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 NO_3 (49. 66, and 71 mg/l as NO_3).

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.