10.0 Appendices

APPENDIX A

SUMMARY OF HISTORICAL CASCADE WATERSHED MONITORING

A. Watershed Monitoring

A.1 Historical Water Quality Monitoring

A.1.1 Reservoir Monitoring

Cascade Reservoir has been the subject of numerous studies over the past 30 years. These studies are summarized in Table A.1 below.

Table A.1 Cascade Reservoir Studies

Year	Conducted By	Parameters	Purpose
1968	IDFG[1]	DO	Limnological & fisheries
1974	BOR[2]	DO , conductivity, temperature, nutrients, minerals, chlorophyll a	Concerns for low DO and nuisance algae
1975	DEQ[3]	DO , temperature, nutrients, minerals, chlorophyll a, phytoplankton, bacteria	Study coincided with issuance of the McCall NPDES permit
1975	EPA[4]	DO , temperature, conductivity, pH, nutrients, minerals, alkalinity, chlorophyll a, phytoplankton, bacteria	National Eutrophication Study
1978-present	BOR[5]	Phosphorus, chlorophyll a	Reservoir trend monitoring
1980-1982	IDFG[6]	DO	Develop criteria for winter storage to enhance fish survival
1988-1991	Citizens[7]	DO , temperature, nutrients, secchi depth, chlorophyll a, phytoplankton	Citizen concern
1989	Entranco[8]	DO , temperature, conductivity, pH, secchi depth, nutrients, chlorophyll a, phytoplankton, bacteria	Phase I Clean Lakes Grant funded study
1993-present	DEQ[9]	DO , temperature, conductivity, pH, secchi depth, nutrients, chlorophyll a, phytoplankton, bacteria	Expand database to assist in the development of a restoration management plan

1 = Irizarry, 1970; 2 = Bureau of Reclamation, 1974 and 1975; 3 = Clark and Wroten, 1975; 4 = EPA, 1977; 5 = Zimmer, 1983; 6 = Horner and Riemand, 1981, Reininger . 1982, Reininger . 1993; 7 = Klahr, 1989 and Ingham, 1992; 8 = Entranco, 1991; 9 = Worth, 1994.

A.1.2 Tributary Monitoring

Nonpoint source water quality and related biological data have been collected by a number of state and federal agencies and private land owners. Water quality monitoring has been conducted on several local streams and rivers related to specific timber management activities on endowment state lands and within the national forests. Bacterial contamination has been infrequently monitored in conjunction with issues related to sanitary disposal of waste water from septic tanks. These are summarized in Table A.2 below.

Table A.2 Studies of tributaries to Cascade Reservoir

Year	Conducted By	Parameters	Comments/Location
1975	EPA[1]	Nutrients, DO , temperature, pH, bacteria	National Eutrophication Study
1975	DEQ[2]	Nutrients, DO , temperature, pH, bacteria	Boulder Cr., Gold Fork R., Lake Fork Cr., Mud Cr.
1980	BOR[3]	Nutrients, DO , temperature, pH, bacteria, stream flow	Expansion to biweekly sampling
1984-present	Boise Cascade[4]	Nutrients, DO , temperature, pH, bacteria, stream flow, suspended sediment	Trend monitoring, Gold Fork R.
1986	DEQ[5]	Nutrients, DO , temperature, pH, bacteria, stream flow, suspended sediment	Focused on streams primarily influenced by agriculture, Boulder Cr., Mud Cr., Lake Fork Cr.
1989	Entranco[6]	Nutrients, DO , temperature, pH, bacteria, stream flow, suspended sediment	Development of a water quality management plan, all major tributaries
1991-present	BNF[7]	Stream flow, bacteria, nutrients	Monitor impacts to streams from grazing allotments on the Westside
1992-1994	DEQ and VSWCD[8]	Nutrients, DO , temperature, pH, bacteria, stream flow, suspended sediment, riparian condition	BMP effectiveness on Boulder Cr.
1993-present	DEQ[9]	Nutrients, DO , temperature, pH, bacteria, stream flow, suspended sediment	Determine mass loading from each tributary
1991-present	PNF[10]	Stream flow, bacteria, nutrients	Trend monitoring in Kennally Creek

1 = EPA, 1977; 2 = Clark and Wroten, 1975; 3 = Zimmer, 1983; 4 = Glass, 1995; 5 = Klahr, 1986; 6 = Entranco, 1991; 7 = Fischer, 1995; 8 = Ingham, 1992; 9 = Worth, 1995; 10 = PNF, 1995.

Nine major subwatersheds have been identified that directly drain to Cascade Reservoir (Figure A.1). Bulk nutrient contributions of each watershed have been computed representing the collective contribution of nutrients from monitoring sites located at the lower ends of each tributary (Figure A.2).

The BNF, Cascade District began monitoring the smaller tributaries on the reservoirs west side in 1991. This monitoring has continued through 1995. The streams are monitored to determine the effects of grazing conducted under permits issued on lands managed by the BNF. Monitoring includes stream flow rates, nutrients (total phosphorus, dissolved-PO_4, bacteria (fecal coliform) and physical data (temperature and DO). Measurements are taken above and below the grazing allotments to estimate relative differences ascribed to grazing management.

A.1.3 Reservoir Sediment Monitoring

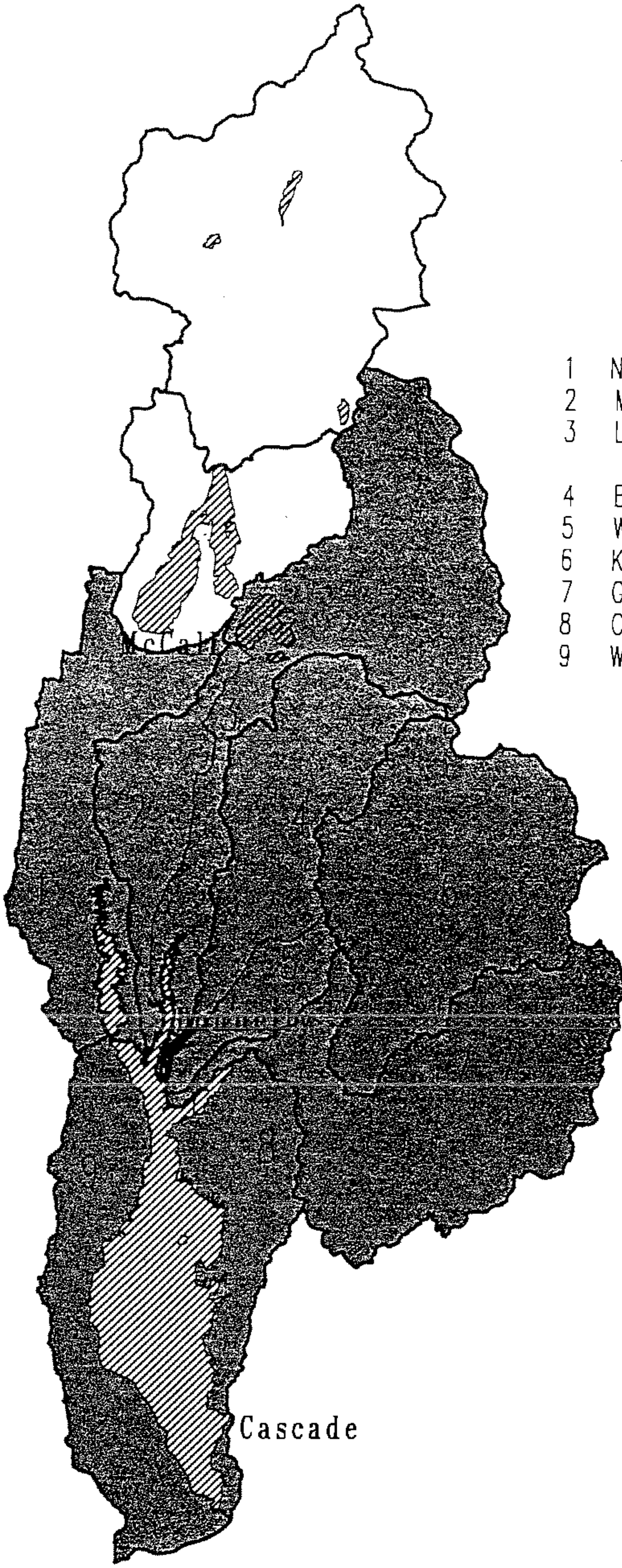
Studies of Cascade Reservoir have identified sediment bound phosphorus as an important source of this limiting nutrient (EPA, 1977; Zimmer, 1983; Entranco, 1991; Chapra, 1990). Efforts to measure and quantify phosphorus sources and distribution of sediments have been conducted (Worth, 1993) to enhance accuracy and utility of a simulation model previously developed for Cascade Reservoir (Chapra, 1990). Ongoing studies will provide a direct measure of the quantity and form of phosphorus available in the sediments of Cascade Reservoir.

A.1.4 Watershed Soil Monitoring

Soil erosion estimates were initially made by the U.S. Soil Conservation Service based on a field survey in 1988. This survey focused on some of the larger tributary rivers to Cascade Reservoir. No additional data on rates of erosion have been collected since this initial survey. Potential phosphorus loads associated with these sediments were not quantified.

Studies have been initiated by DEQ (Worth, 1993) to analyze the phosphorus content of surface soils representing the major soils series (United States Department of Agriculture (USDA), Valley County Soil Survey). Major soil series of interest include Archabal, Gestrin, Roseberry, Donnel, and Melton. Soil samples collected from cross-sections of streams from one high water mark to the other will be used for comparison of their phosphorus content with surrounding soils in each subwatershed.

Figure A.1.



Subwatersheds

1 North Fork Payette (HUC #1705012305)
2 Mud Creek (HUC #170501230801)
3 Lake Fork Creek (HUC #170501230802 and #1705012309)
4 Boulder Creek (HUC #170501231001-1004)
5 Willow Creek (HUC #170501231005)
6 Kennally Creek (HUC #1705012312)
7 Gold Fork (HUC #1705012311)
8 Cascade (HUC #170501230402)
9 West Mountain (HUC #170501230401)

N

kilometers

0 5 10 20

Projection: UTM Zone 11

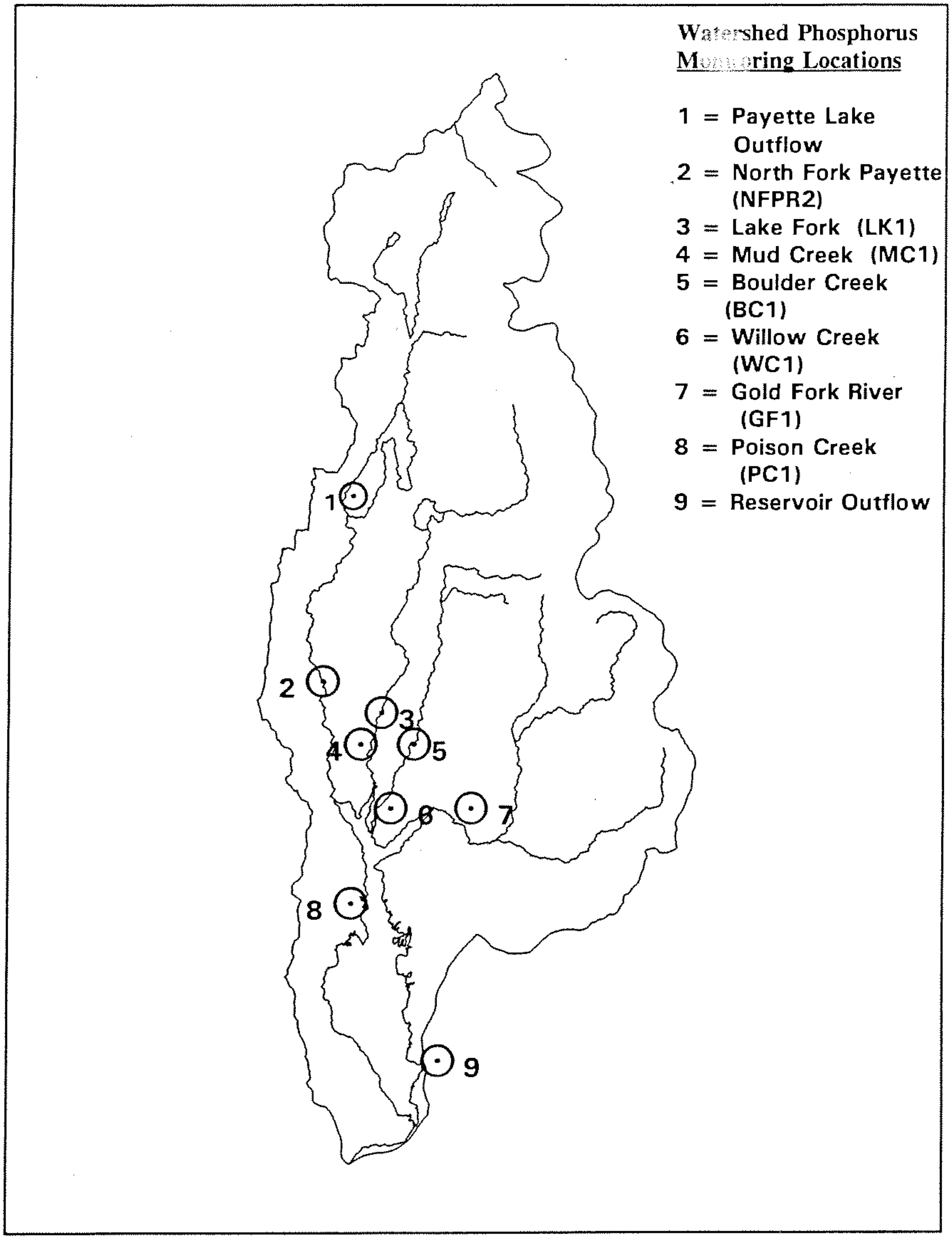


Figure A.2. Watershed Phosphorus Monitoring Locations

A.1.5 Ground Water Monitoring

With the exception of bacterial surveys, very few studies have evaluated the importance of ground water as a nutrient source for Cascade Reservoir. Zimmer (1983) reported concentrations of dissolved ortho-phosphorus frequently exceeded concentrations of surface inflows, indicating ground water could be an important source of nutrient loading to the reservoir. Estimates of the importance of ground water to the cumulative reservoir loading of nutrients could not be determined.

Clark and Lappin (1986) conducted an intensive study of bacteria contamination in surface and ground water related to recreational housing and cattle grazing along the reservoir southwest shore. The area of study included high density use of summer cabins.

A.1.6 Point Source Monitoring

Effluent water quality from the City of McCall WWTP has been routinely monitored since August 1981. Monthly reports are submitted characterizing the average and maximum concentrations of total and dissolved phosphorus, ammonia, nitrogen, total and suspended solids, total and fecal coliform bacteria, chlorine and biological oxygen demand (BOD).

Analysis of hatchery effluent quality has been sporadically reported to DEQ since 1975. Data is limited and consists primarily of phosphorus concentrations measured in the inflow water diverted from the North Fork Payette River and effluent return water after passing through the hatchery. Ingham and Boyle (1991) monitored hatchery effluent approximately biweekly from July to September, 1988. Additional monitoring was conducted monthly from January to September, 1989, in conjunction with reservoir and watershed monitoring sponsored by the DEQ (Entranco, 1991).

APPENDIX B

ANALYSIS OF CASCADE WATERSHED WATER QUALITY DATA

B. Water Quality Data

B.1 Reservoir Water Quality

Water quality in Cascade Reservoir has been a subject of public concern since the 1970's due to continuing occurrences of noxious algal blooms, increased growth of aquatic weeds and frequent episodes of fish kills. More recently in summer 1993, a severe outbreak of toxic blue-green algae caused the death of 23 cattle after drinking water from the reservoir (Worth and Lappin, 1994). These and other water quality indicators demonstrate that designated beneficial uses of the reservoir are not fully supported. The apparent decline in the aquatic health of the reservoir has largely been attributed to excessive nutrient loading from both point and non-point sources.

B.1.1 Temperature and Dissolved Oxygen

Earliest records of DO monitoring suggest reservoir concentrations of hypolimnetic DO begins declining below state standards (6.0 mg/l) during July and August coinciding with warm surface water temperatures (≥ 20°C)(Irizarry, 1970). Extremely low concentrations (≤ 3.0 mg/l) were reported in August 1968. Additional monitoring by the BOR in 1974 (BOR, 1975), showed low DO concentrations (<2.0 mg/l) were present at several monitoring sites in August. Similar results were reported by Clark and Wroten (1975). Low DO conditions (<5.0 mg/l) were prevalent in late summer coinciding with warmer water temperatures. Severe oxygen depression was observed at one site during September 1974, during the EPA National Eutrophication Study (EPA, 1977).

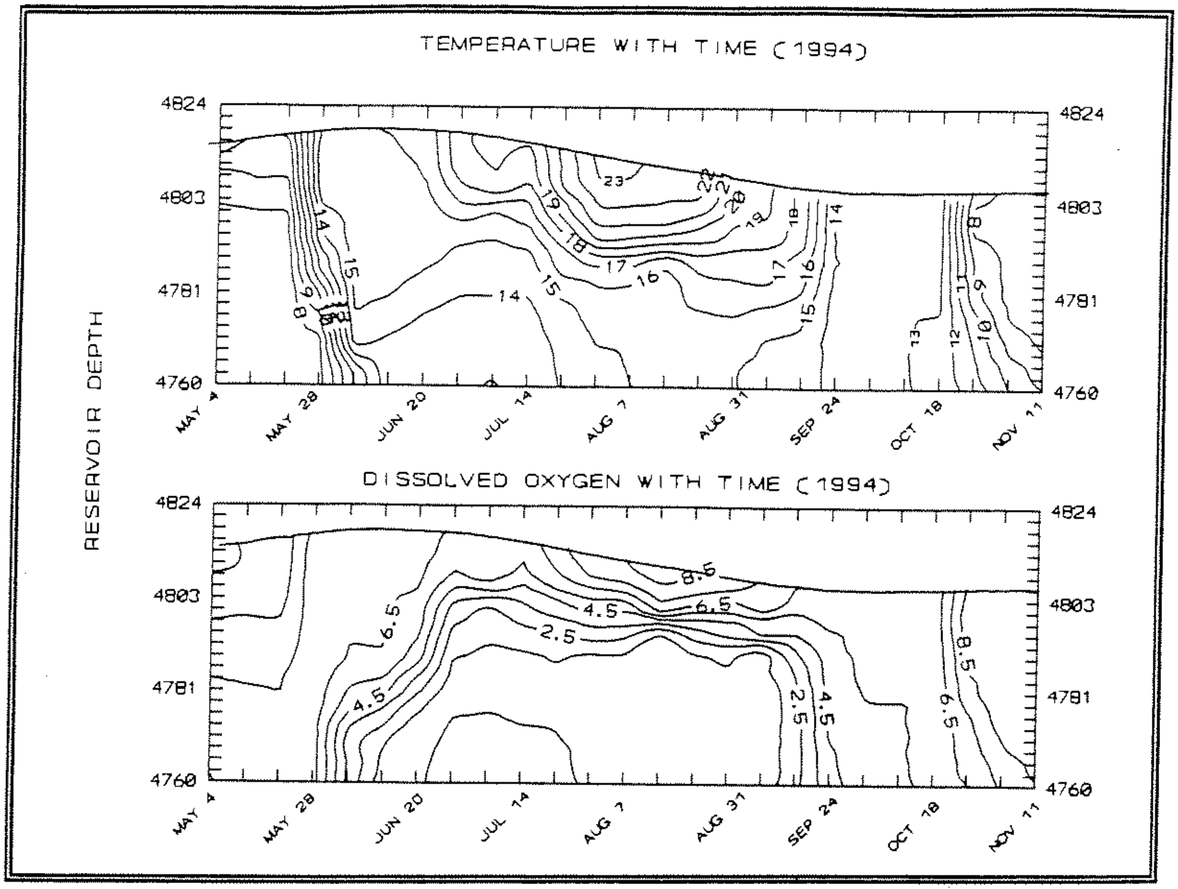
A more detailed survey by Horner (1980) showed low DO concentrations (≤ 3.0 mg/l) present in July and persisting through late August. Reininger et al. (1983) reported similar findings of lowest DO levels (<1.0 mg/l) during summer stratification (July to September) and during winter stagnation (February to March). Monitoring of oxygen concentrations from selected tributaries showed winter concentrations varied between 9.7 and 10.1 mg/l.

Figure B.1 depicts seasonal temperature and DO profiles at key reservoir monitoring sites during a 1994 survey conducted by DEQ and BOR. Results show Cascade Reservoir typically stratifies in early June and remains stratified until fall turn over in mid September. Lowest DO concentrations occur during stratified conditions when atmospheric re-aeration of the hypolimnion is inhibited.

B.1.2 Nutrients and Reservoir Productivity

Early measures of reservoir nutrient concentrations were reported for two stations in May and June of 1968 by the IDFG (Irizarry, 1970). Nitrate nitrogen ranged from 1.0 to 1.2 mg/l on three different dates of collection. Total phosphorus concentrations ranged from 0.005 to 0.04 mg/l. Measurements of chlorophyll a were not taken.

Figure B.1. Seasonal temperature and DO profiles 1994.



Results of the National Eutrophication study in 1974 (Table B.1), show average reservoir concentrations of chlorophyll a ranged from 7.0 to 10.1 ug/L with highest concentrations present in September (14.3 ug/L). Average reservoir concentrations in total phosphorus ranged from 0.019 to 0.031 mg/L and were slightly greater on the reservoir bottom compared with surface values. BOR monitoring of five reservoir stations, also conducted in 1974, showed nitrate-nitrogen concentrations varied from 0.03 to 0.08 mg/L and phosphorus ranging from 0.02 to 0.35 mg/L. Nutrient concentrations were sufficiently high to support algal growth. Clark and Wroten (1975) also reported peak chlorophyll a concentrations present in August. Inorganic nitrogen concentrations varied from 0.020 to 0.273 mg/L while dissolved phosphorus (total phosphorus not reported) varied from 0.01 to 0.315 mg/L. Phosphorus concentrations in the reservoir were often highest on the reservoir bottom. Blue green algae were the dominant phytoplankton species in late summer coinciding with the highest concentrations of chlorophyll a.

