sites to the management people within the watershed. (15)

Federal and State grant moneys have requirements. - Solution: Be consistent when using them. (2)

Request RWQCB to review Butte Creek as critical watershed and make recommendations (i.e., timber, and fire). (22)

Do Cost-benefit analysis: who benefits? What is cost? (33)

Use existing info - don't rehash. (31)

CCC should also be used. Cost too high, needs to be modified. (36)

DWR has money for gauges "real-time." Need along creek. (40)

Need to educate on appropriate management practices. (48)

HEC2 studies need to be done. (62)

Interdisciplinary agency participation a harvesting natural resources. (92)

Is the Upper Watershed Project just a study of habitat or does it include options to open up the habitat? (96)

Who can obtain a copy of RFP now on Internet? To request $ now available to Butte County and private proposal requests? (85)

Don't differentiate classes. (50)

CalFed none of those funds. Who else is managing these funds? (89)

Need guide to resource managers, etc. - local. (43)

Contact person list with the minutes. (91)

Ground water recharge capabilities need to be considered. (65)

Does BCWC have projects before the Butte County Public works dept to clean up flood debris on both sides of Butte Creek? What kind of creek bank erosion control is planned without cost to landowners? How and from whom does landowner go to get funds for flood damage land, creek banks, sand/silt removal? (93)

Many of these items are discussed elsewhere or are difficult to understand. Those that are clear are the need for better management practices in terms of water quality, (22), flow, (40), flooding and floodplain management, (62), groundwater management, (65), habitat conditions, (96), and flooding, (93). These have all been discussed elsewhere. The Watershed Management Strategy will incorporate these and help guide local resource managers in protecting, restoring and enhancing the watershed (43).

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LIST OF ABBREVIATIONS

AFRP	Anadromous Fish Restoration Program
BLM	Bureau of Land Management
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CNPS	California Native Plant Society
COE	US Army Corps of Engineers
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ESA	Endangered Species Act
GIS	Geographical Information System
LMRP	Lassen Land and Resource Management Plan
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRCS	National Resource Conservation Service
NTU	Nephelometric Turbidity Units
PG&E	Pacific Gas and Electric
RWQCB	Regional Water Quality Control Board
SWP	State Water Project
SWRCB	State Water Resources Control Board

TAC	Technical Advisory Committee
THP	Timber Harvest Plan
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WAC	Watershed Advisory Committee
WCWD	Western Canal Water District
WLPZ	Watercourse and Lake Protection Zone
wy	water year

Accretion – Sediments carried by a stream and deposited along banks or surrounding areas.

Acre-foot– A quantity or volume of water covering one acre to a depth of one foot (43,560 cubic feet).

Active Restoration – Specific human actions taken to reestablish the natural process, vegetation, and resultant habitat of an ecosystem.

Agency Preferred Alternative - The alternative which the agency (or agencies) believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Aggrade (aggradation) – To raise the channel of a river by depositing sediment and similar materials.

Alluvial – Pertaining to clay, silt, sand, gravel, or other sedimentary matter deposited by flowing water, usually within a river valley.

Anadromous – Pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.

Annual Demand – Total yearly amount of water required for irrigation, usually expressed in a volume (acre-feet).

Approach Velocity – The velocity of water flowing towards and perpendicular to a fish screen face.

Avoidance Periods – Time periods of days, weeks, or months that represent critical life history stages for species. Disruption during these stages could harm individuals and/or populations.

Baffle – A device used to direct water flow, often to equalize flow across a boundary surface such as a fish screen.

Bank Protection – A method of erosion control in which materials (usually rock revetment) are placed along the banks of a river in order to prevent encroachment on adjacent land.

Bank Stabilization – The prevention of channel migration through bank protection.

Basin – An area drained by a river and its tributaries.

California Environmental Quality Act (CEQA) – Act requiring California public agency decision makers to document and consider the environmental impacts of their actions. Also requires an agency to identify ways to avoid or reduce environmental damage and to implement those measures where feasible, and provides a means to encourage public participation in the decision-making process.