Zimmer (1983) summarized BOR monitoring results for the period 1978 through 1982 (Figure B.2). Total phosphorus concentrations in the reservoir ranged from 0.018 to 0.102 mg/L. Highest concentrations were observed on the reservoir bottom and tended to increase in surface waters during August and September. Concurrently, chlorophyll a concentrations in surface waters were highest in August and September, averaging 18 and 11 ug/L, respectively. The highest observed concentrations during this period reached 120 ug/L in August 1978.

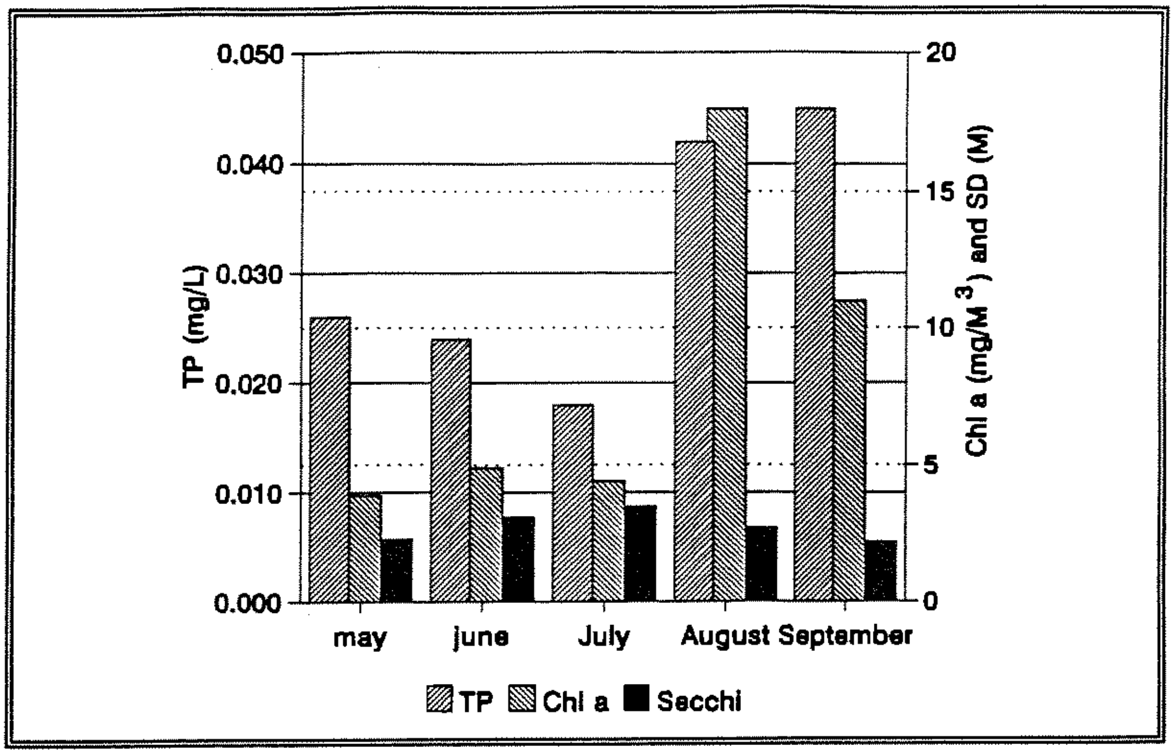
Table B.1 Results of EPA National Eutrophication Study

IN-LAKE WATER QUALITY DATA

EPA 1977 Study (Data collected in water year Oct 1974 - Sep 1975)

Date	Depth	Station	Chl a	NO_3+NO_2	NH_4	TKN	Diss $O-PO_4$	Tot.N	TP	Inches Secchi	DO
6/04/75	surface	1 Dam location	8.1	0.02	0.03	0.6	0.014	0.65	0.038	47	10.4
		2 NF Arm	4.7	02	0.04	0.3	0.009	0.54	0.025	30	9
		3 Sugarloaf	6.7	0.02	0.03	0.3	0.016	0.35	0.047	44	10
		4	8.1	0.02	0.04	0.3	0.017	0.36	0.04	45	9.6
		5 South end	7.6	0.02	0.04	0.4	0.014	0.46	0.04	46	10
	1.5 meter	1 Dam location		0.02	0.03	0.4	0.015	0.45	0.044		9.4
		2 NF Arm		0.02	0.04	0.2	0.015	0.26	0.03		9
		3 Sugarloaf		0.02	0.03	0.2	0.008	0.25	0.037		9.4
		4		0.02	0.05	0.3	0.2	0.37	0.04		9.8
		5 South end		0.02	0.04	0.3	0.013	0.36	0.037		9.8
8/01/75	surface	1 Dam location	8.7	0.02	0.03	0.2	0.009	0.25	0.019	84	7.5
		2 NF Arm	5.6	0.02	0.02	0.2	0.016	0.24	0.02	108	8.6
		3 Sugarloaf	11.2	0.02	0.02	0.2	0.009	0.24	0.017	108	7.4
		4	5.4	0.02	0.03	0.3	0.008	0.35	0.016	120	7.8
		5 South end	4.6	0.03	0.03	0.3	0.015	0.36	0.021	72	8
	1.5 meter	1 Dam location		0.02	0.04	0.4	0.019	0.46	0.024		7
		2 NF Arm		0.02	0.03	0.3	0.008	0.35	0.02		7.4
		3 Sugarloaf		0.02	0.02	0.3	0.009	0.34	0.02		7.2
		4		0.02	0.03	0.2	0.007	0.25	0.022		7.2
		5 South end		0.02	0.03	0.4	0.014	0.45	0.021		4.6
9/16/75	surface	1 Dam location	6.7	0.02	0.03	0.3	0.003	0.35	0.026	126	8
		2 NF Dam	6.3	0.02	0.02	0.3	0.002	0.34	0.025	132	8.6
		3 Sugarloaf	9.8	0.02	0.02	0.4	0.004	0.44	0.033	108	8.4
		4	14.3	0.02	0.04	0.4	0.013	0.46	0.035	120	8.4
		5 South end	13.4	0.02	0.02	0.4	0.006	0.44	0.034	84	8.6
	1.5 meter	1 Dam location		0.02	0.04	0.3	0.005	0.36	0.029		8
		2 NF Arm		0.02	0.02	0.3	0.002	0.34	0.032		8.8
		3 Sugarloaf		0.02	0.02	0.3	0.003	0.34	0.029		8.6
		4		0.02	0.04	0.4	0.006	0.46	0.022		8.4
		5 South end		0.02	0.02	0.4	0.004	0.44	0.041		8.8
Mean summer 1975			8.08	0.03	0.03	0.32	0.016	0.38	0.029	85	8.5
n =			15	30	30	30	30	30	30	15	30

Figure B.2. Summary of reservoir total phosphorus (TP), chlorophyll_a (CHLa), and Secchi depth (SD) during the period 1978 - 1982

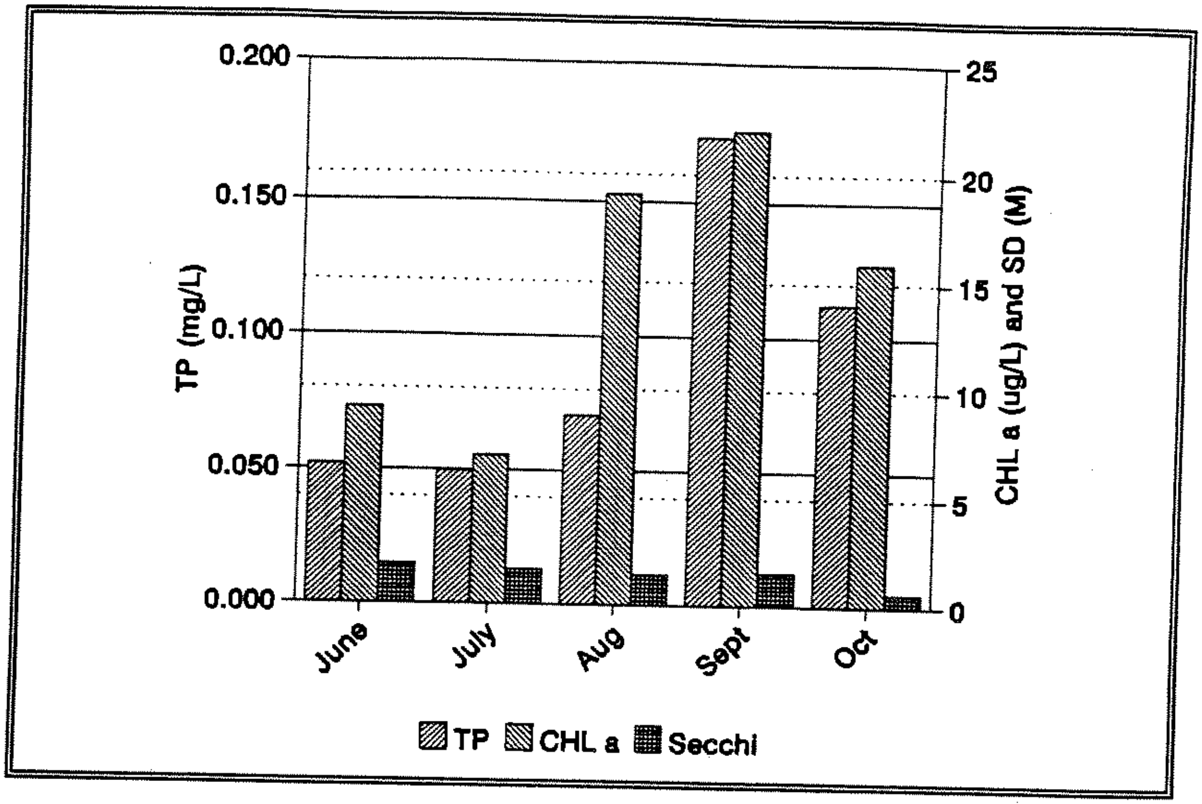


This same seasonal pattern of increases in chlorophyll a concentrations and predominately higher total phosphorus concentrations on the reservoir bottom was observed in subsequent studies conducted from 1988 to 1991 using citizen volunteer monitoring (Klahr, 1989; Entranco, 1991; Ingham, 1992) and during recent monitoring (Worth, 1993, 1994; Figure B.3). The relative difference in total phosphorus concentrations between the reservoir surface and bottom roughly follow this same trend.

From the available data, there is a consistent seasonal trend of increasing algal biomass (as reflected in chlorophyll a concentrations) beginning in May and reaching a maximum in August and September. This peak may be further enhanced by availability of hypolimnetic phosphorus released by reservoir sediments during periods of anoxia. Temporary breakdown of the thermocline by wind mixing events may provide a ready infusion of nutrients to the photic layers of the reservoir and further stimulate algal growth.

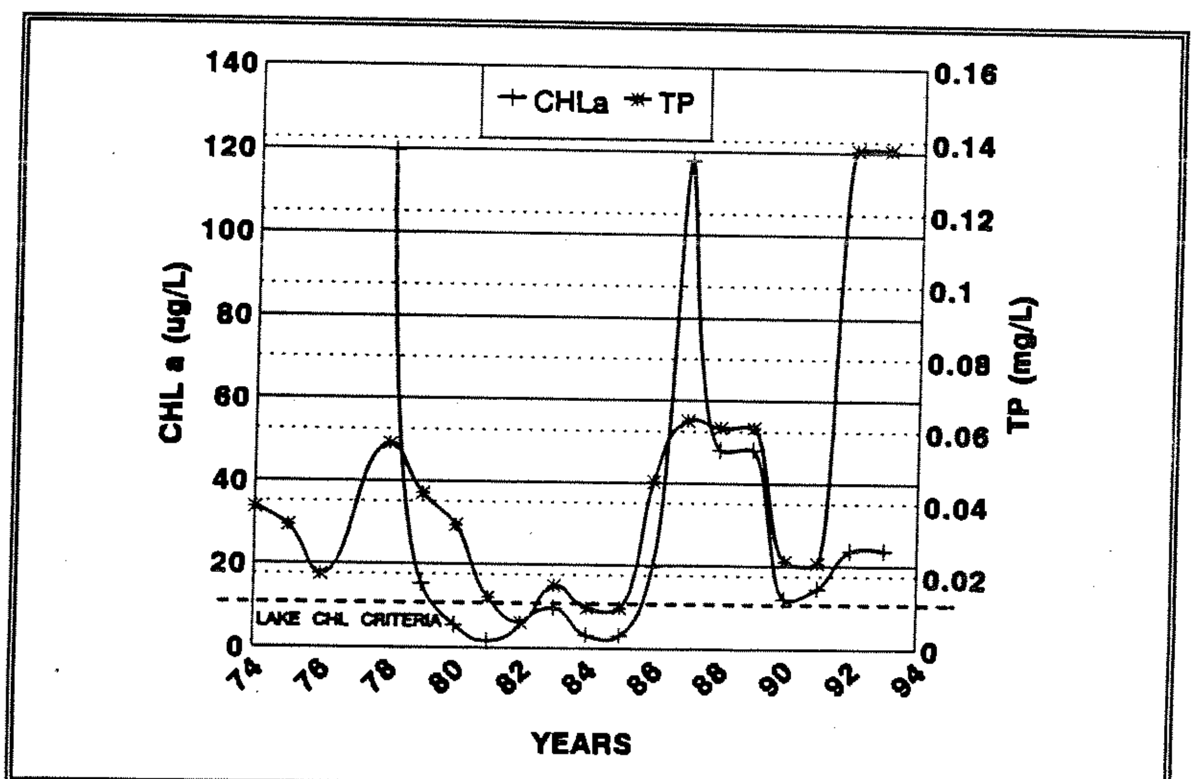
Summer chlorophyll a and total phosphorus concentrations vary from year to year because of phosphorus loading from runoff and internal recycling. Long term monitoring (contiguous records > 10 years) has been conducted near the reservoir dam outflow (referred to as log boom site or dam site; site CWQ002, See Appendix D, Figure 6) and within the upper third of the reservoir just north of the central embayment and west of Sugar Loaf Island (site CWQ005, See Appendix D, Figure 6). These sites are important indicators of reservoir conditions due to their differences in limnological conditions and spatial position relative to longitudinal gradients in reservoir water quality.The reservoir dam site is one of the deepest monitoring locations and close in proximity to southern third of the reservoir where summer concentrations of chlorophyll a are typically high and DO is low. A dramatic increase in water column phosphorus

Figure B.3. Summary of reservoir total phosphorus (TP), chlorophyll a (CHLa), and Secchi depth (SD) during the period 1993-1994.



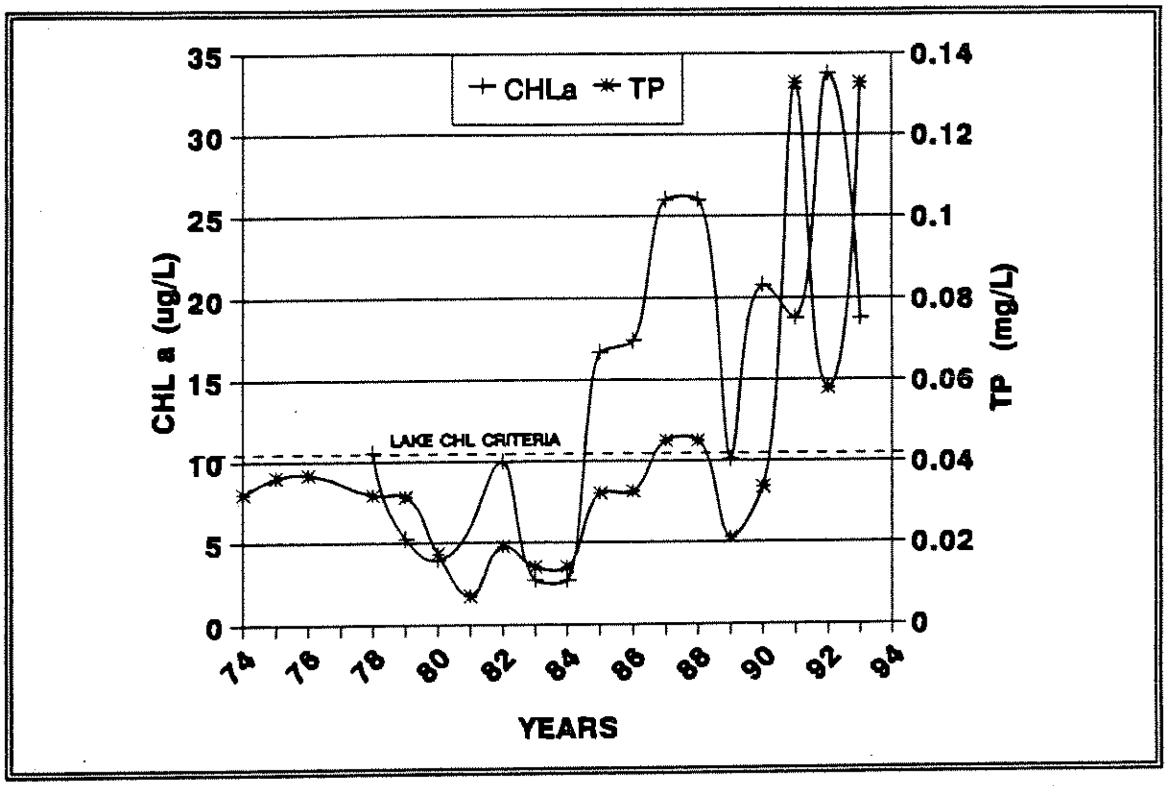
concentrations was observed at this site in 1992 and 1993 (Figure B.4). Although average summer chlorophyll a concentrations were lower compared to previous years, chlorophyll a concentrations were well above the 10 ug/l target established as the restoration goal.

Figure B.4. Average summer total phosphorus and chlorophyll a at the Cascade dam site.



In contrast, concentrations of chlorophyll a are typically lower and DO is higher in vicinity of the Sugar Loaf Island site (Figure B.5). Water column concentrations of total phosphorus are similar to the Dam site and show a dramatic increase beginning in 1991. Other factors such as prevailing winds, hydraulic influence of the tributary inflows to the north and shorter hydraulic residence time may influence biological production at this site. Annual variations in total reservoir nutrients and chlorophyll a concentrations are summarized in Appendix B Table B.1.

Figure B.5. Average summer total phosphorus and chlorophyll a at the Cascade Reservoir Sugar Loaf Island site. (Variations may be due to number of samples collected in a given year)



A sanitary survey of bacteria within the reservoir was conducted in 1974 (Clark and Wroten, 1975) found concentrations were below state standards for most sites within 30 feet of the shoreline. Similar results were reported in the BOR reservoir survey in 1974 (BOR, 1975). One violation was reported exceeding the 500 counts/100 ml standard in the Lake Fork arm of the reservoir during more extensive reservoir surveys between 1978 and 1982 (Zimmer, 1983). Mean counts of all sites combined exceeded the geometric mean standard (50 counts/100 ml in September, 1981. High average coliform counts were reported in August 1979 and September 1981.

Recent surveys indicate bacteria counts are below state standards, based on data obtained from monitoring stations in 1993 and 1994. However, these stations are located in the pelagic zones of the reservoir and may not reflect conditions along the shoreline where bacterial contamination from tributaries, seeps and drains are more likely to impact water quality.

B.2 Reservoir Tributaries

B.2.1 Dissolved Oxygen and Temperature

The BOR conducted tributary monitoring at selected sites in August 1974. Results showed DO levels generally exceeded state minimum standards for cold water biota (>6.5 mg/l) for the North Fork Payette River, Lake Fork Creek, and several smaller tributaries on the west shore of the reservoir. Water temperatures ranged from a high of 20°C in Lake Fork Creek to 5°C for the west shore tributaries. Similar results were reported by Clark and Wroten (1975) during a survey from May to November 1975. DO concentrations for major tributaries such as Gold Fork River, Lake Fork Creek, Boulder Creek, Mud Creek and North Fork Payette River met state standards for cold water biota. Reininger, (1983) reported DO concentrations from selected tributaries during winter 1982 varied between 9.7 to 10.1 mg/l at temperatures of 1 to 4°C.

Major tributaries monitored in 1989 (Figures B.6-B.9) (Entranco, 1991) and 1993 through 1994 (Figures B.10-B.13), show seasonal affects on DO and temperature. Concentrations of DO are highest in winter and steadily decline as water temperatures increase. All of these streams drain large surface areas of the valley floor, flowing south toward the reservoir over relatively flat topography. Tributaries lacking adequate riparian cover such as Mud Creek, Willow Creek, and Boulder Creek generally increase in temperature and decline in DO more rapidly, compared to other streams.

Figure B.6. Seasonal distribution of temperatures for Willow, Mud, and Boulder Creeks

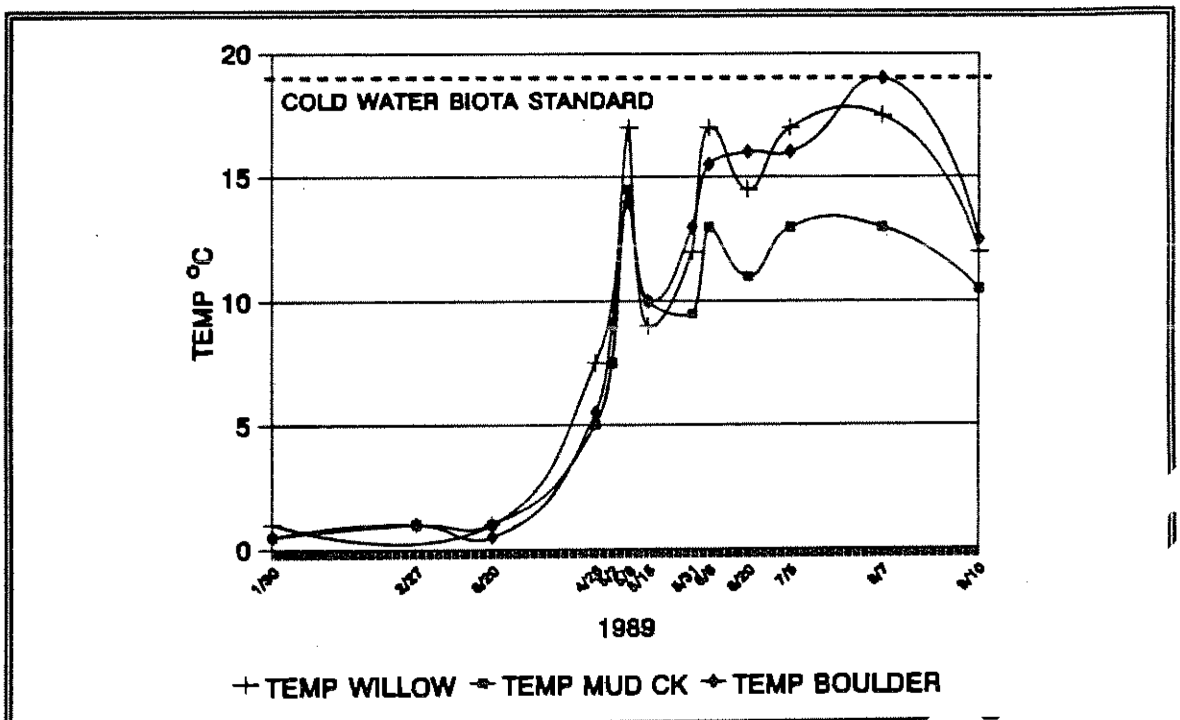


Figure B.7. Seasonal distribution of DO for Willow, Mud, and Boulder Creeks

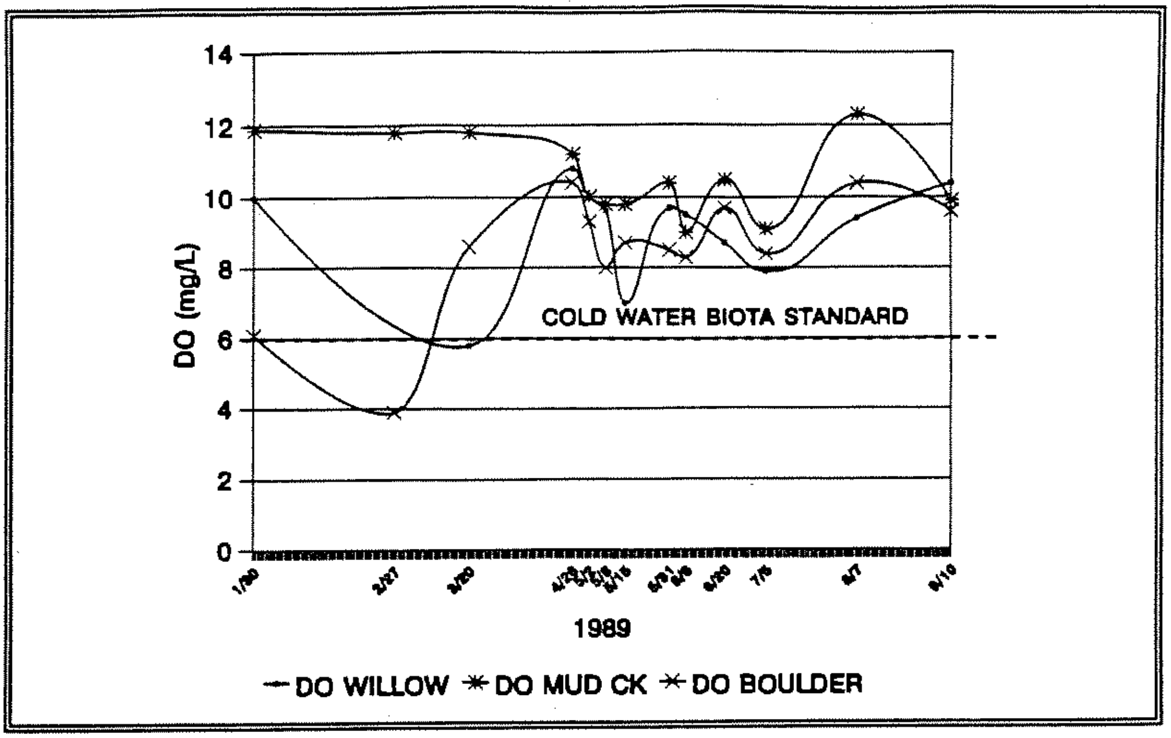


Figure B.8. Seasonal distribution of temperature in the North Fork, Lake Fork, and Gold Fork of the Payette River.

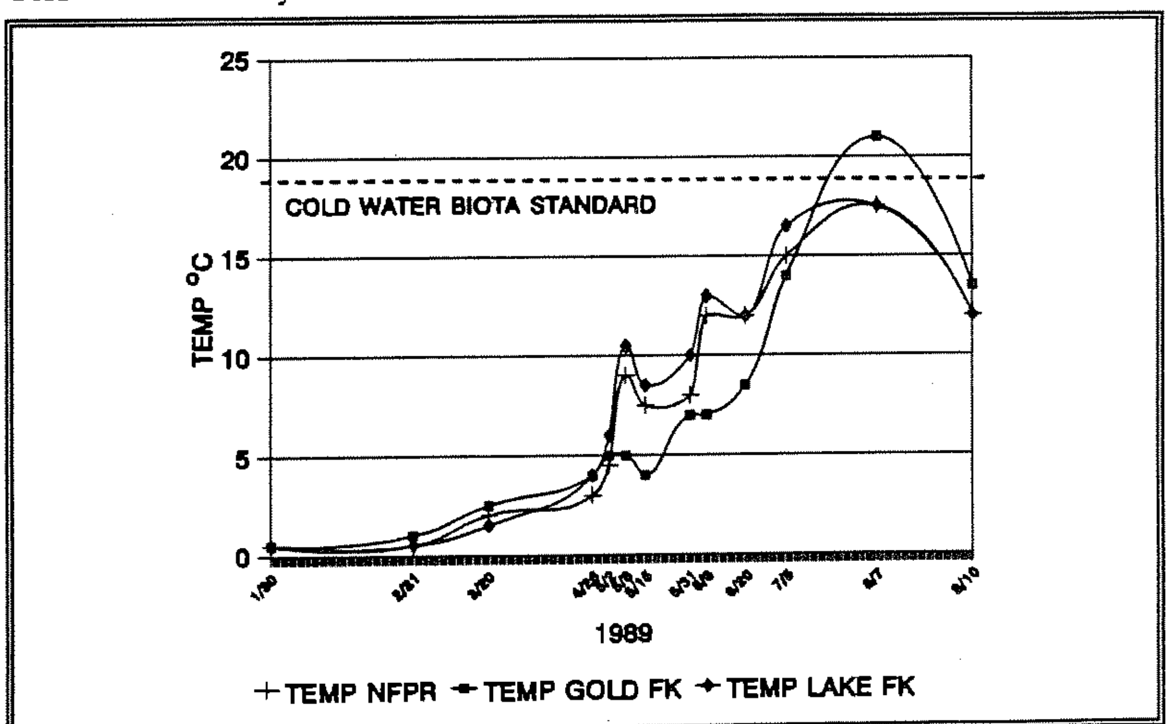


Figure B.9. Seasonal distribution of DO in the North Fork, Lake Fork, and Gold For k of the Payette River.

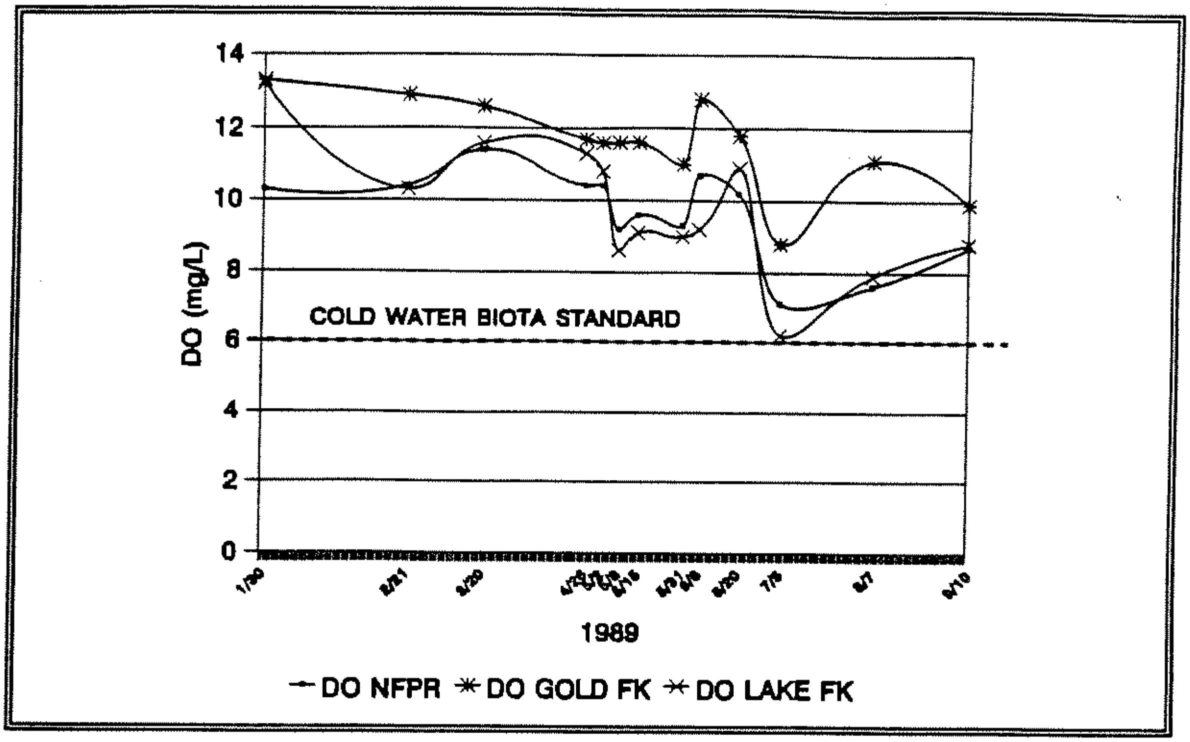


Figure B.10. 1993-1994 Seasonal distribution of temperature in Willow, Mud, and Boulder Creeks.

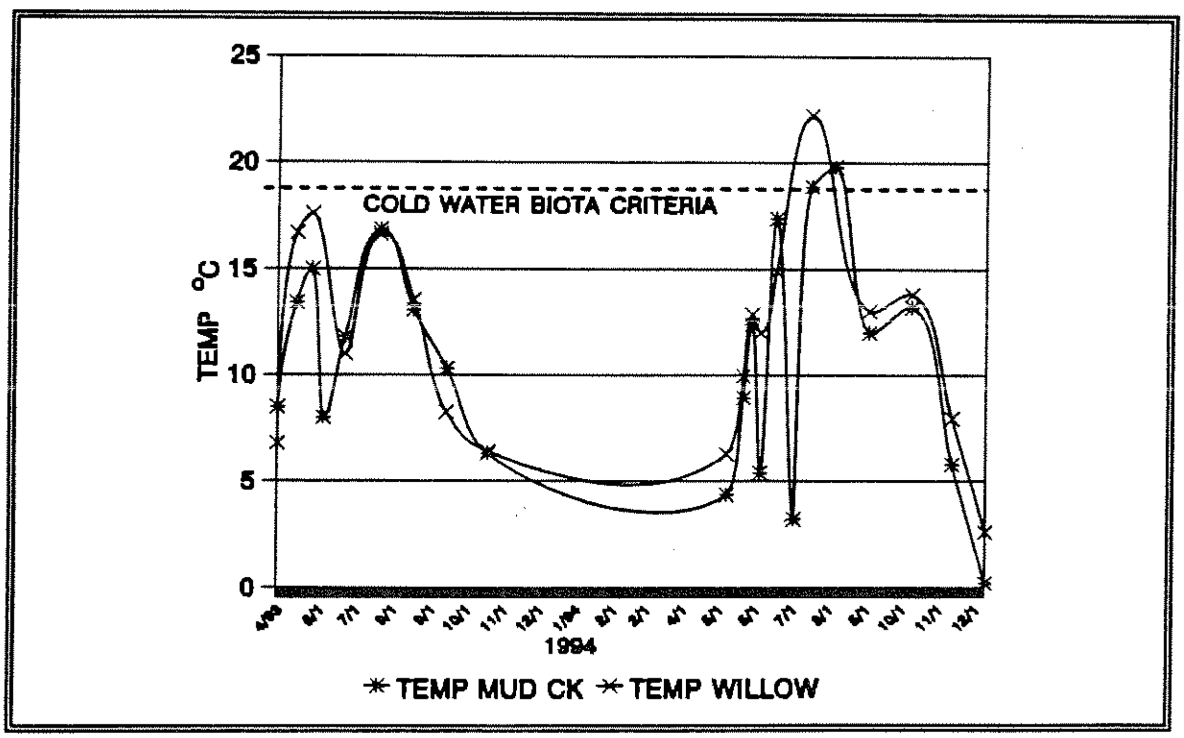


Figure B.11. 1993-1994 Seasonal distribution of DO in Willow, Mud, and Boulder Creeks.

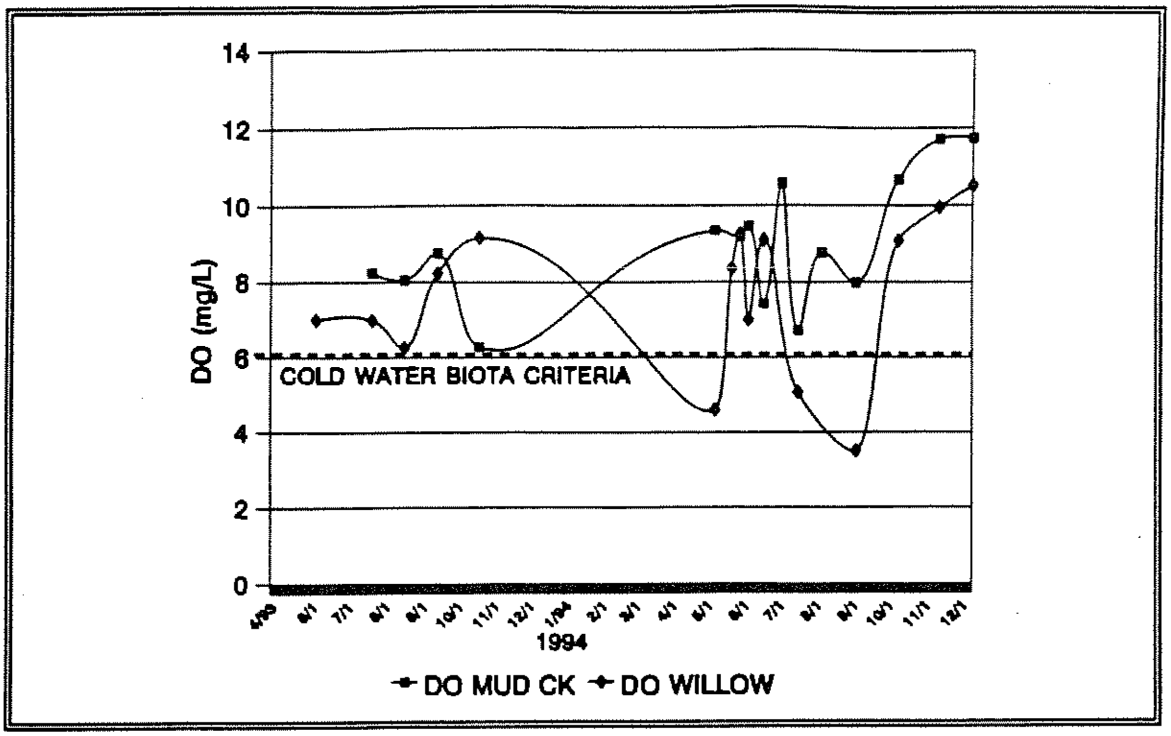


Figure B.12. 1993-1994 Seasonal distribution of temperature in the North, Lake, and Gold Forks of the Payette River.

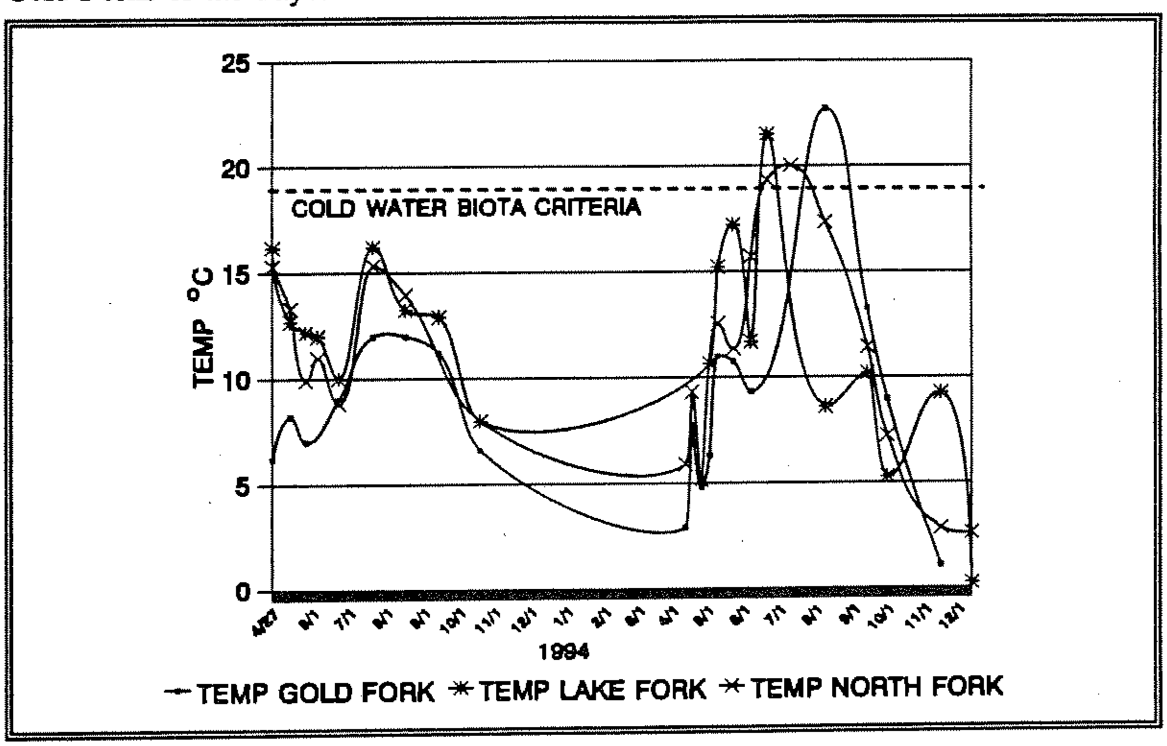
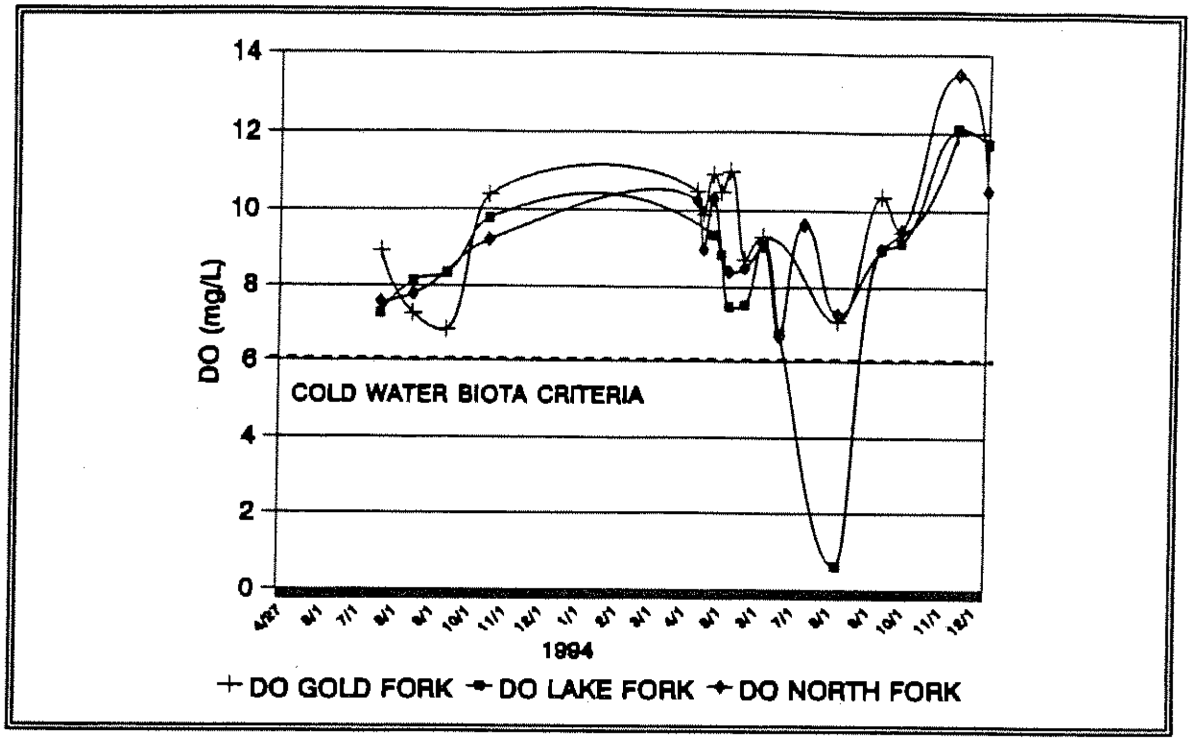


Figure B.13. 1993-1994 Seasonal distribution of dissolved oxygen in the North, Lake, and Gold Forks of the Payette River.



B.2.2 Water Quality and Hydrology

Nutrient concentrations reported for major tributaries are presented in Table B.2. are based on the respective water year. Estimates for total nitrogen (TN) in years 1976 and 1979 to 1980, contain inorganic nitrogen only. Measures of ammonia nitrogen were generally not reported for the tributaries monitored by the BOR in 1981 (Zimmer, 1983). Consequently, computed TN concentrations as shown in the table are lower than would be expected. High detection limits were used for total phosphorus measurements in the 1989 data, resulting in a large number of ≤ 0.05 mg/l measurements for the Gold Fork River and Lake Fork Creek tributaries.

The data suggest Willow and Boulder Creeks consistently have higher concentrations of nutrients compared to other major tributaries. Based on mass loadings for 1975, the Gold Fork River contributed 25.0% of the total annual phosphorus load (40,545 kg TP), with the North Fork Payette River, Lake Fork Creek and other drainage areas contributing 21.3%, 15.1%, and 14.8%, respectively (EPA, 1977).