Central Valley Project (CVP) – Agricultural water supply system that is operated and maintained by the Federal Bureau of Reclamation; water from the Sacramento River is captured and conveyed from Lake Shasta to the San Joaquin Valley.

Channel – The space above the bed and between the banks occupied by a natural or artificial waterway that confines water.

Channel Migration – The lateral movement of a river as it adjusts to balance erosion with deposition.

Chute Cutoff – A channel that connects the converging areas of a meander bend: a chute cutoff creates an oxbow lake from an existing meander bend.

Conservation – Reduction in applied water due to more efficient water use.

Conservation Easement – Legally binding restrictions that landowners voluntarily place on their properties that bind present and future owners; these restrictions limit certain rights and uses of the property for conservation, preservation or restoration purposes.

Cooperating Agency – A cooperating agency may be any federal agency other that the lead agency that has jurisdiction by law or special expertise with respect to the environmental impacts expected to result from a proposal.

Critical Habitat – A specific area or type of area considered to be essential for the survival of a species and designated as such under the Endangered Species Act.

Dewater – To remove water.

Degrade (degradation) – Opposite of aggrade (aggradation); to erode or deepen a river channel.

Designated Floodway – The river channel and that portion of the adjoining floodplain required to reasonably provide passage for the 100-year flood (defined by State Reclamation Board).

Distributary – A branch of the river that flows away from the main river channel without rejoining it.

Diversion – The removing or turning of water from its natural channels.

Drainage Water – Excess surface or subsurface water collected and conveyed from irrigated lands. May be recaptured and reused or conveyed for downstream demands.

Dredging – Widening or deepening of water channel by removing sand, mud, silt, or gravel. Dredging can be accomplished using suction pumps or mechanical scrappers.

Ecosystem – A community of different species interacting with one another and their environment.

Ephemeral – Lasting a short time; a stream that does not flow year round.

Extirpation – Local extinction or complete disappearance of a species from a region.

Effects – CEQA Guidelines Definition 15358 states "Effects" and "impacts" are synonymous. Effects include:

(1) Direct or primary effects which are caused by the project and occur at the same time and place.

(2) Indirect or secondary effects, which are caused by the project and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect or secondary effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.

(3) Effects analyzed under CEQA must be related to physical change.

Emigrate – To migrate or move from one habitat to another; in the case of anadromous fish such as salmon, to migrate or move in a downstream direction from fresh riverine systems to estuarine and marine systems as juveniles.

Endangered Species Act – State and Federal laws which authorize and establish the process for the protection of habitats and populations of species threatened with extinction. The stated purposes of the of the Endangered Species Act are to provide conservation of the ecosystems upon which endangered and threatened species depend and to establish and implement a program to conserve these species.

Enhancement – Actions that improve the quality of existing habitat beyond its originally designed purpose or condition.

Entrainment – Process by which fish are pulled through or around the fish screen face and are carried into the intake channel.

Environmentally Superior Alternative – That alternative which minimizes adverse environmental effects. If the no-project alternative is identified as environmentally superior, CEQA Guidelines 15126 (d)(4) indicates the EIR shall also identify an environmentally superior alternative among the other alternatives.

Exposure Time – The average length of time fish could be exposed to the fish screen face.

Feasible – CEQA Guidelines Definition 15364 states: "Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors.

Fish and Wildlife Coordination Act – The Fish and Wildlife Coordination Act and related acts express the policy of Congress to protect the quality of the environment as it affects the conservation, improvement, and enjoyment of fish and wildlife resources. Under this act, any federal agency that proposes to control or modify any body of water, or to issue a permit allowing control or modification of a body of water, must first consult with the U.S. Fish and Wildlife Service and State fish and game officials.

Fish Migration – Movement of fish from one aquatic habitat to another; in the case of anadromous fish, movement from freshwater to estuarine and marine habitats or vice versa.

Floodplain – The relatively flat area along the sides of a river which is naturally subject to flooding.