Elevated levels of bacteria were reported by Clark and Wroten (1975) for those portions of the reservoir directly receiving inflows from major tributaries (Boulder Creek, Mud Creek, and Gold Fork River). A BOR study in 1974, showed several tributaries exceeding state standards and was attributed to contamination by both animal (cattle) and human influence (shoreline development). Boulder Creek coliform counts exceeded 9,000/100 ml with fecal counts greater than 2,000/100 ml. The Cambell creek tributary on the southwest shore of the reservoir was reported to contain coliform counts of 2,400/100 ml.

Zimmer (1983) reported consistently high values of coliform bacteria for the North Fork Payette River, Lake Fork Creek, Boulder Creek, and Gold Fork River from 1978 to 1982. High fecal coliform and fecal streptococcus counts were reported for streams along the southwest shore in 1984 and 1985 (Lappin and Clark, 1986). Highest counts were observed below cattle grazing areas (400 to 800/100 ml). Elevated levels were also reported for sites below recreational cabins compared to stream sites located above.

More recently, the BNF reports significant differences in bacteria counts for streams along the west shore of the reservoir flowing through grazing allotments during studies 1991 to 1994.

Table B.2. Mean of total phosphorus concentrations (mg/l) measured in Cascade Reservoir tributaries reported by the BOR (BOR, 1983).

	NF Payette River			Lake Fork			Boulder Cr.			Gold Fork River			Willow Cr.			Mud Cr.		
	TP	DisP	TN	TP	DisP	TN	TP	DisP	TN	TP	DisP	TN	TP	DisP	TN	TP	DisP	TN
1975*	.033	.016	.558	.022	.012	1.33	.076	.046	.486	.060	.020	.464	ND	ND	ND	.052	.019	.987
1981+	.023	.006	.250	.015	.004	.250	.080	.019	.370	.021	.007	.230	.086	.031	.600	.035	.008	.365
1989°	.058	.007	.346	<.05	.002	.295	.079	.027	.453	<.05	.008	.255	.125	.054	.695	<.05	.008	.599
1993@	.037	.025	.306	.041	.017	.252	.139	.057	.517	.059	.027	.224	.135	.061	.719	.062	.028	.474
1994@	.068	.029	.472	.053	.023	.258	.117	.051	.320	.089	.047	.192	.209	.071	.649	.101	.040	.577

* Data source EPA (1977), + Data source Zimmer (1983), ° Data Source Entranco (1991), @ Data source DEQ (1993 and 1994) total phosphorus (TP), dissolved phosphorus (DisP), total nitrogen (TN)

B.2.3 Watershed Soils

Local soil characteristics and erosion of surface materials can have a significant impact on the phosphorus loading rates of a watershed. Limited preliminary analysis by DEQ suggests that eroding soils throughout the watershed may contribute more than 60% of the estimated phosphorus load to Cascade Reservoir. Local citizens and land managers have expressed concern that soils are a naturally high source of phosphorus.

DEQ is currently conducting soil monitoring in the Cascade Reservoir watershed. The importance of soil nutrient storage and its impact on Cascade Reservoir water quality is poorly understood. Soils, under varying environmental conditions act as either a source or sink for nutrients suspended or dissolved in the water column. As nutrient concentrations in the water column increase, lake sediments typically become saturated with nutrients, reaching an equilibrium with concentrations in the overlying water. Through diffusion and other biogeochemical processes (changes in pH, redox potentials, iron and aluminum oxidation states, etc.), these nutrients may later be released from saturated sediments, increasing availability of limiting nutrients in the water column (Bostrum, 1982; Holman, 1988; Martinova, 1993; Driscoll, 1993). The bioavailability, rate and amount of soil nutrients released in this manner have a significant impact on algal productivity and other ecological linkages within the reservoir.

B.2.4 Status and Attainability

Water quality of Cascade Reservoir is impaired due to an abundance of nutrients and sediment entering the reservoir through the many creeks, streams and overland runoff. Influx of excess nutrients and sediment have altered the ecology of the reservoir effecting complex chemical and biological processes, cycling of nutrients within the reservoir and changes in the composition and production of algae and aquatic plants. These changes are further amplified by climatic conditions which affects the quantity of water available to the reservoir. Operational changes in storage, release of water from the reservoir and diversion of local streams for irrigation purposes also impact the quantity of water available to the reservoir.

The DEQ has adopted water quality standards through the Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 16.01.0200 et seq). These standards are designed to protect designated beneficial uses of surface waters and establish criteria for continued support and protection of these uses. Beneficial uses for Cascade Reservoir include domestic and agricultural water supply, cold and warm water biota, salmonid spawning, and primary/secondary contact recreation. General Surface Water Quality Criteria have been incorporated within the standards (IDAPA 16.01.0200 et seq.) to provide further narrative guidelines for beneficial use protection of surface waters. Table B.3 lists the status of these criteria as they currently relate to Cascade Reservoir. Due to repeated violations of water quality standards, Cascade Reservoir was designated as a Stream Segment of Concern in 1989 (Dunn 1990) and listed with the U.S. EPA as a water quality limited waterbody under Section 303(d) of the Federal CWA.

B.2.5 Other Watershed Streams

Other tributary streams draining to Cascade Reservoir exhibit varying levels of impairment due to violations of one or more State Water Quality Standards related to temperature, sediment, and nutrients. This plan is intended to ensure that water quality standards are attained in Cascade Reservoir as well as its tributaries. Table B.4 lists the status Cascade Reservoir and its tributaries with regard to state water quality standards.

Table B.3. General Surface Water Quality Criteria; narrative standards applicable to gauging status protection of beneficial uses for Cascade Reservoir.

General Water Quality Standards and Narrative Guidelines	Status in Support of Beneficial Uses
Excess Nutrients Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated or protected beneficial uses.	Excess nutrients frequently available causing nuisance growth of algae and aquatic plants.
Floating, Suspended or Submerged Matter Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may adversely affect designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities.	Standard frequently exceeded due to chronic algae blooms.
Oxygen Demanding Materials Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition.	Standard frequently exceeded due to presence of excess organic matter (algae).
Biological Criteria Surface waters of the state shall be of adequate quality to support aquatic species without detrimental changes in the resident biological communities. This condition shall be determined by monitoring of indicative flora or fauna as established by the Department. This information may be used in conjunction with appropriate chemical, physical, habitat structure, and microbial measurements.	Standard frequently exceeded due to growth of undesirable species of algae and aquatic plants

Table B.4. Status of local streams draining to Cascade Reservoir based on general surface water quality criteria. Compliance with numerical water quality criteria are designated as X=meets standards, O= occationally exceeds standards, E=generally exceeds standard, and C=chronically exceeds standards. Blanks denote condition is unknown.

Status of Stream Compliance with Numerical Guidelines					
Stream Name	Primary Contact Recreation [1]	Secondary Contact Recreation [2]	Dissolved Oxygen - Cold Water Species 6.0 mg/l	pH 6.5 - 9.5	Temp Cold Water Biota 22°C max daily avg 19°C
Cascade Reservoir^	X	X	O	C	E
MAJOR TRIBUTARIES					
*Gold Fork (Headwaters to Reservoir)	X	X	O	X	O
*Lake Fork	X	X	O	X	O
Boulder Creek	X	X	C	X	O
*Willow Creek	O	O	C	X	O
*N.Fork Payette River (Big Payette Lake to Cascade Reservoir)	O	X	X	X	O
*Mud Creek	E	E	C	X	O
*Poison	O	O	X	X	X
*Van Wyck	X	X			X
*Deer	E	E			X
French					
*Silver					X
*Cambell	O	X			C
Wolf Pasture	X	X			
Trib S Silver					
*Hazard	E	E			
2nd Trib N Cambell					
2nd Trib N Gibson	E	E			
2nd Trib N Hazard	O	X			

The streams marked with an * have been surveyed through the DEQ Beneficial Use Reconnaissance Program in 1994 and 1995 for beneficial use attainability and use status. Data interpretation, beneficial use attainability and status of these streams is preliminary at this time pending formal DEQ policy resolution. The Boulder Creek assessment was performed by DEQ from 1992 through 1994 in cooperation with the VSWCD.

^ Monitoring only reflects deep water starions and does not include near shore conditions.

[1] Coliform Bacteria 500/100 ml at any time; 200/100 ml in more than 10% of samples in 30 days; geometric mean of 50/100 ml form 5 samples over 30 day period.

[2] Coliform Bactera 800/100 ml at any time; 400/100 ml in more than 10% of the total samples taken over a 30 day period; and a geometric mean of 200/100 ml based on a minimum 5 samples taken over a 30 day period

B.3 Point Source Impacts

Concentrations of phosphorus, nitrogen and suspended solids measured in the City of McCall WWTP effluent vary seasonally (Figure B.14) and typically exceed ambient concentrations in the North Fork Payette River (Table B.5). Dissolved ortho-phosphorus in the effluent accounts for >90% of the total phosphorus discharged with concentrations ranging from 1.0 to 6.0 mg/l.

Figure B.14. Seasonal distribution of phosphorus and ammonia concentrations in the City of McCall waste water effluent.

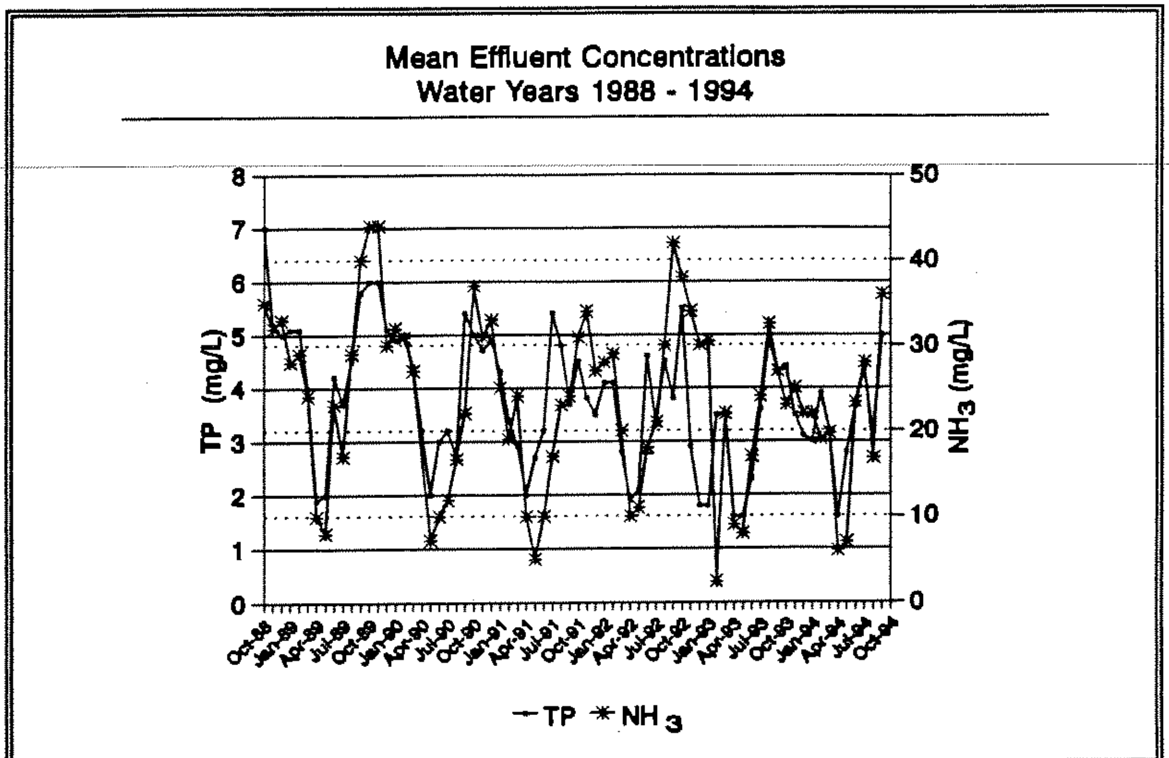
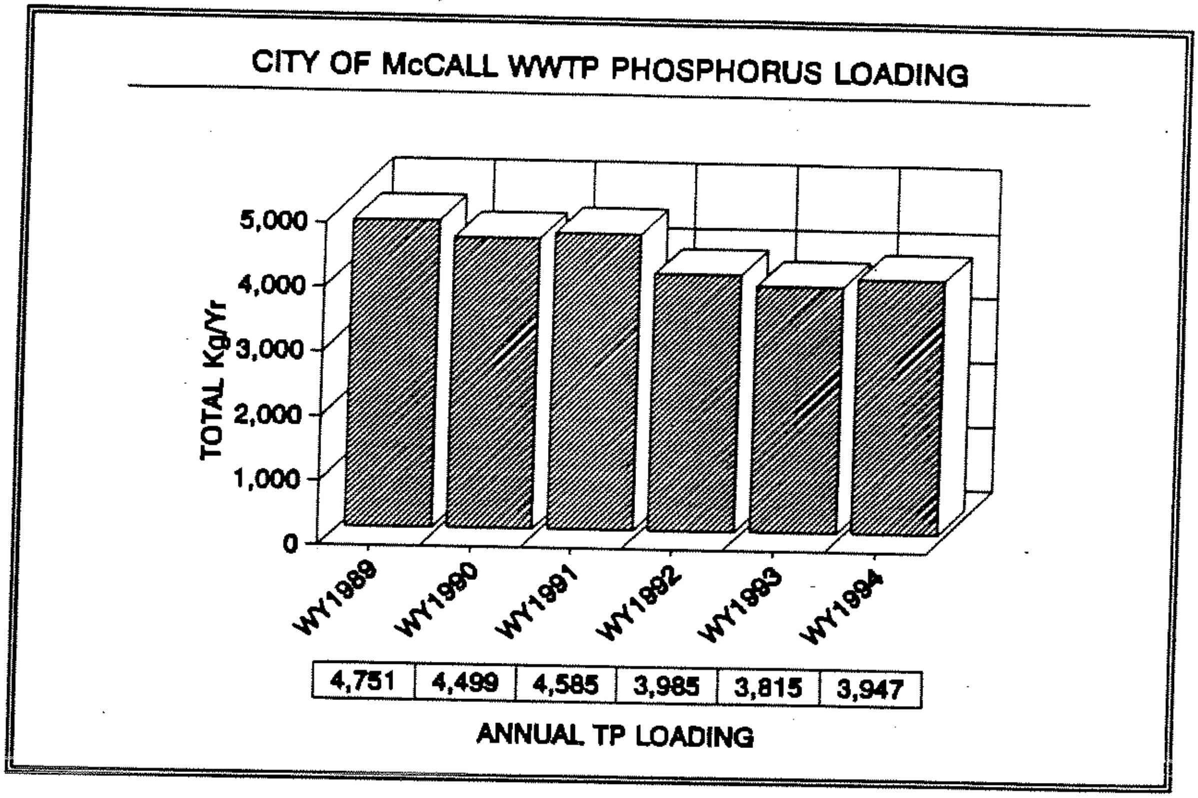


Table B.5. Average ambient and (range) of nutrient concentrations and other water quality parameters from the North Fork Payette River upstream of the City of McCall WWTP.

Year (Period)	TN mg/l	TP mg/l	Ortho PO_4 mg/l	Total Coliform #/100 ml	Data Source
1975 Avg. (May-Oct)	NR	NR	0.016 (<0.005-0.065)	39 (1-200)	Clark & Wroten, 1975
1981 Avg. (Annual)	NR	0.005 (0.004-0.006)	0.002	NR	Zimmer, 1983
1988 Avg. (July-Sept)	0.194	<0.05	0.001 (0.001-0.004)	NR	Ingham & Boyle, 1991
1994 Avg.		0.005			Worth, 1994

Annual loading rates were computed for the WWTP during surveys conducted by EPA (EPA, 1977) and the BOR (Zimmer, 1983) prior to routine monitoring of effluent quality. These studies reported 1,520 kg phosphorus and 1,780 kg phosphorus were contributed by the WWTP in 1974 and 1981, respectively. Annual loading contributions have increased concurrent with an increase in population and recreational use but have remained stable since 1988 (Figure B.15).

Figure B.15. Annual Total Phosphorus loading City of McCall Waste Water Treatment Plant (Water Years 1989-1994).



A comparison of total phosphorus concentrations from the fish hatchery influent and effluent monitoring suggest there are no differences in concentrations after passing through the hatchery prior to 1994 (Table B.6). This may be the result of poor analytical sensitivity due to high detection limits used during this reporting period (≥ 0.05 mg/l). Differences in concentrations were reported following changes in analytical sensitivity (TP detection limits <0.05 mg/l) in November 1994. These differences, however, have been mitigated by substitution of lower phosphorus fish feed and modifications in feeding practices (personnel communication Don Anderson, IDFG).

Table B.6 Comparison of fish hatchery nutrient influent and effluent quality.

Date		Tot. Diss. Solids (mg/l)(mg/l)	NO_3-N (mg/l) (mg/l)	NH_3 (mg/l)	TKN-N	TP
TP food content 1.7% by weight						
4/29/75	(i)	----------------	data not	reported NR	----------------	----------------
	(e)	18.3	0.03	NR	NR	≤0.05
11/25/91	(i)	NR	0.10	0.05	0.10	≤0.05
	(e)	NR	0.27	0.05	2.50	≤0.05
Post diet change - TP food content reduced to 1.2% by weight						
10/12/93	(i)	NR	0.10	0.05	0.10	≤0.05
	(e)	NR	0.10	0.05	0.10	≤0.10
Post diet change - TP food content reduced to 0.7% by weight						
8/18/94	(i)	NR	NR	NR	NR	≤0.05
	(e)	NR	NR	NR	NR	≤0.05
10/03/94	(i)	NR	NR	NR	NR	0.23*
	(e)	NR	NR	NR	NR	0.05
10/04/94	(i)	NR	NR	NR	NR	0.05
	(e)	NR	NR	NR	NR	0.05
11/21/94	(i)	NR	NR	NR	NR	0.02
	(e)	NR	NR	NR	NR	0.03
11/22/94	(i)	NR	NR	NR	NR	≤0.01
	(e)	NR	NR	NR	NR	0.03
2/22/95	(i)	NR	NR	NR	NR	0.02
	(e)	NR	NR	NR	NR	0.03

* High turbidity reported in Big Payette Lake due to storm.

B.4 Methods to Interpret Water Quality Data

B.4.1 Statistical Methods

Although the previous review of data sources would suggest a large data base of reservoir and tributary conditions exist, monitoring data has in fact been sporadic and lacking in consistency of collection over complete water years, temporal scale and analytical levels of precision. These factors may unduly influence specific application of a statistical analysis of trends in the data or related analysis normally applied to a set of time series water quality data (Reckhow 1993). Further refinement of the data will be required before statistical measures of the general trends in reservoir or tributary water quality can be ascertained.

Sufficient data is available to aggregate information describing some limited seasonal and annual trends in reservoir water quality. Temporal and spatial data are analyzed and compared with previous studies conducted by the BOR and DEQ. These studies provide the comparable monitoring of nutrients, biological productivity and limnological characteristics at equivalent monitoring stations.

B.4.2 Water and Nutrient Budgets

The net flux and change in export of nutrients associated with land use activities within the Cascade Reservoir watershed is highly variable. Sufficient data is available to establish an estimated accounting of total nutrients and water entering Cascade Reservoir which identifies various nonpoint sources such as surface erosion, irrigation return flows and ground water. This accounting of nonpoint sources is discussed in more detail in Section 3. Continued monitoring as part of this phased Watershed Management Plan will be required to 1) verify annual contributions from all sources, 2) modify the nutrient budget as appropriate and 3) determine overall effectiveness of state, federal and local efforts to achieve load reduction goals. Information from this effort will subsequently be used to target specific subwatersheds for implementation of BMPs and other improvements to reduce nutrient loading.

Data collected by the EPA in 1975 (EPA, 1977), provide the earliest estimates of the water and nutrient budgets for Cascade Reservoir. Similar data exist for 1981 (Zimmer, 1983), 1989 (Entranco, 1991) and from monitoring conducted by DEQ in 1993 and 1994. These data provide information about nutrient loading contributed by the subwatersheds under a range of climatic conditions. The expected nutrient loading for average annual rainfall conditions will be used as baseline conditions for present watershed contributions. Although 1989 was a near normal water year at 98% (SNOTEL - NRCS, 1989), runoff patterns were abnormal. Therefore, 1989 was not appropriate to be used as a baseline water year. The 1993 water year was 116% (SNOTEL - NRCS, 1993) of normal precipitation. Precipitation patterns were not normal during the 1993 water year, and previous water years were drought years. Both of these conditions may have affected phosphorus loads relative to a "norm". With these factors in mind, an arithmetic average of four years, 1981, 1989, 1993 and 1994 is currently being utilized as baseline. As we learn more about phosphorus cycles in the watershed and the effects of drought and variations in the annual rainfall patterns on phosphorus loads, we may choose a different baseline. Future loading will be compared to baseline to determine the effectiveness of efforts to reduce external inputs of nutrients to Cascade Reservoir.

B.4.3 Trophic State Index

A trophic state index similar to the Carlson Index (Carlson, 1977) is used to integrate measures of chlorophyll a, Secchi transparency and total phosphorus concentrations. Changes in this index over time will be analyzed to ascertain trends in reservoir response to nutrient loading. Adjustments will be made to account for higher turbidity and water color experienced in Cascade Reservoir.

Because of the importance of DO to fisheries and its influence on the anaerobic release of nutrients from reservoir sediments, a net DO index will be computed on a seasonal basis and compared annually (Welch, 1989; Welch, 1992). This information will reveal when conditions are suitable for release of nutrients from the sediments that may impact DO and the fishery.

B.4.4 Lake Response Models

DEQ is utilizing predictive models to evaluate various nutrient loading scenarios to changes in the biological productivity and water quality of Cascade Reservoir. Models are often used in the TMDL process as a guide to determine loading capacity of a waterbody and whether efforts are adequate to achieve a desired standard for improvement of water quality. These models are also useful in establishing a frame of reference for estimating how quickly water quality improvements may occur in response to reductions of external loading. Several modeling efforts are needed for Cascade Reservoir to further address questions concerning affects of reservoir operations on water quality (selective withdrawal), importance of internal recycling of nutrients, and to predict changes in water quality related to annual variability of water inflows, nutrient loadings and reservoir drawdown.

A computer simulation model was previously developed for Cascade Reservoir in 1990 (Chapra, 1990). The Cascade Model is a one-dimensional but vertically segmented to represent stratified and mixed conditions. This earlier model provides some simulation capability to evaluate reservoir water quality in response to external nutrient loading and internal recycling of nutrients (phosphorus). Utility of this model has been limited due to the lack of available data required to refine aspects of the model dealing with reservoir operation, sediment dynamics and variability in annual loading rates. The University of Colorado is currently developing a refined version of this model for DEQ that will incorporate the above additional flexibility. This model will be available for Phase II of the plan in the fall of 1996.

A second model developed by the Tennessee Valley Authority (BETTER MODEL, Bender, 1990) for use in reservoirs is currently being adapted for use with Cascade Reservoir. The BETTER model is a more rigorous two dimensional model providing spatial and temporal segmentation of reservoir water quality conditions. Spatial analysis of the differences in reservoir water quality will provide important information concerning reservoir response to incremental changes in water quality improvements. The model has been designed to reproduce observed seasonal patterns of temperature, DO, nutrients, pH and algal biomass based on changes in external nutrient loading. A weakness of this model is the inability to modify reservoir water quality based on sediment interactions, which is particularly critical to Cascade Reservoir. This deficiency will be corrected by the inclusion of a model code that will describe sediment interactions similar to those used in the Cascade Model.

Combined simulations of both models will be used as a basis for describing reservoir response to changes in nutrient loading. Use of both models will enhance reliability of water quality results and reduce the potential uncertainty in selection of management alternatives by reliance on a single model simulation.

Additional modeling capabilities may be needed in the future to assess changes in hydrology and nutrient transport within the watershed. An expanded capability to simulate watershed nutrient and water transport would provide better information to analyze and characterize effectiveness of various BMPs.

APPENDIX C

ADDITIONAL CASCADE WATERSHED DATA

1. INLAKE WATER QUALITY DATA

2. SUBWATERSHED SOILS AND HYDROGRAPHY

3. SUBWATERSHED SOILS EROSION SENSITIVITY AND HYDROGRAPHY

4. PHOSPHORUS AND WATER BUDGET CALCULATIONS FOR WY 1993 AND WY 1994

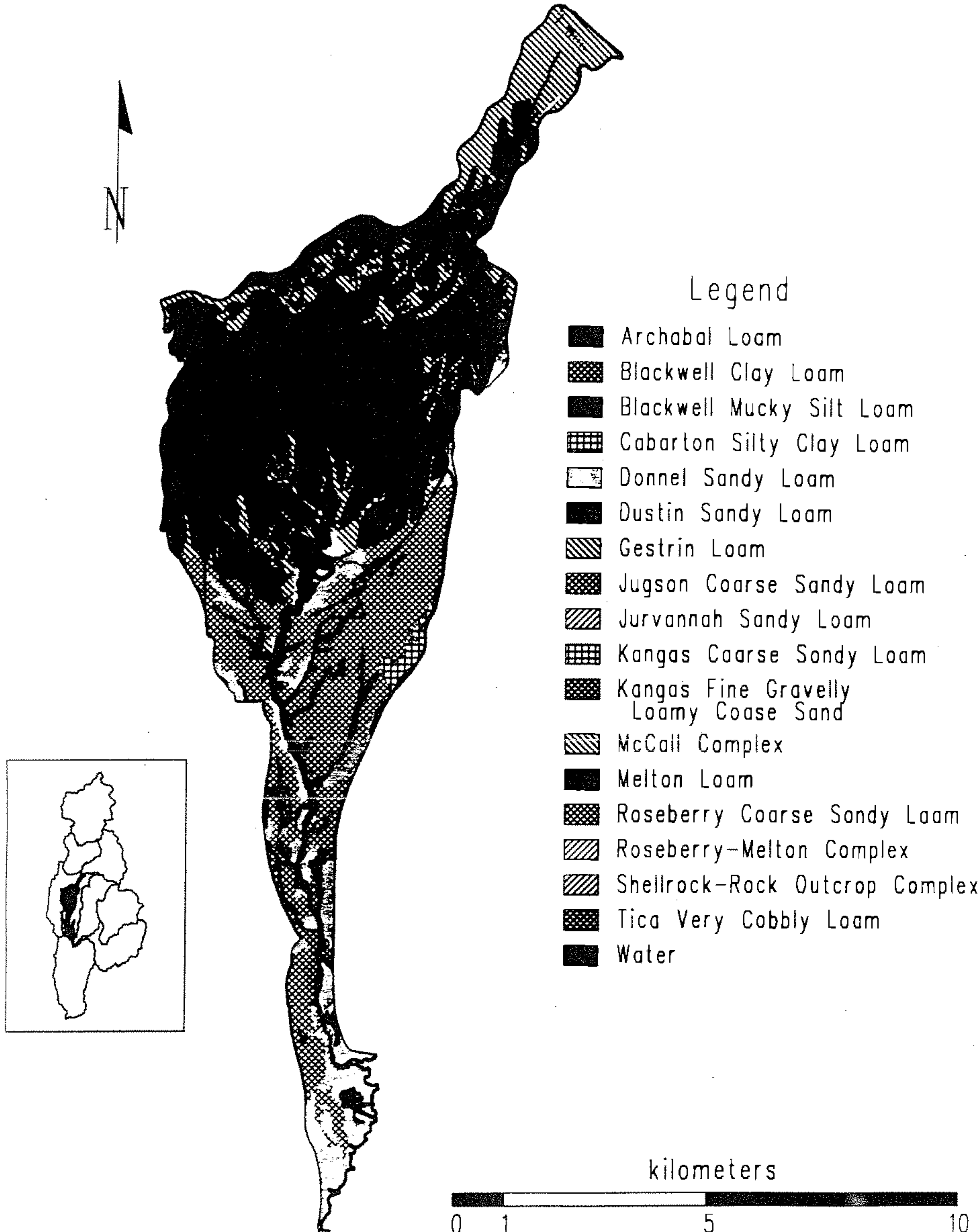
Annual summary of Cascade Reservoir water quality for the period of record 1974 - 1994, excluding 1977 (no data).

	1 TURB	2 SECCHI	3 PH	4 NH3 N	5 NO2	6 NO3	7 KJDL	8 KJDL	9 NO3	10 TOT P	ERR DIS oP	ERR CHLa
1985												
Mean		1.9	6.1	0.013			0.465		0.000	0.028	0.004	21.0
Max		2.6	6.3	0.020			0.590			0.036	0.006	30.9
Min		1.2	6.0				0.360			0.022	0.002	15.7
1986												
Mean		1.8		0.020			0.437		0.000	0.041	0.005	18.1
Max		2.7		0.050			0.630			0.078	0.008	42.5
Min							0.240			0.014	0.002	5.4
1987												
Mean		1.4		0.001			0.879		0.000	0.055	0.011	44.3
Max		4.2		0.010			2.820			0.120	0.018	228.0
Min							0.330			0.006	0.006	6.4
1988												
Mean		1.1		0.012			[illegible]		0.000	0.065	0.001	38.0
Max		1.4		0.040			0.530			0.100	0.004	49.0
Min		0.8					0.400			0.043		27.0
1989												
Mean		1.7	7.1	0.000			0.408		0.000	0.035	0.007	14.0
Max		2.1	7.5				0.480			0.042	0.012	22.2
Min		1.1	7.2				0.370			0.027		8.7
1990												
Mean	2.0	2.3		0.000			0.443		0.000	0.027	0.000	14.7
Max	3.0	2.9					[illegible]			0.035		22.1
Min	1.0	1.3					0.325			0.021		10.1
1991												
Mean	1.8	2.1		0.005			0.472		0.002	0.031	[illegible]	16.8
Max	2.0	4.5		[illegible]			0.710		0.010	0.050	[illegible]	33.4
Min	1.0	1.0		[illegible]			0.310			0.014		6.0
1992												
Mean	4.3	1.5		0.06[illegible]			0.790		0.00[illegible]	0.057	0.022	41.2
Max	8.0	1.8		0.290			1.140		0.03[illegible]	0.091	0.048	57.9
Min	3.0	0.9					0.490			0.048	0.010	14.0
1993												
Mean	3.2	1.9		0.023			0.591		0.076	0.132	0.019	18.7
Max	13.0	3.0		0.255			2.990		[illegible]	0.530	0.390	125.5
Min	1.0	0.7								0.025	0.003	1.4
1994												
Mean	2.7	1.3		0.029			0.603		0.022	0.058	0.013	11.5
Max	8.0	2.5		0.089			0.920		0.670	0.150	0.034	46.1
Min				0.005			0.290			0.017		

Annual summary of Cascade Reservoir water quality for the period of record 1974 - 1994, excluding 1977 (no data).

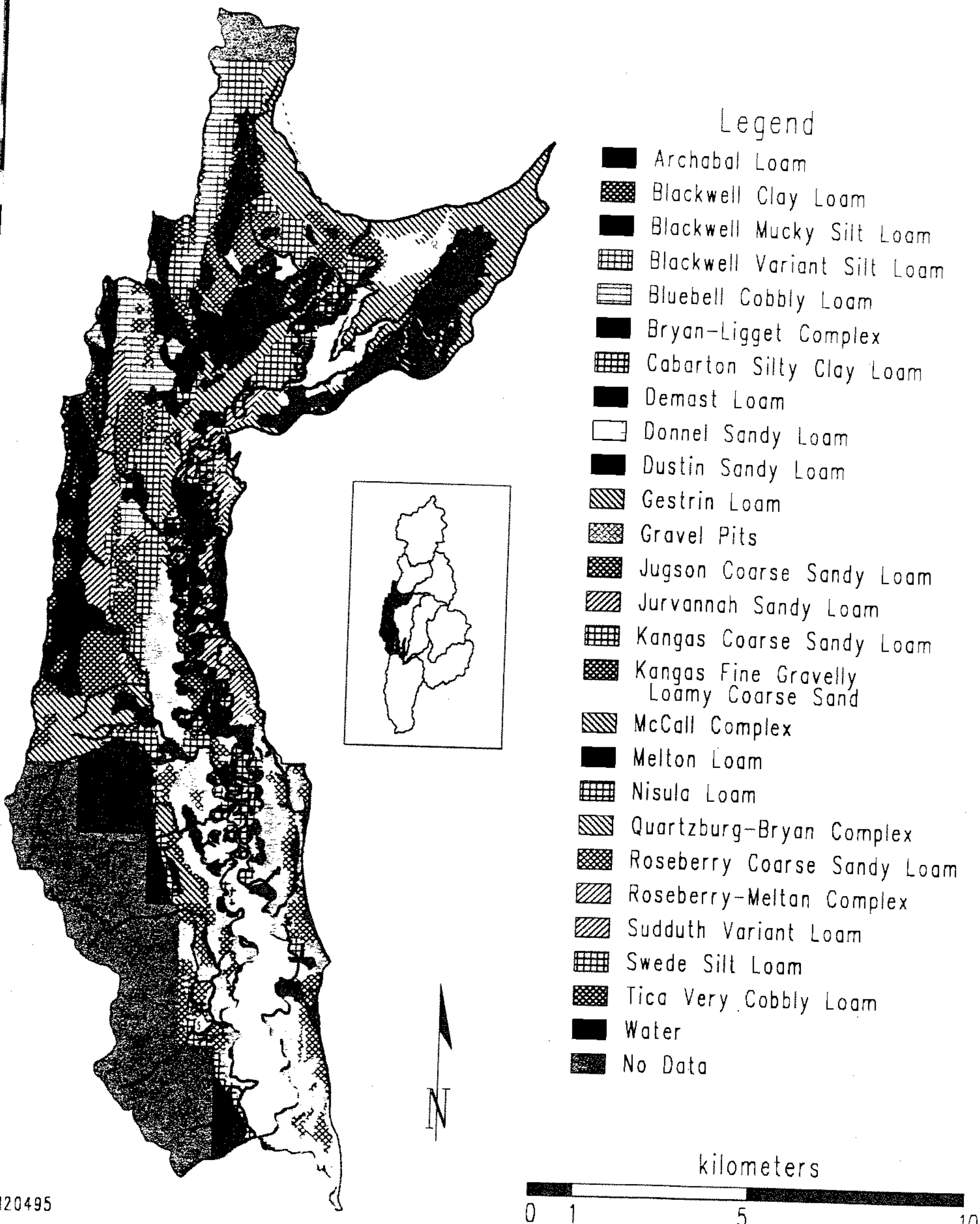
	1 TURB	2 SECCHI	3 PH	4 NH3 N	5 NO2	6 NO3	7 KJDL	8 KJDL	9 NO3	10 TOT P	12 DIS oP	13 CHLa
1974												
Mean	3.0		7.0	0.015	0.000	0.043		0.280		0.034	0.005	
Max	6.0		7.5	0.090		0.060		0.460		0.050	0.030	
Min	1.0		6.7			0.020		0.120		0.020		
1975												
Mean	2.4		7.1	0.012	0.000	0.042		0.314		0.031	0.014	
Max	7.0		7.5	0.090		0.100		0.580		0.070	0.060	
Min	1.0		5.9			0.020		0.190		0.010		
1976												
Mean	1.6		7.3	0.000	0.000	0.023		0.289		0.024	0.000	
Max	3.0		8.6			0.060		0.410		0.080		
Min			6.5					0.220		0.010		
1978												
Mean	2.8	1.6	8.2	0.007	0.000	0.023		0.730		0.054	0.004	55.7
Max	6.0	1.9	8.8	0.020		0.030		1.200		0.059	0.009	119.7
Min	1.0	1.0	7.5			0.010		0.420		0.047	0.001	15.4
1979												
Mean	1.8	1.8	7.1	0.031	0.000	0.039		0.319		0.042	0.009	12.0
Max	5.0	3.9	7.5	0.150		0.060		0.750		0.081	0.015	35.9
Min		0.9	6.5			0.010		0.170		0.008	0.001	0.7
1980												
Mean	1.5	2.7	7.3	0.0165	0.000	0.042		0.325		0.035	0.010	6.2
Max	2.0	3.8	7.7	0.060		0.060		0.540		0.065	0.023	11.9
Min	1.0	1.7	7.1			0.030		0.140		0.015	0.005	1.5
1981												
Mean		3.0					0.324		0.006	0.027	0.022	3.2
Max		[illegible]					0.590		0.020	0.062	0.004	13.2
Min							0.180			0.005		1.0
1982												
Mean		3.3		0.013				0.210	0.025	0.009	0.002	5.3
Max		5.3		0.02				0.230	0.100	0.012	0.006	[illegible]
Min		2.5		0.010				0.100		0.007	0.001	1.3
1983												
Mean		2.5	6.9	0.005			0.305		0.003	0.022	0.001	4.0
Max		4.3	7.0	0.023			0.330		0.010	0.029	0.002	10.0
Min		2.2	6.8				0.280			0.017		7.8
1984												
Mean		3.4		0.003			0.197		0.000	0.016	0.002	3.3
Max		4.2		0.010			0.290			0.023	0.002	5.9
Min		1.9					0.090			0.011	0.001	1.4