Floodway – The river zone that could theoretically (based on surveying data and hydraulic calculations) convey the 100-year flood with only a one foot rise of water level above the height of the unconstricted flood; construction is generally prohibited in these areas.

Flow – The volume of water passing a given point per unit of time. Same as streamflow.

Fluvial – Pertaining to a river.

Forb – An herb that is not considered to be a grass or grasslike.

Fry – Life stage of fish between the egg and fingerling stages.

Geomorphology – The form or shape of the earth or landscape.

Groundwater – Water contained beneath the land surface of the earth that can be collected with wells, or drainage galleries, or water that flows naturally to the earth's surface via seeps or springs.

Habitat – The environment of a plant or animal species.

Hard Points – Structures located adjacent to a river, such as buildings, bridges, or levees, that change the direction or rate of channel migration by interfering with the river's movement.

Hydrologic Hydraulic "Hot Spot" – An area along the screen face that is subject to velocities or unusual flow patterns that could impinge, entrain, or entrap small fish.

Hydrology – The science concerned with the properties, distributions and characteristics of the water in relation to the earth.

Immigrate – To migrate or move from one habitat to another; in the case of anadromous fish such as salmon, to migrate or move in an <u>upstream</u> direction from estuarine and marine systems to freshwater riverine systems as adults.

Impacts – "Impacts" and "Effects" are synonymous. See "Effects" for a complete description.

Impingement – Flows causing fish to become stuck to the face of a fish screen.

Incidental Take – The loss or harassment of a listed species or degradation of their habitat incidental to an otherwise lawful activity.

Instantaneous (Peak) Demand – Peak daily amount of water required to meet near-term irrigation needs. This is usually expressed as flow (cubic feet per second).

Internal Fish Bypass – Opening (bays) along the screen face that leads to pipelines which take juvenile fish downstream of the fish screen. Its purpose is to minimize fish screen exposure time.

Lead Agency – CEQA Guidelines Definition 15367 states: "Lead Agency" means the public agency that has the principal responsibility for carrying out or approving a project.

Levee – An embankment designed to prevent the flooding of a river; may be natural or human made.

Levee Toe – The outer edge of the levee base where it meets the levee grade.
Mainstem – The principal channel of the river.

Meander – A turn or winding in a river or streambed that changes over time.

Meander Scar – The area of land marked by the earlier presence of a meandering river channel.

Mitigation – CEQA Guidelines Definition 15370 states: "Mitigation" includes: (a) avoiding the impact altogether by not taking an action or certain parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the impacted environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments.

Mortality – The rate or proportion of deaths.

National Environmental Policy Act (NEPA) - Directs federal agencies to prepare an environmental impact statement for all major federal actions which may have a significant effect on the human environment. States that it is the goal of the federal government to use all practicable means, consistent with other considerations of national policy, to protect and enhance the quality of the environment. Requires all federal agencies to consider the environmental impacts of their proposed actions during the planning and decision-making process.

Natural Levee – Naturally occurring deposits along the sides of a river that constrain frequent floods.

Non-point Source Pollution – Water pollution deriving from a broad area rather than a specific place; for example, urban and agricultural runoff may contain non-point source pollutants.

One-hundred-year Floodplain – The relatively flat portion of the river channel that has a one percent chance of being inundated by flood waters in any given year.

Overwinter – To remain in a particular habitat during the winter season.

Oxbow – Crescent shaped bend in the river.

Pacific Flyway – An established air route of waterfowl and other birds migrating between wintering grounds in Central and South America and nesting grounds in Pacific Coast states and provinces of North America.

Phreatophyte – Plant that draws water from saturated soils typically found in river floodplains.

Pumping – To draw water from a river.

Recapture – Water diverted for reuse from runoff of agricultural fields.

Redd – A depression dug by spawning salmon in gravel into which eggs are laid.

Reforestation – The replanting of trees in an area that was previously forested.