MUD CREEK SUBWATERSHED
Soils and Hydrography



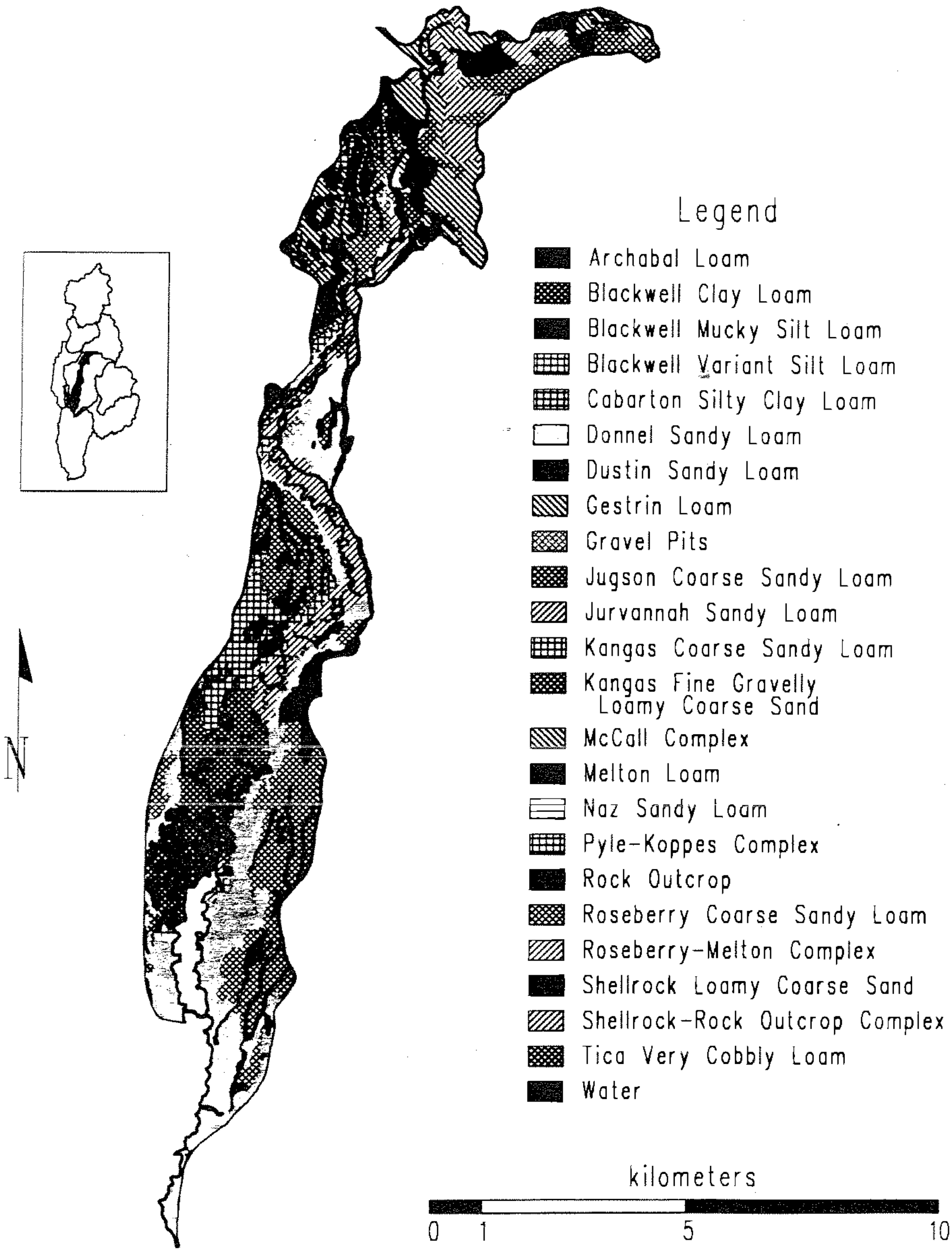
120495

NORTH FORK PAYETTE WATERSHED
Soils and Hydrography



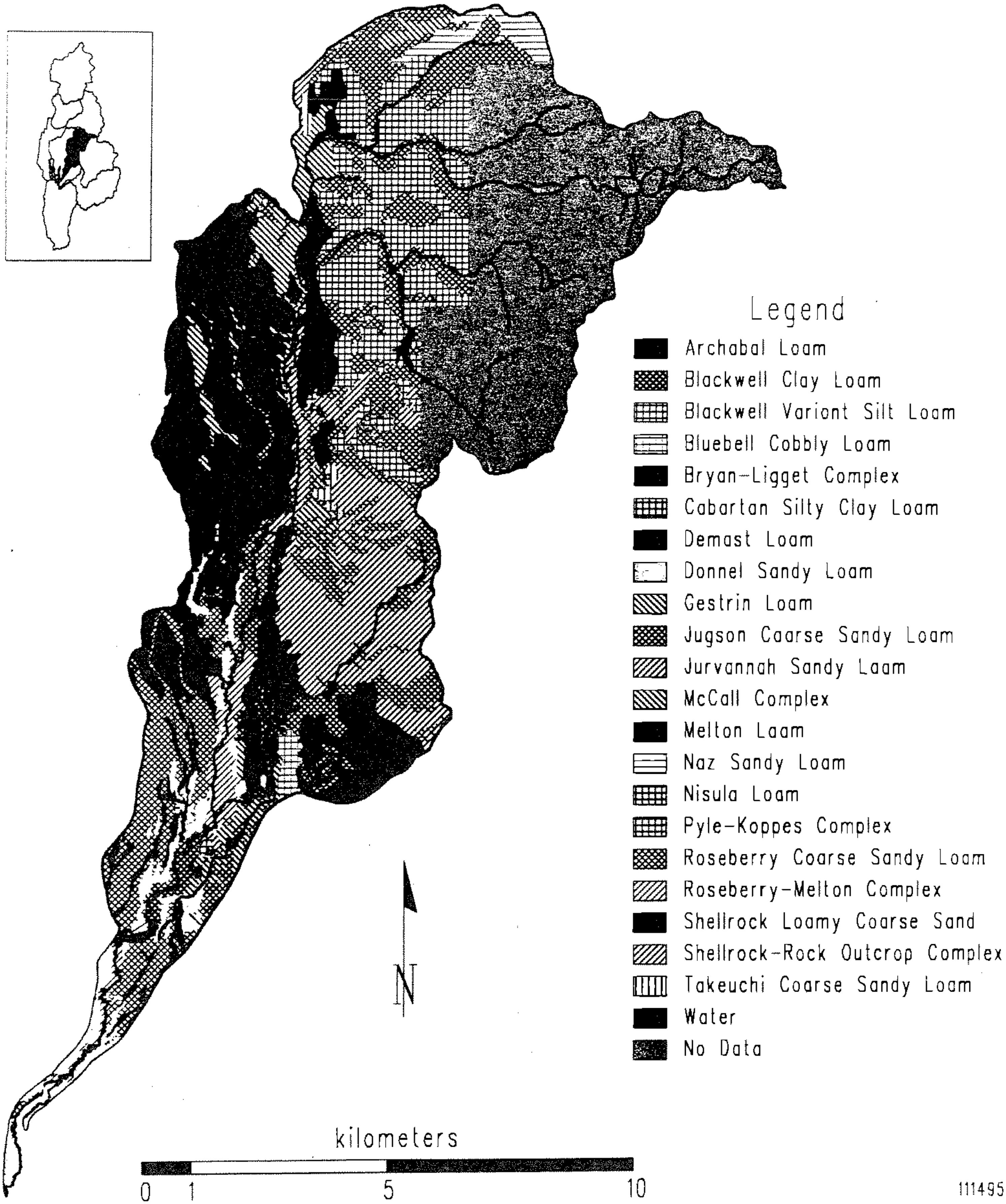
120495

LAKE FORK CREEK WATERSHED
Soils and Hydrography



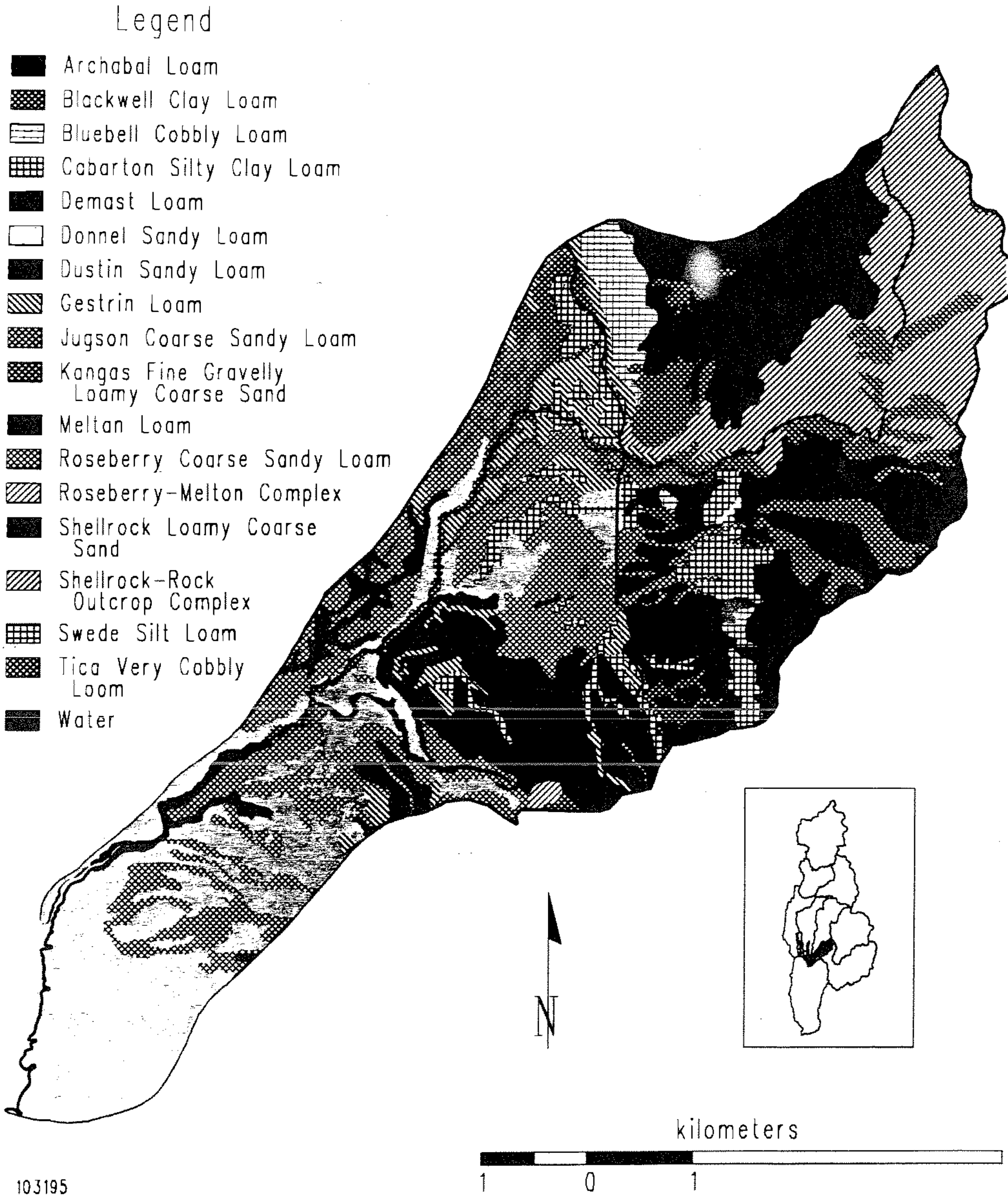
103195

BOULDER CREEK WATERSHED
Soils and Hydrography

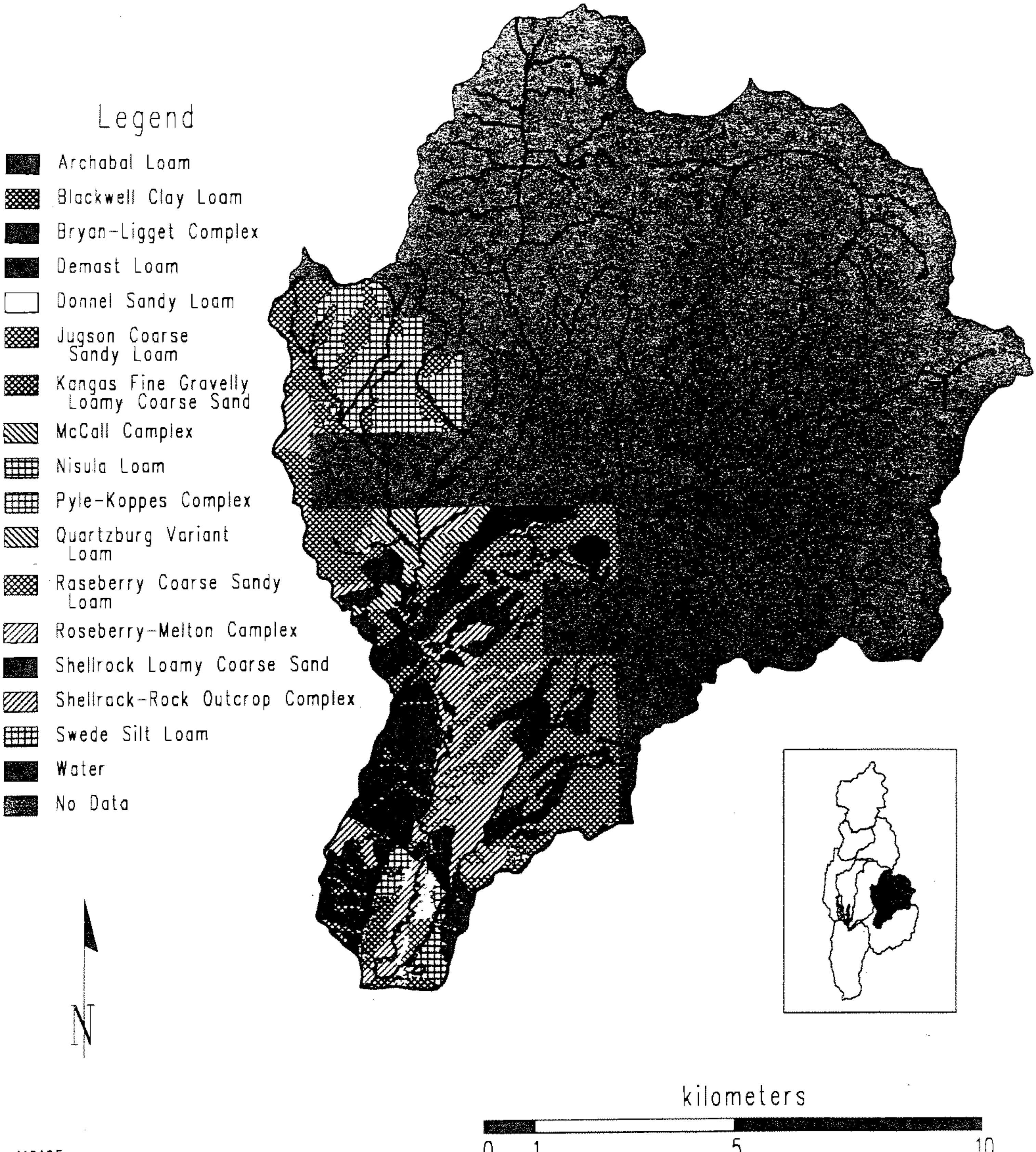


111495

WILLOW CREEK WATERSHED
Soils and Hydrography

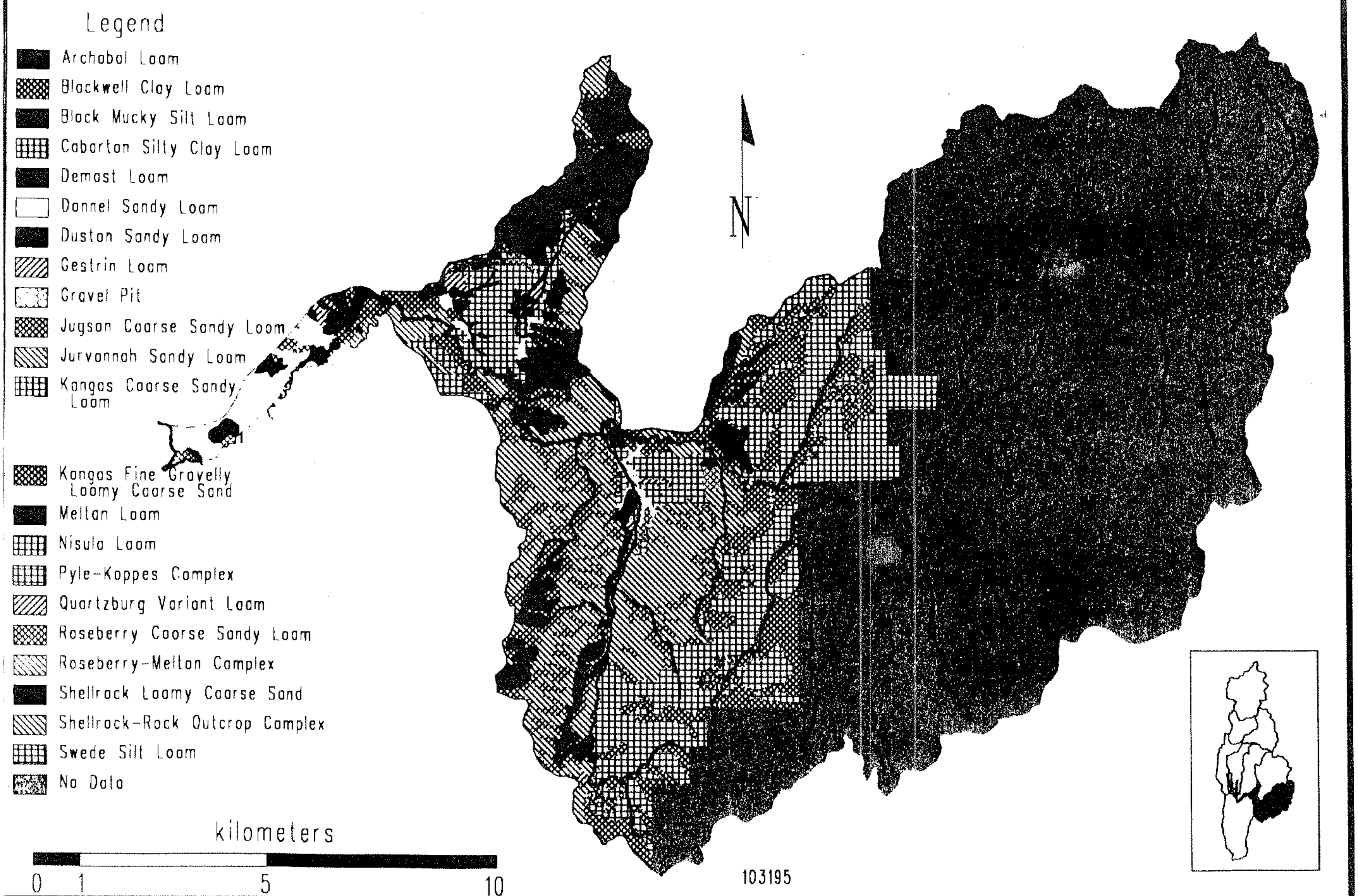


KENNALLY CREEK WATERSHED
Soils and Hydrography

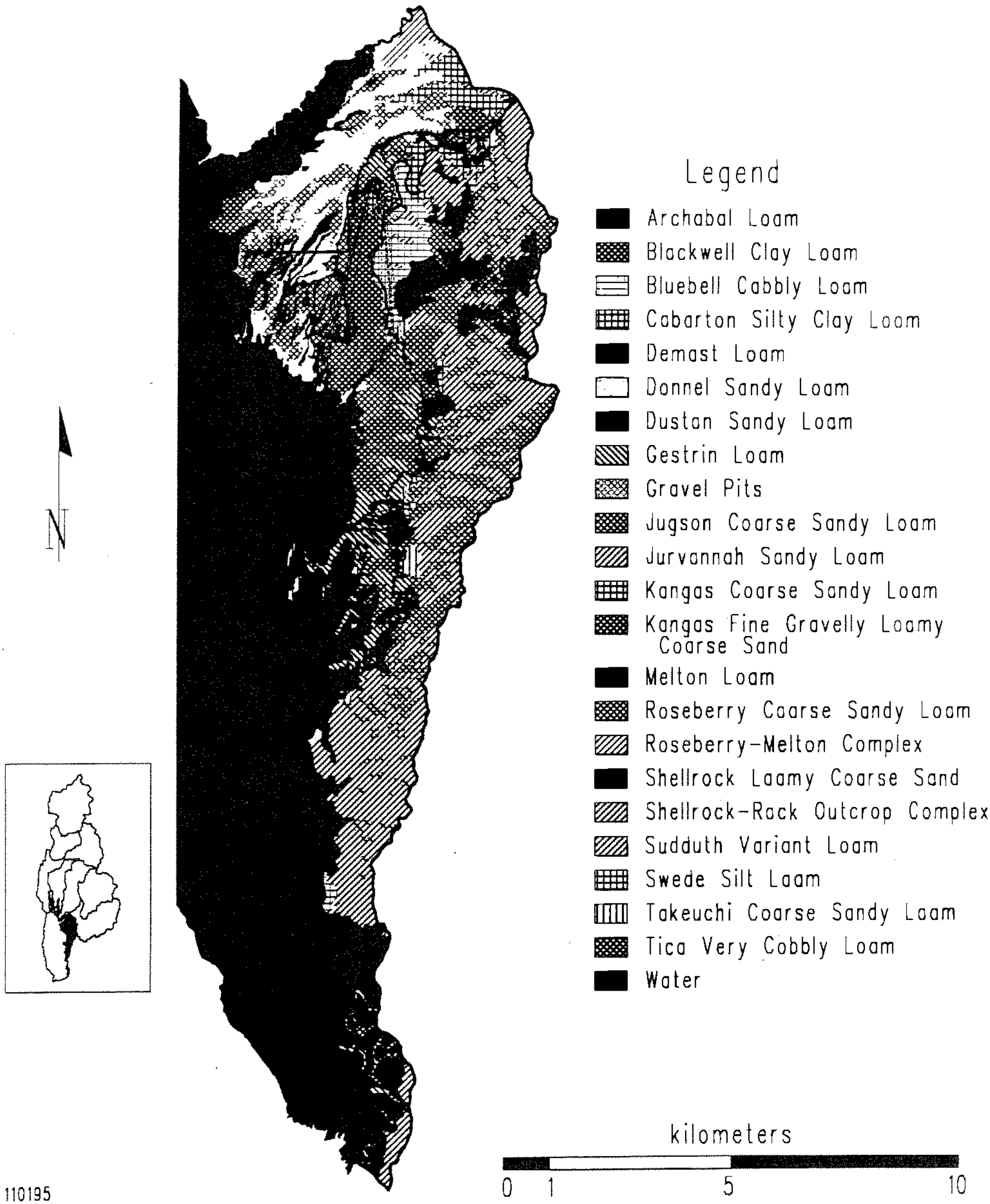


110195

GOLD FORK CREEK WATERSHED
Soils and Hydrography

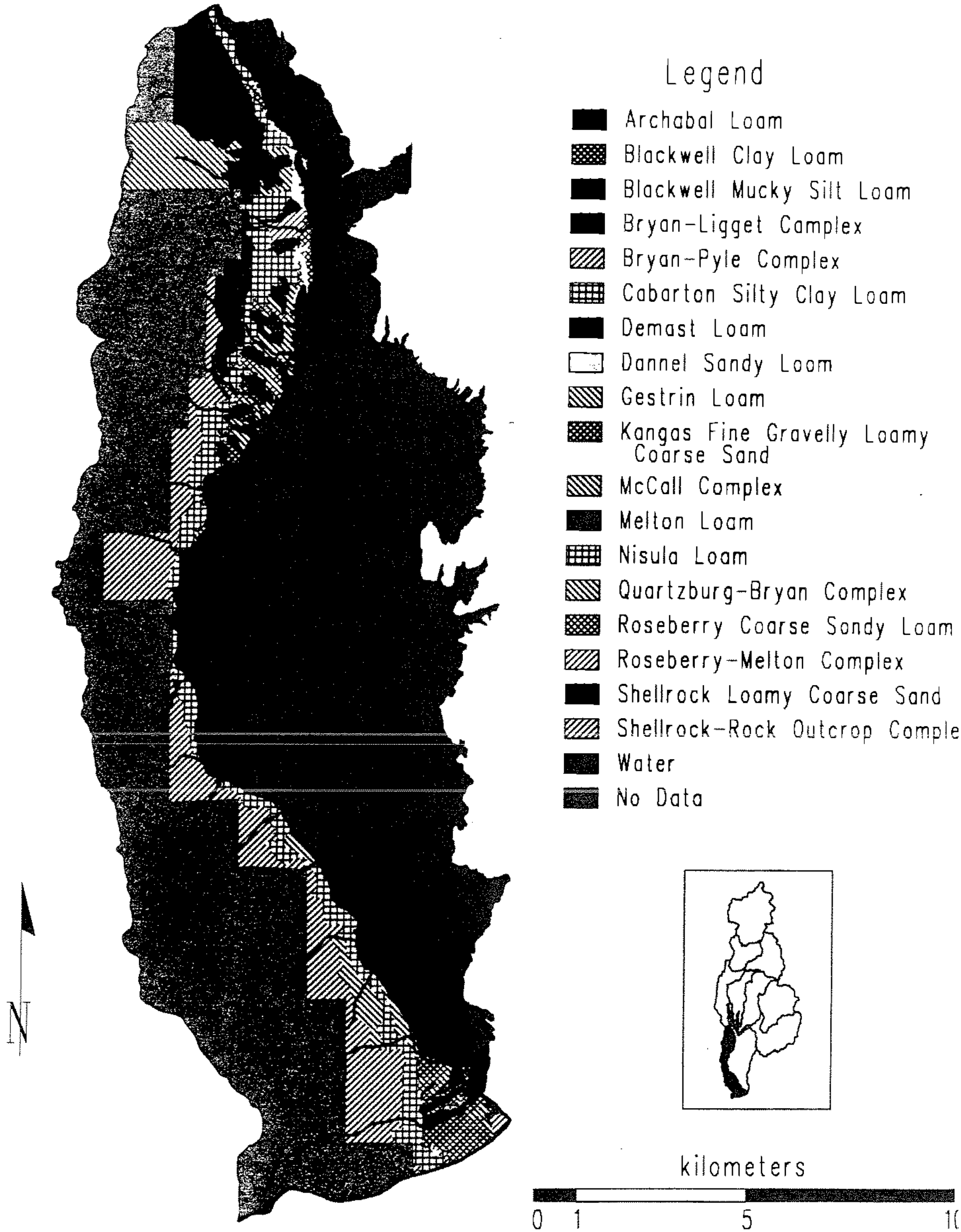


CASCADE WATERSHED
Soils and Hydrography



110195

WEST MOUNTAIN SUBWATERSHED
Soils and Hydrography



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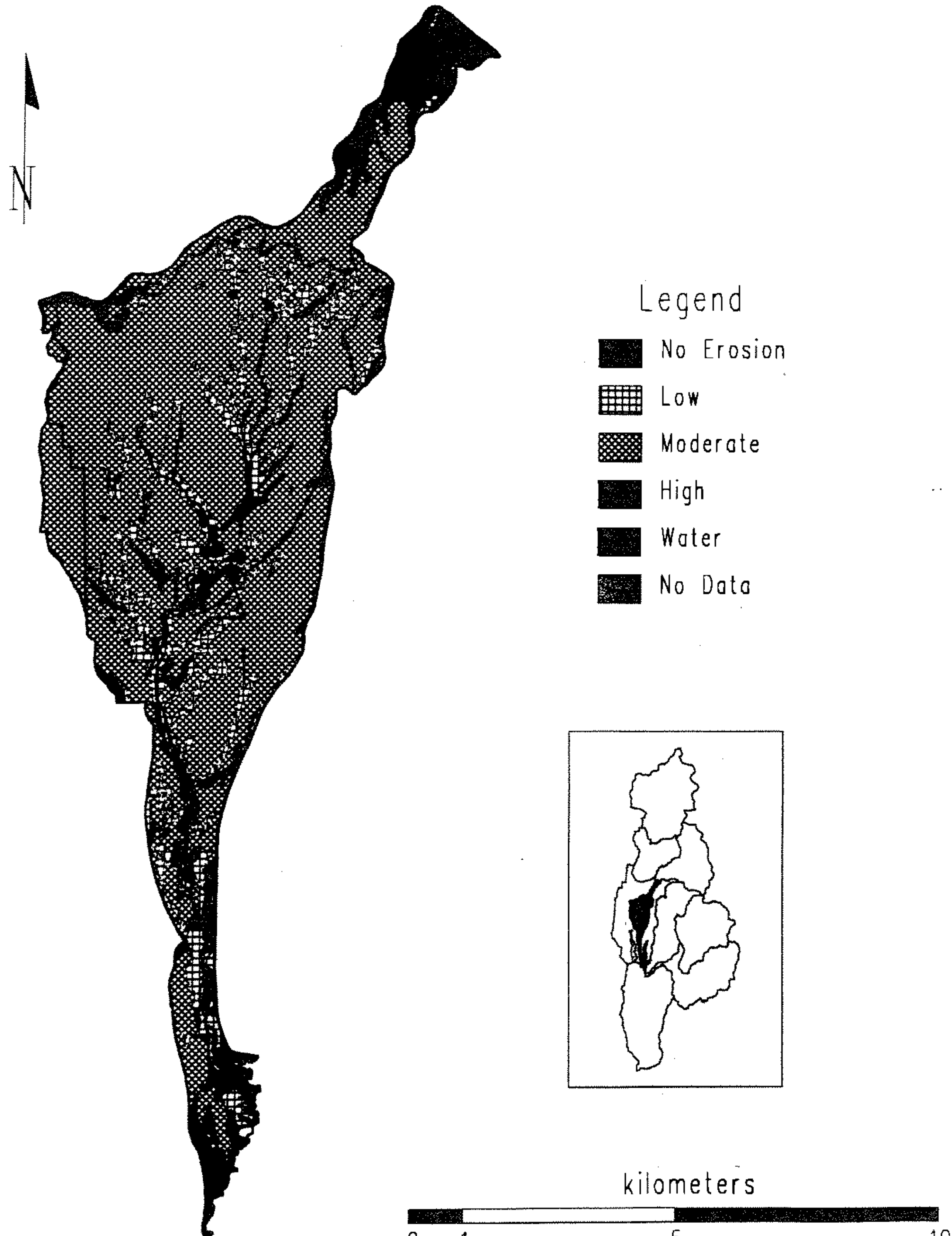
MUD CREEK SUBWATERSHED
Soils Erosion Sensitivity with Hydrography



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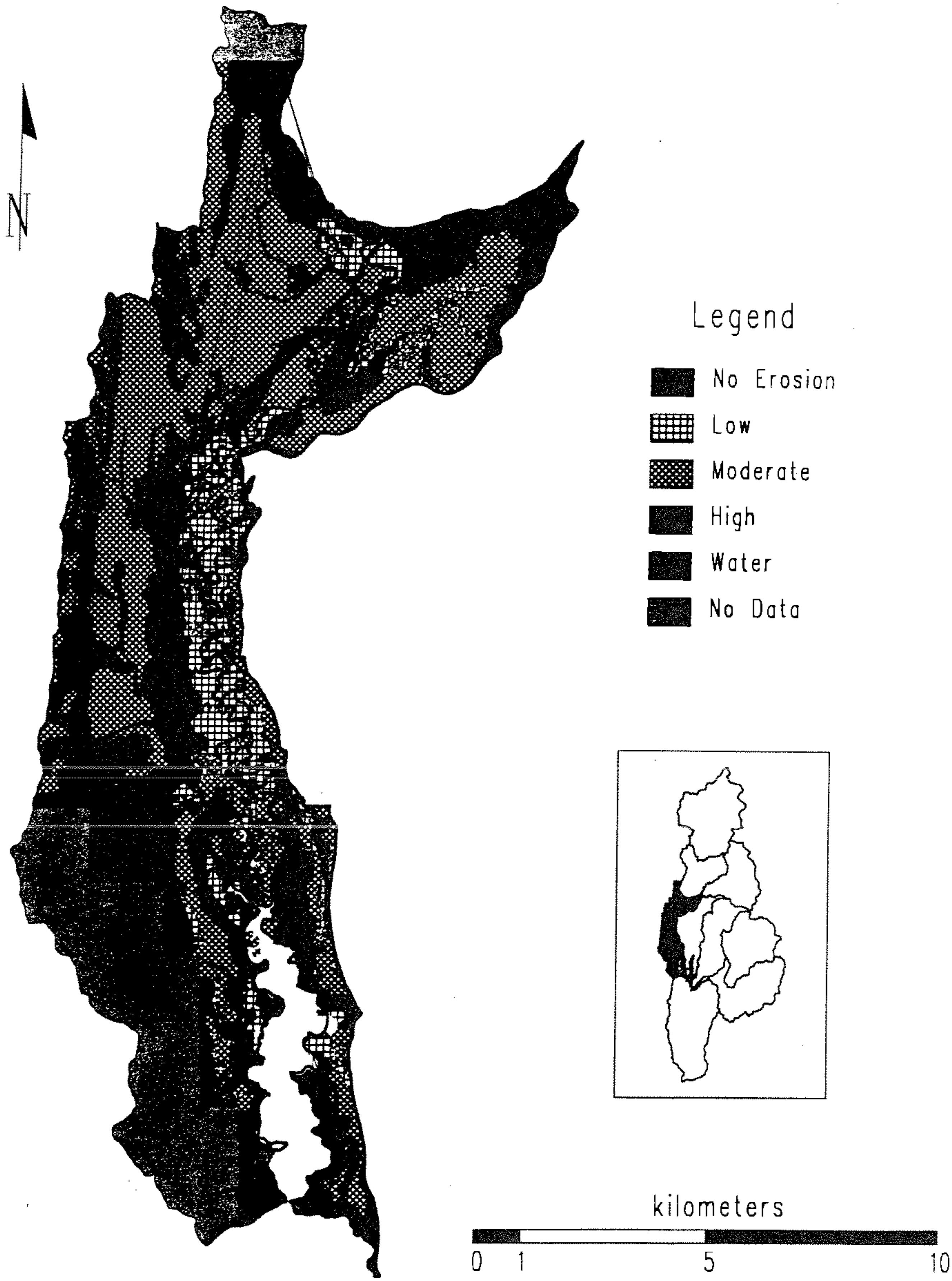
NORTH FORK PAYETTE WATERSHED
Soils Erosion Sensitivity with Hydrography



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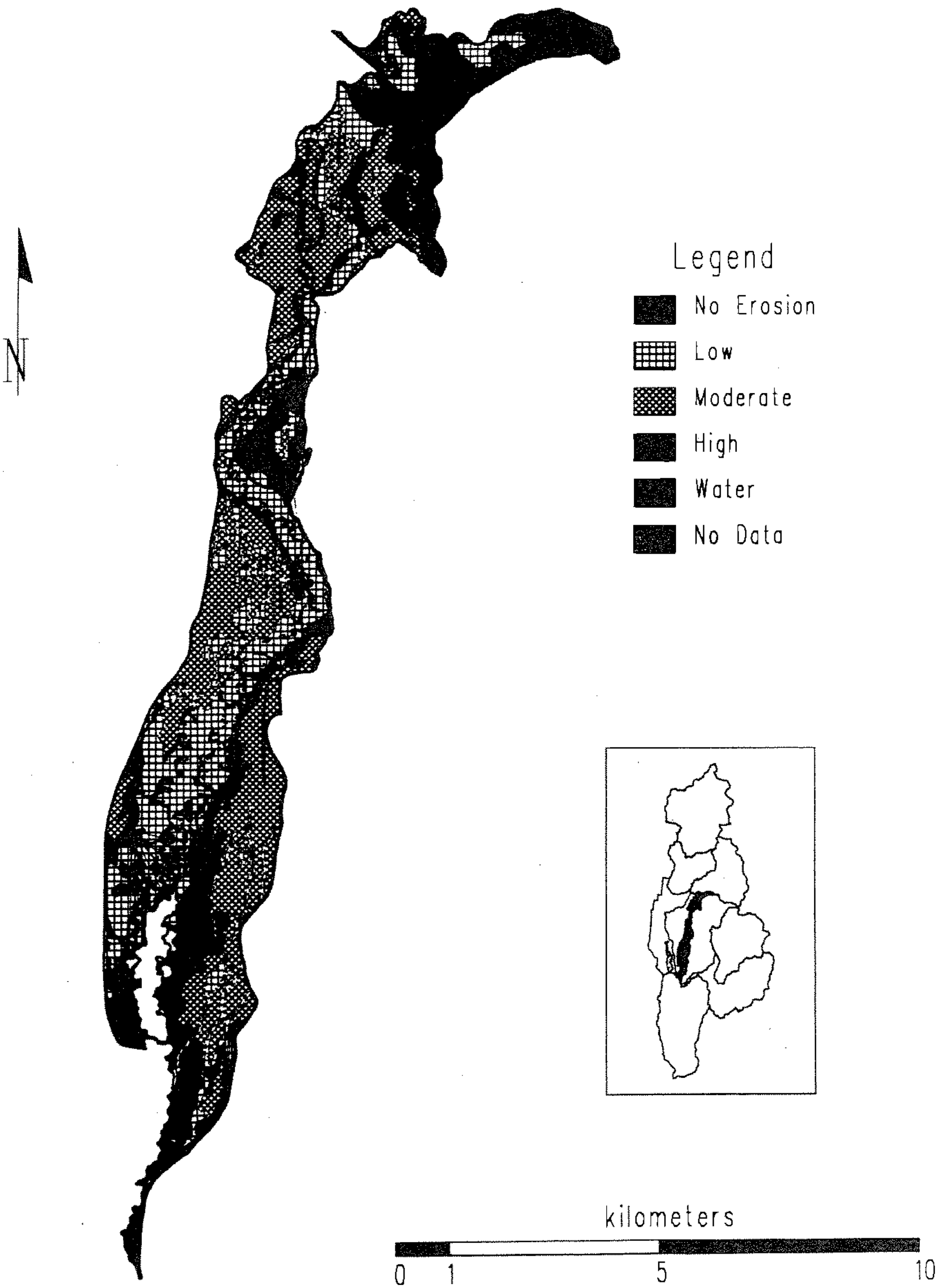
LAKE FORK CREEK SUBWATERSHED
Soils Erosion Sensitivity with Hydrography



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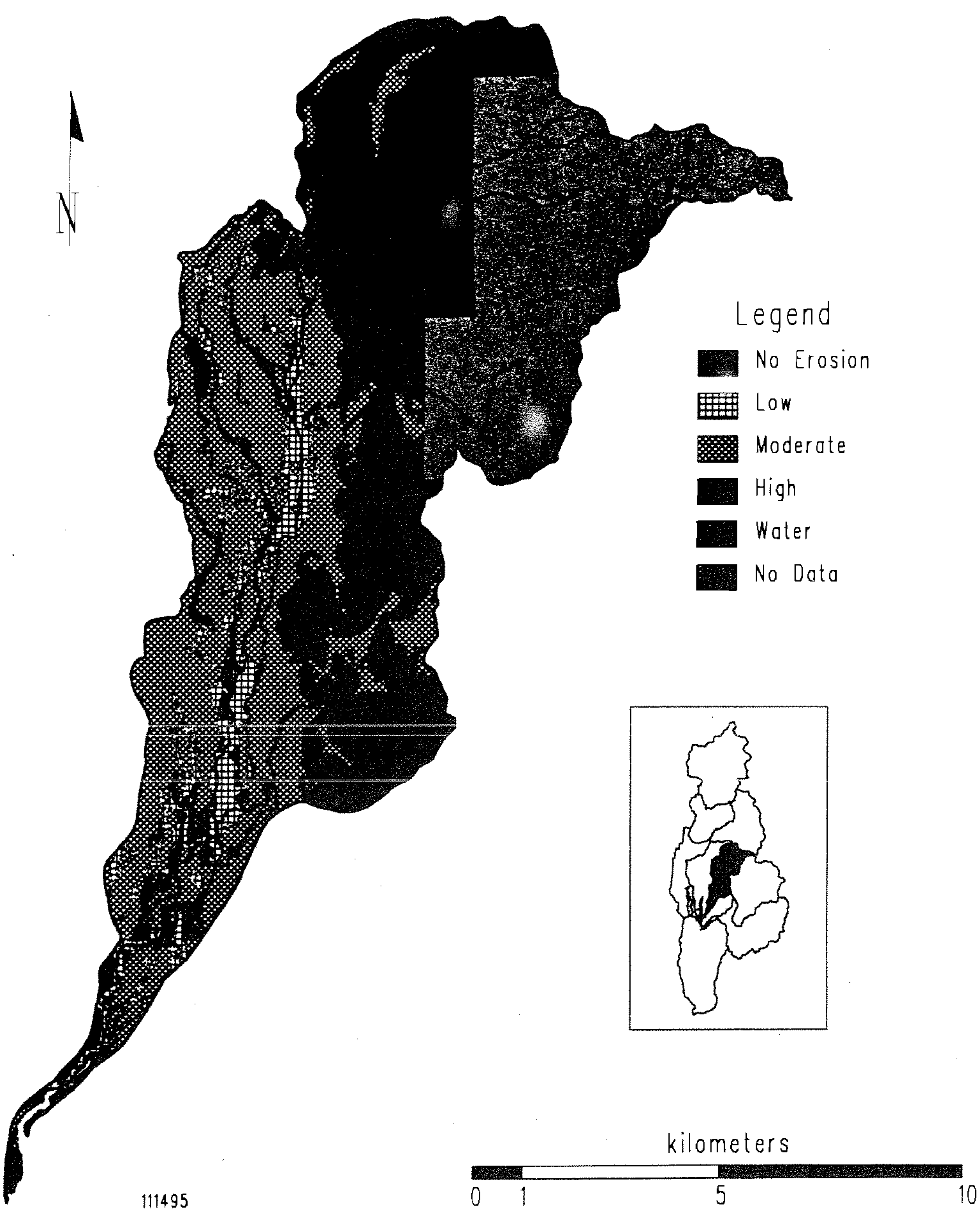
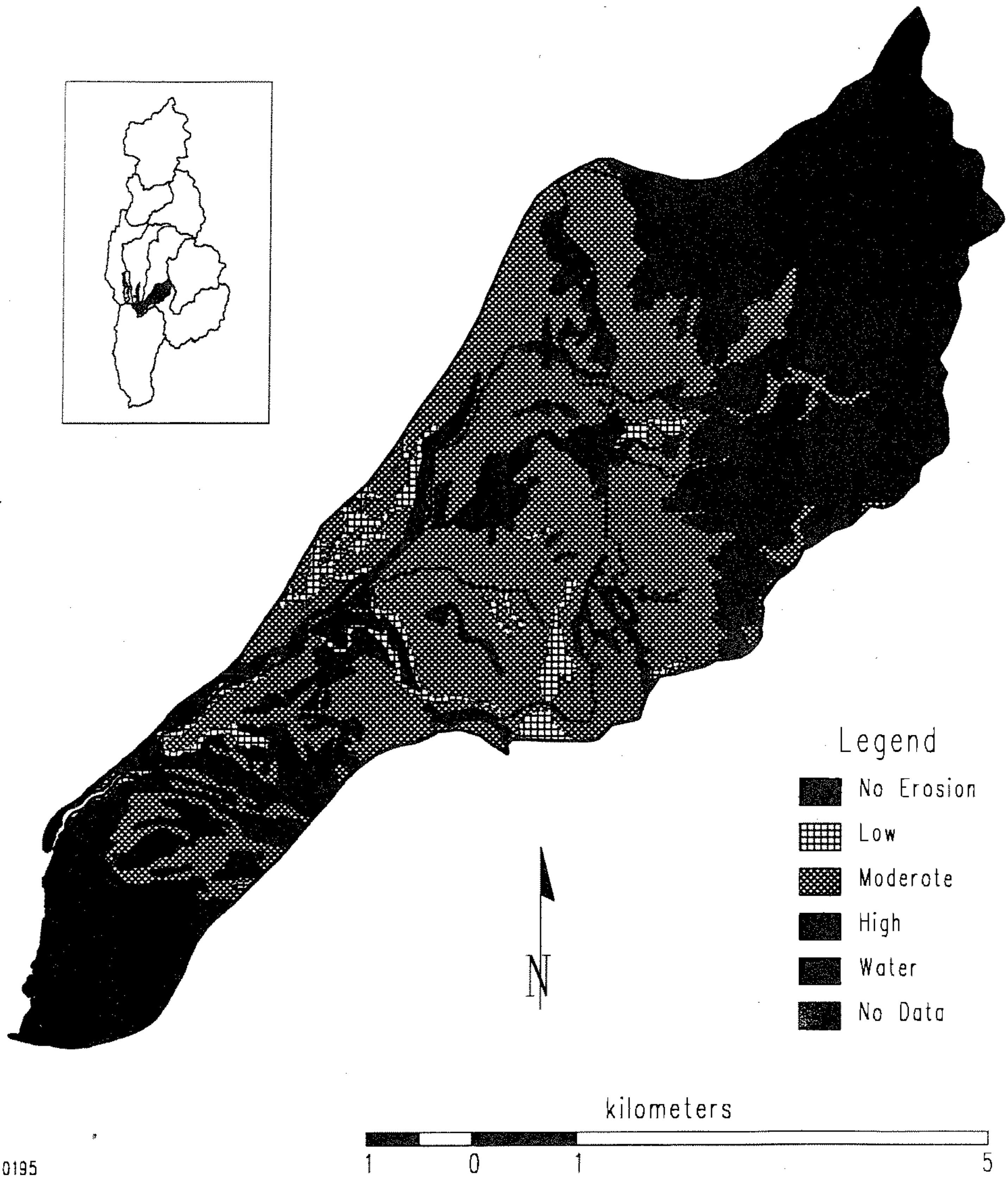
BOULDER CREEK WATERSHED
Soils Erosion Sensitivity with Hydrography



WILLOW CREEK SUBWATERSHED
Soils Erosion Sensitivity with Hydrography



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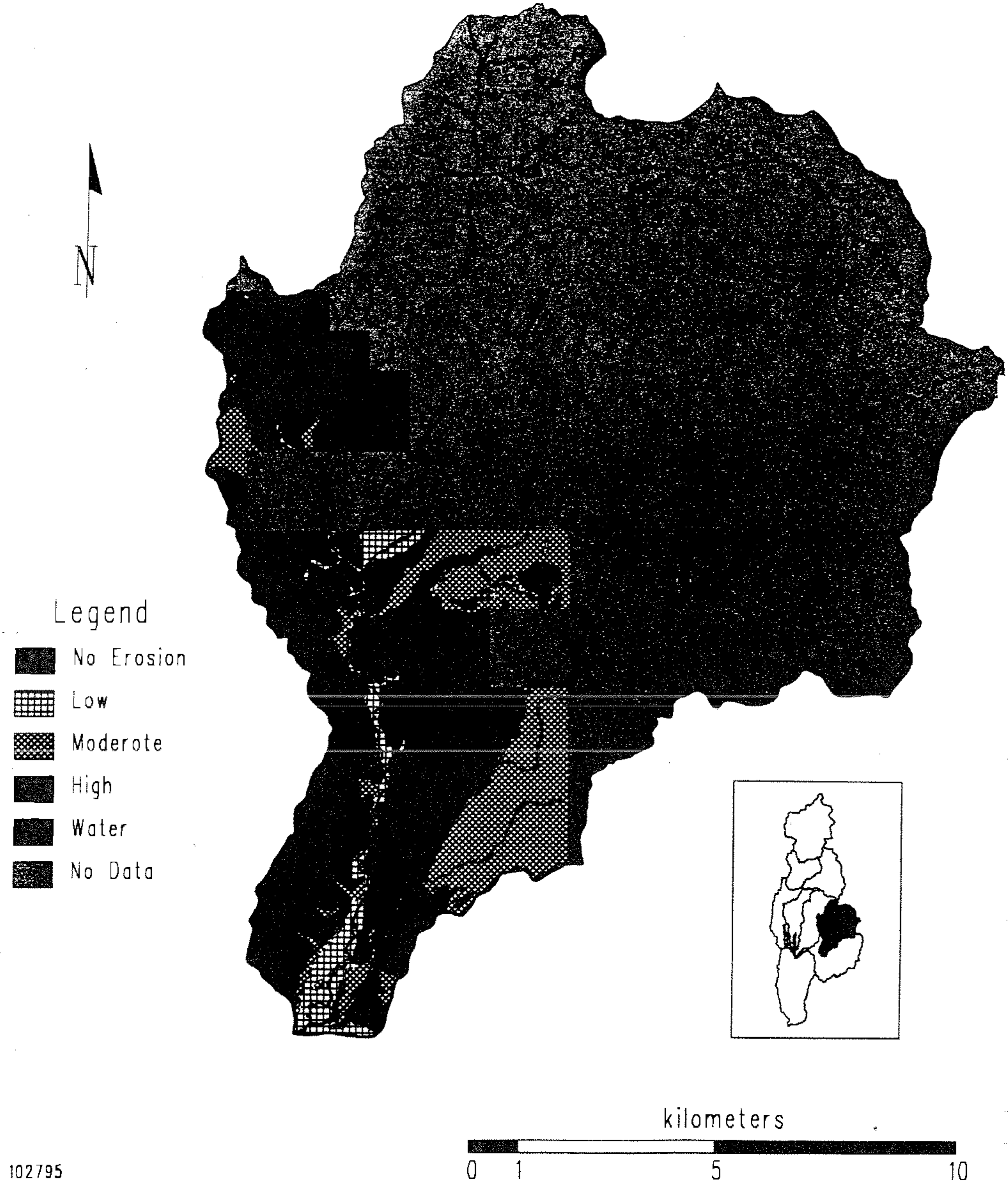
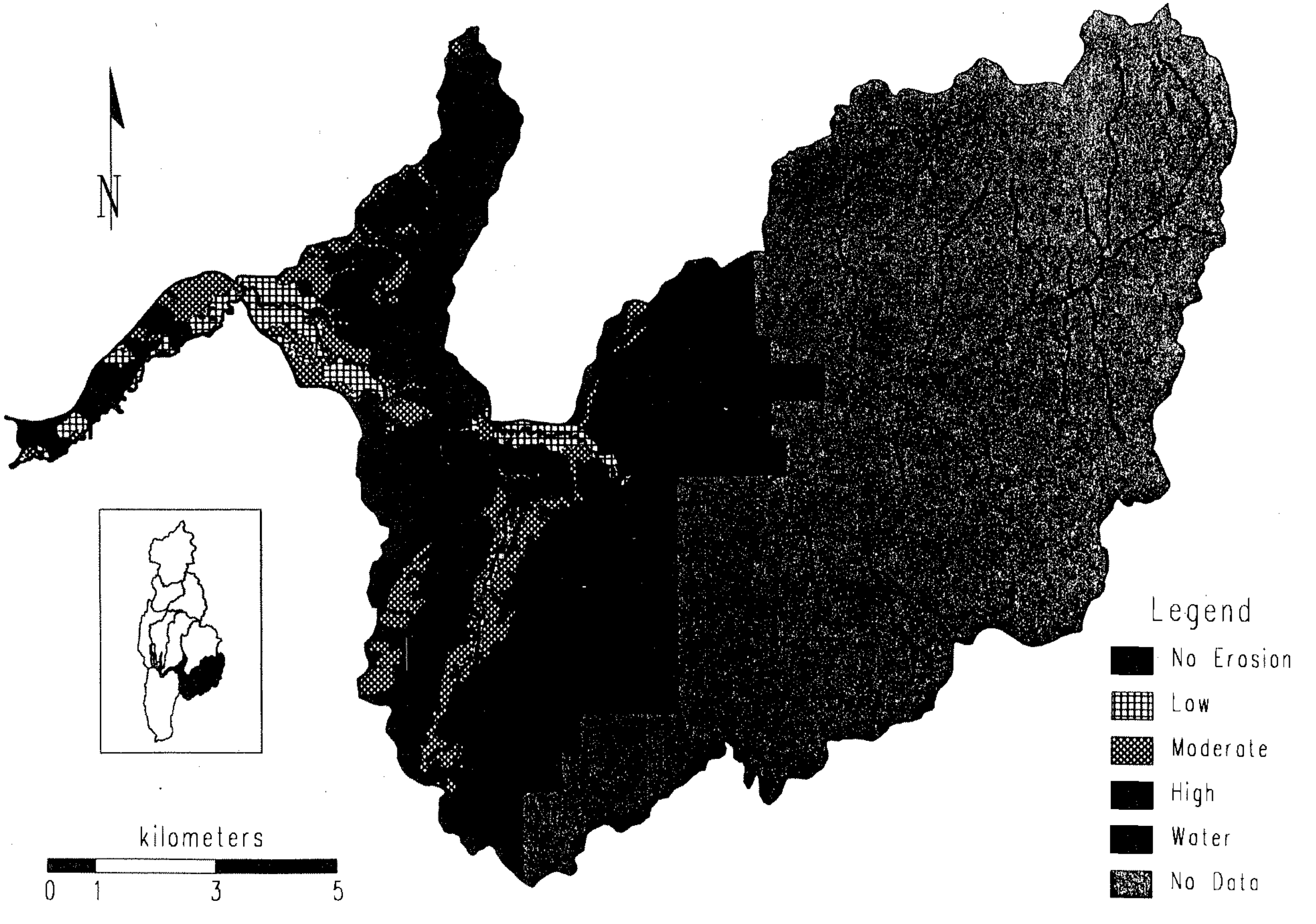
KENNALLY CREEK WATERSHED
Soils Erosion Sensitivity with Hydrography