Responsible Agency – CEQA Guidelines 15381 states "Responsible Agency" means a public agency which proposes to carry out or approve a project, for which a Lead Agency is preparing or has prepared an EIR or Negative Declaration. For the purposes of CEQA, the term "Responsible Agency" includes all public agencies other than the lead agency which have discretionary approval over the project.

Restoration/Revegetation – Reestablishing a habitat or plant community in an area that historically supported it.

Revetment – Materials (e.g. rock, riprap, or matting) or a structure placed to restrain underlying material from being transported away.

Revetted Bank – Shoreline protected by riprap.

Riffle – The topographic high points on a streambed profile composed of the coarsest bed material being transported by the river.

Riparian – Located on the banks of a stream, river, lake, or pond.

Riparian Corridor – A band of native riparian vegetation, or frequently flooded land, of variable width, adjacent to a river channel.

Riparian Habitat – An area composed of native riparian vegetation that provides habitat for wildlife.

Riprap – A foundation or wall made of broken stones or other erosion-resistant materials (e.g. concrete).

River Gradient - The slope of a river's water surface profile.

Riverine – Relating to, formed by, or situated on a river.

Rock Revetment – A layer of rock designed to protect a river embankment.

Sacramento River Water Management System – The upper Sacramento River, its tributaries, and facilities affecting the timing and amounts of flows in the river.

Salinity – The quality, state, or degree of saltiness.

Salmonid – A fish or species of the salmon and trout family.

Scoping – An early, open process for determining the scope of issues to be addressed and identifying the significant issues related to a proposed action.

Screen Extension – The feature or alternative that would lengthen the existing screen.

Sedimentation – Soil or gravel transported by water from other streams and bodies of water that settle out of water and are deposited.

Sensitive Species – A plant or animal species listed by the state or federal government as threatened, endangered, or as a species of special concern. SEE ALSO: threatened species, endangered species.

Seral Stages – Ecological communities that succeed one another in the biotic development of an area.

Set-back Levee – Levees that are constructed at a distance from the river channel in order to allow the river to occupy a portion of its floodplain; these levees are usually smaller in size than levees placed immediately adjacent to the river channel. SEE ALSO: levee, natural levee.

Shaded Riverine Aquatic Cover (SRA Cover) – Unique, nearshore aquatic areas occurring at the interface between a river (or stream) and adjacent woody riparian habitat. Characteristics include: the adjacent bank being composed of natural, eroding banks supporting riparian vegetation that either overhangs or protrudes into the water; waters containing variable amounts of woody debris, such as leaves, logs, roots, and branches. This type of habitat has been designated as Resource Category 1 under U.S. Fish and Wildlife Service Mitigation Policy.

Sinuous – Having many curves, bends, or turns, such as a meandering river.

Snag – A dead tree or part of a tree, such as a stump, located in a river channel.

State Water Project (SWP) – The water storage and conveyance system that is operated and maintained by the California Department of Water Resources.

Special-Status Species – Any species listed or proposed for listing under the Endangered Species Act.

Streamflow – The volume of water passing a given point per unit of time.

Succession – The replacement of one plant community by another over time.

Thalweg – Generally defined as the center line of a river channel that (where uncontrolled) is constantly changing as a function of flow, sedimentation, and erosion processes, and other physical properties.

Threatened Species – A species that is still abundant in its natural range but may become endangered if it declines in number.

Tributary – A stream or body of water that flows into a larger body of water, such as a larger river.

Turbidity – Suspended matter in water that causes scattering or absorption of light rays and a cloudy appearance.

Understory – Underlying, low vegetation often including shrubs, small trees, grasses, and forbs.

Watershed – The total area above a given point on a watercourse that contributes water to its flow; the entire area from which a river receives its water supply. Also referred to as catchment or catchment basin.

Weir – A notch or depression in a dam or other water barrier through which the flow of water is either measured or regulated.

Wetland – Lands that are transitional between terrestrial and aquatic systems where water is usually at or near the surface or the land is covered by shallow water (typically streams, lakes, and the open ocean).