GOLD FORK CREEK WATERSHED
Soils Erosion Sensitivity with Hydrography



CASCADE SUBWATERSHED
Soils Erosion Sensitivity with Hydrography

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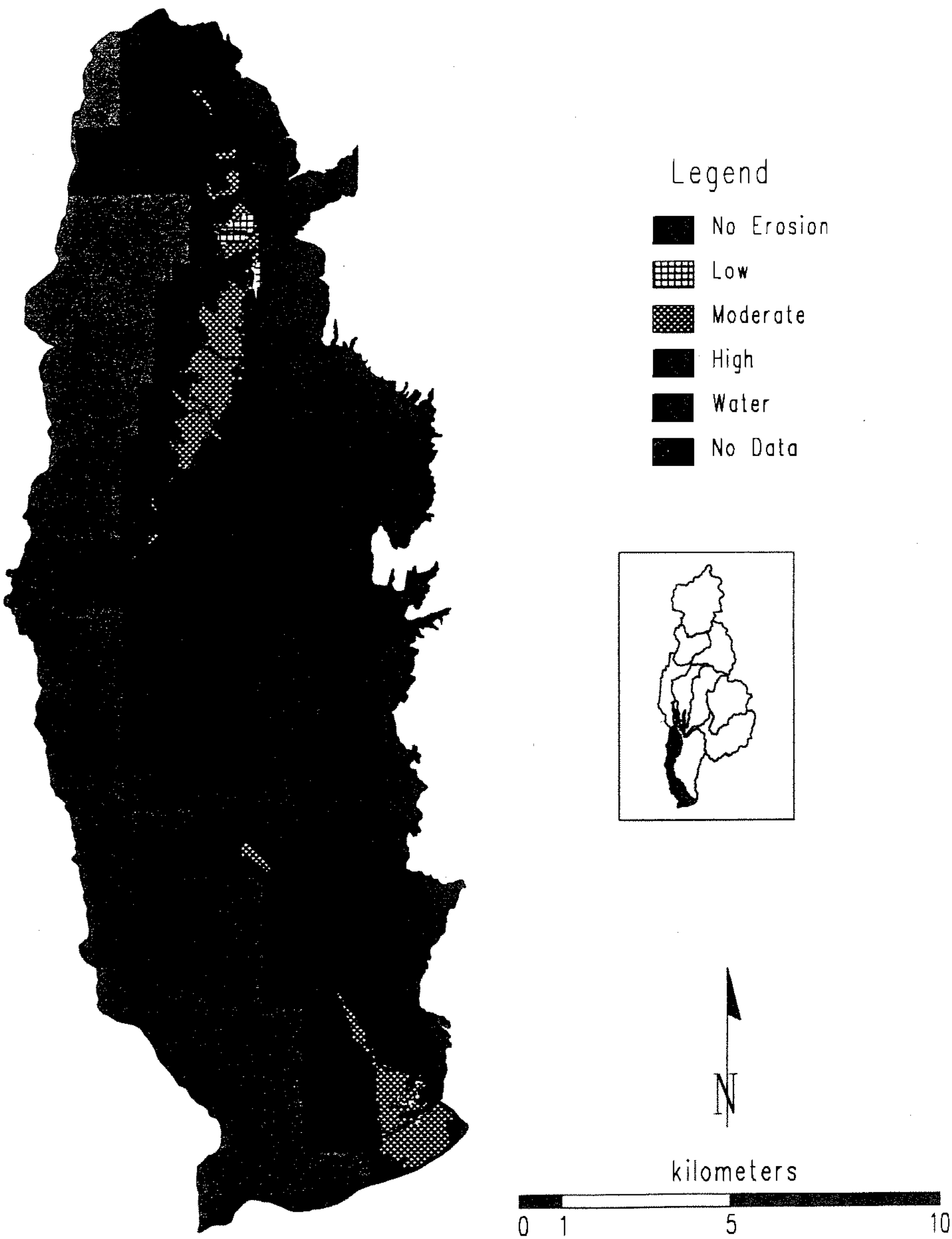
WEST MOUNTAIN SUBWATERSHED
Soils Erosion Sensitivity with Hydrography



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WATER BUDGET FOR CASCADE RESERVOIR: WY 1993

FLOW ACFT

DATE	Int, # days	Estimated values based on BOR Inflow Data — Cumulative Inflows (acft): BC1	QF1	LF	HC	UFPR	PC	WC	Est. West S.	Total
01-Oct-92	0									
31-Oct-92	31	594	3936	2458	261	7205	86	162	834	15450
30-Nov-92	30	580	3844	2401	255	7037	84	158	815	15090
31-Dec-92	31	824	5459	3409	363	9994	120	224	1157	21430
31-Jan-93	31	777	5146	3214	342	9420	113	211	1091	20200
28-Feb-93	28	638	4226	2639	281	7737	93	174	896	16590
31-Mar-93	31	1993	13206	8247	877	24176	290	542	2799	51840
12-Apr-93	11	2106	5066	4089	1453	8706	79	731	761	22913
27-Apr-93	15	3522	8384	3902	742	12892	119	626	1145	31292
12-May-93	15	3129	20145	13777	449	33289	533	434	5136	76358
24-May-93	12	2796	33339	14410	428	65889	740	149	7215	124226
03-Jun-93	10	2523	29110	12545	201	57084	484	349	4660	106480
22-Jun-93	19	3288	30351	27069	702	32354	467	508	4500	98771
20-Jul-93	28	690	3660	584	1217	10011	180	521	1737	18420
17-Aug-93	28	1438	3854	2425	2765	9406	157	1888	1519	23291
14-Sep-93	28	863	888	3970	801	13256	214	363	2064	22205
01-Oct-93	17	357	2440	2056	357	8354	36	78	367	14782
Annual	365	26,119	173,052	108,074	11,495	316,810	3,803	7,105	36,684	679,338
Measured	183	20,713	137,236	85,706	9,116	251,241	3,016	5,631	29,092	538,738

Days April 1 - Sept 30

% of Yr= 79.30
Diff= 140,600
% Remain 20.70

%Residual Error 11.92

	BC1	QF1	LF	HC	UFPR	PC	WC	West S.	Total
Percent Total Measured Flows acft 538,738 752,260	3.8	25.5	15.9	1.7	46.6	0.6	1.0	5.4	100.0
1989 Water Year Measured Flows acft 445,199 586,160	9.3	24.9	13.1	1.4	46.1		0.8	4.3	99.9

Total Annual

Total Phosphorus Budget for Cascade Reservoir: WY 1993

DATE	Int. days	Cumulative TP Load in Kg BCI	GFI	LF	MC	NFPR	PC	WC	Est. West S.	Total
01-Oct-92	0	0	0	0	0	0	0	0	0	0
31-Oct-92	31	2	145	144	23	400	8	24	79	817
30-Nov-92	30	39	221	141	23	391	8	22	77	914
31-Dec-92	31	46	286	141	32	555	11	34	109	1204
31-Jan-93	31	40	377	188	31	523	11	31	103	1292
28-Feb-93	28	46	287	155	25	429	9	23	85	1050
31-Mar-93	31	145	1063	403	78	1362	27	87	264	3463
12-Apr-93	11	2512	370	341	199	636	10	122	113	4293
27-Apr-93	15	733	724	393	102	1113	18	123	71	3260
12-May-93	15	362	1165	1434	36	1925	31	18	507	5446
24-May-93	12	446	3416	820	39	3751	68	30	890	9393
03-Jun-93	10	283	1959	703	20	7681	54	106	288	11040
22-Jun-93	19	301	1245	1586	41	1096	27	101	183	5352
20-Jul-93	28	156	436	10	30	417	7	56	69	1174
17-Aug-93	28	274	321	49	329	347	6	426	64	1811
14-Sep-93	28	119	35	128	73	1058	9	48	109	1569
30-Sep-93	17	51	158	43	21	268	2	6	11	562
Annual	365	5,556	12,200	6,759	1,101	22,733	306	1,257	3,021	52,639
Measured April 1 - Sept 10	183	5,236	9,839	5,507	882	19,093	232	1,037	2,307	43,900

% of Yr-	83.40
Diff-	8,739
% Remain	16.60

Percent Total		BCI	GFI	LF	MC	NFPR	PC	WC	Est. West S.	Total
Measured	43,900	11.9	22.4	12.5	2.0	43.5	0.5	2.4	5.3	100.0
Annual	52,639	10.6	23.2	12.8	2.1	43.2	0.6	2.4	5.7	100.0
1989 WY	Kg	5,578	6,827	1,057	466	12,713		969	1,056	28,666
Annual Percent	28,923	19.3	23.6	3.7	1.6	44		3.4	3.7	99.3

WATER BUDGET FOR CASCADE RESERVOIR: WY 1994

Water Budget		CUMULATIVE AC FT								
DATE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	PCI	[illegible]	WEST SIDE	TOTAL
01-Oct-93		0	0	0	0	0	0	0	0	0
19-Oct-93	18	357	2,420	2,856	357	8,354	36	71	344	14,768
17-Nov-93	29	575	2,646	1,265	368	3,279	89	155	863	9,151
15-Dec-93	28	555	4,390	2,068	333	3,629	86	167	833	11,975
12-Jan-94	28	833	4,390	2,060	333	3,629	86	167	833	12,253
01-Mar-94	48	952	7,526	3,545	571	6,221	148	286	1,428	20,529
15-Mar-94	14	278	2,305	925	167	2,046	43	56	416	6,192
22-Mar-94	7	208	1,000	479	124	1,155	22	96	208	3,270
29-Mar-94	7	607	1,556	729	280	1,287	29	328	283	5,070
05-Apr-94	7	571	2,996	946	635	2,270	30	637	289	8,344
12-Apr-94	7	536	2,721	1,163	292	2,592	40	139	388	7,832
18-Apr-94	6	320	2,936	714	97	2,219	66	27	626	6,949
25-Apr-94	7	619	5,125	1,094	185	14,208	78	19	757	22,007
05-May-94	10	436	5,380	1,256	131	15,125	82	40	790	23,158
10-May-94	5	148	5,638	3,138	33	11,225	124	6	1,198	21,383
23-May-94	13	487	8,200	3,404	88	21,092	126	59	1,219	34,517
07-Jun-94	15	402	4,073	3,110	99	9,255	92	183	883	18,005
20-Jun-94	13	49	1,150	295	177	7,856	68	59	660	10,246
12-Jul-94	22	79	436	189	53	3,930	15	119	143	4,949
08-Aug-94	27	268	536	152	205	5,733	16	65	155	7,113
12-Sep-94	35	347	437	187	139	8,611	17	14	161	9,896
30-Sep-94	18	179	225	96	71	4,429	9	7	83	5,090
	Days	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	PCI	[illegible]	WEST SIDE	TOTAL
Total	364	8,806	66,095	*******	4,738	138,144	1,303	2,696	12,570	262,727
Percent Annual		3.4	25.2	11.3	1.8	52.6	0.5	1.0	4.8	100

* PCI not included in total - West Side Included.

BOR est.=298,100 ac ft

TOTAL PHOSPHORUS BUDGET FOR CASCADE RESERVOIR: WY 1994

TOTAL PHOSPHORUS CUMULATIVE TRIB LOAD IN KG DATE	Days	BCI	GCI	LKI	MCI	NFPR2	PCI	WCI	WEST SIDE	TOTAL
01-Oct-93		0	0	0	0	0	0	0	0	0
19-Oct-93	18	21	78	53	11	206	1	7	14	389
17-Nov-93	29	43	457	320	41	324	11	27	106	1,325
15-Dec-93	28	185	1,354	357	82	806	16	58	156	2,995
12-Jan-94	28	144	146	51	49	582	5	49	46	1,066
01-Mar-94	48	18	186	83	56	537	11	60	106	1,046
15-Mar-94	14	37	711	16	18	202	3	19	31	1,034
22-Mar-94	7	39	42	11	9	66	1	32	8	206
29-Mar-94	7	172	134	22	55	127	4	190	35	736
05-Apr-94	7	70	296	46	70	336	2	162	19	1,199
12-Apr-94	7	99	336	115	50	195	6	38	57	890
18-Apr-94	6	39	326	53	11	274	10	6	94	803
25-Apr-94	7	69	164	67	21	438	6	3	56	819
05-May-94	10	32	113	124	13	354	3	5	30	672
10-May-94	5	20	556	464	2	1,800	15	1	148	2,991
23-May-94	13	54	162	55	5	598	7	8	65	947
07-Jun-94	15	54	100	42	4	274	4	27	34	536
20-Jun-94	13	8	113	5	15	203	4	11	41	397
12-Jul-94	22	10	156	7	2	291	1	28	11	505
08-Aug-94	27	23	40	15	63	389	7	31	67	628
12-Sep-94	35	38	32	3	38	414	2	1	20	546
30-Sep-94	18	19	16	2	19	213	1	1	10	281
Total	364	1,195	5,518	1,919	637	8,629	119	962	1,149	20,010
Percent Annual		6.0	27.6	9.6	3.2	43.1	0.6	4.8	5.7	100
TOTAL 1993 WY	KG/YR	5554	12208	6759	1104	22732	306	1257	3023	
	PERCENT	10.6	23.2	12.8	2.1	43.2	0.6	2.4	5.7	

* PCI not included in total - West Side included.

APPENDIX D

COORDINATED MONITORING PLAN
FOR
IMPLEMENTATION OF A TMDL ALLOCATION ON CASCADE RESERVOIR AND CONTRIBUTING WATERSHEDS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

BACKGROUND

The "Idaho Water Quality Standards" (IDHW 1985) designate beneficial uses for Cascade Reservoir as: domestic and agricultural water supply, cold and warm water biota, salmonid spawning, and primary/secondary contact recreation (Table 1). Cascade Reservoir was designated as a Stream Segment of Concern in 1989 (Dunn 1990) due to impaired water quality and the perception that beneficial uses were no longer fully supported. Accordingly, the reservoir would receive higher consideration for monitoring activity through the Antidegradation Agreement established in 1988.

Past studies have indicated the reservoir is highly eutrophic (Clark and Wroten 1975; EPA 1977; Zimmer 1983; Klahr 1988; Entranco Engineers 1991) due to excessive nutrient loading, primarily from phosphorus. Excessive algal blooms have been reported on Cascade Reservoir since the early 1970s. These algal blooms are the most conspicuous indicator of nutrient pollution problems and affect other beneficial uses designated for the reservoir. Growth of toxic blue-green algae were linked to the death of 23 cattle that used the reservoir as a drinking source in summer 1993.

Due to continued violations of water quality standards (Table 2), Cascade Reservoir was listed with the U.S. Environmental Protection Agency as a water quality limited water body under section 303(D) of the Federal Clean Water Act (40 CFR Ch. 1 130, 1987). The Clean Water Act stipulates that Total Maximum Daily Load (TMDL) allocations must be developed by those states having designated a water body as "water quality limited".

A TMDL allocates the allowable amount of pollutants that can be effectively assimilated by a specific water body while continuing to meet state water quality standards. The TMDL quantity must include all potential sources of a designated pollutant of concern, including those derived as point, nonpoint and natural background contributions.

The Idaho Division of Environmental Quality initiated development of TMDL allocation for Cascade Reservoir in February 1994. This document outlines a proposed coordinated monitoring plan for the support, development and implementation of a TMDL allocation to improve reservoir water quality and the quality of runoff from contributing watersheds. Monitoring projects implemented under this effort would additionally conform to the state-wide watershed approach (DEQ Laws 763, 1994).

The monitoring activities proposed in this document are consistent with guidelines for implementation of a phased TMDL for both point and non-point sources of pollution (EPA, 1991). Under the traditional TMDL process, the state is required to adopt and enforce specific numerical water quality criteria that when implemented, would result in restoring full support of designated beneficial uses.

Table 1. Designated Beneficial Uses and condition status for Cascade Reservoir.

Category and Purpose of Designated Beneficial Uses for Cascade Reservoir.	Support Status
Water Supply	
Agricultural - waters which are suitable or intended to be made suitable for irrigation of crops or as drinking water for livestock	Partially Supported
Domestic - waters which are suitable or intended to be made suitable for drinking water supplies	Un-Supported
Industrial - waters which are suitable or intended to be made suitable for industrial water supplies. This use applies to all surface waters of the state.	Supported
Aquatic Life	
Cold Water Biota - waters suitable or intended to be made suitable for protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species which have optimal growing temperatures below 18 C	Partially Supported
Warm Water Biota - waters suitable or intended to be made suitable for protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species which have optimal growing temperatures above 18 C	Supported
Salmonid Spawning - waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes.	Partially Supported
Recreation	
Primary Contact Recreation - surface waters which are suitable or intended to be made suitable for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such waters include, but are not restricted to, those used for swimming, water skiing, or skin diving.	Partially Supported
Secondary Contact Recreation - surface waters which are suitable or intended to be made suitable for recreational uses on or about the water and which are not included in the primary contact category. These waters may be used for fishing, boating, wading, and other activities where ingestion of raw water is not probable.	Supported
Wildlife Habitat Waters which are suitable or intended to be made suitable for wildlife habitat. This use applies to all surface waters of the state.	Partially Supported
Aesthetics This use applies to all surface waters of the state.	Partially Supported

Fully Supported - Designated uses are unrestricted and not impaired by water quality or related conditions.
Partially Supported - Designated uses are restricted or threatened under certain conditions due to impaired water quality or related conditions.
Un-supported - Designated uses are functionally impaired or lost due to impaired water quality or related conditions.

Table 2. General Surface Water Quality Criteria; narrative standards applicable to gauging status protection of beneficial uses for Cascade Reservoir.

General Water Quality Standards and Narrative Guidelines	Status in Support of Beneficial Uses
Excess Nutrients Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated or protected beneficial uses.	Excess nutrients frequently available causing nuisance growth of algae and aquatic plants.
Floating, Suspended or Submerged Matter Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may adversely affect designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities.	Standard frequently exceeded due to chronic algae blooms.
Oxygen Demanding Materials Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition.	Standard frequently exceeded due to presence of excess organic matter (algae).
Biological Criteria Surface waters of the state shall be of adequate quality to support aquatic species without detrimental changes in the resident biological communities. This condition shall be determined by monitoring of indicative flora or fauna as established by the Department. This information may be used in conjunction with appropriate chemical, physical, habitat structure, and microbial measurements.	Standard frequently exceeded due to growth of undesirable species of algae and aquatic plants

Implementation of a phased TMDL strategy acknowledges that specific criteria necessary to restore beneficial uses may be unknown or that additional information is needed before specific criteria can be established with confidence. A phased TMDL provides additional flexibility for the state to collect necessary data and develop criteria through an incremental process with the understanding that, criteria and standards necessary to support designated beneficial uses will be implemented according to a reasonable schedule.

In addition to specific monitoring related to the proposed TMDL implementation, there are State Agriculture Water Quality Programs (SAWQP) in three of the sub-watersheds draining to Cascade Reservoir; Boulder Creek, Willow Creek and Mud Creek. Their purpose is to improve water quality and restore beneficial uses of streams in predominately agricultural subwatersheds through implementation of Best Management Practices (BMPs). The Boulder Creek SAWQP began in 1990, and to date, has implemented fifteen contracts with landowners to improve water quality. The Mud and Willow Creek SAWQP have been recently initiated in 1995. Most BMPs implemented have addressed riparian areas and irrigation water management. An Environmental Protection Agency 319 Grant is also being implemented in the Boulder Creek subwatershed. The purpose of this grant is to demonstrate grazing management practices that may be beneficial to riparian areas and water quality.

NUTRIENT SOURCES

Eutrophication of Cascade Reservoir has been attributed to excess phosphorus and other nutrients carried by various streams and rivers flowing into the reservoir. The source of this phosphorus has been linked to land use activities within the watershed resulting in point and non-point sources of pollution. Point sources of pollution include the McCall Waste Water Treatment Plant and the McCall Fish Hatchery which discharge organic waste directly to the North Fork Payette River. These facilities are permitted under EPA National Pollutant Discharge Elimination System (NPDES) guidelines.

Larger contributions of phosphorus have been measured in runoff from non-point sources such as agricultural lands and forest lands (Entranco Engineers, 1990). Other important contributions of phosphorus are associated with erosion, storm water runoff, recreation, and septic tanks associated with shoreline development. The amount of the annual phosphorus loading attributed to "natural" or background sources, the quantities that would normally be contributed by pristine streams or uncultivated lands, is unknown at this time.

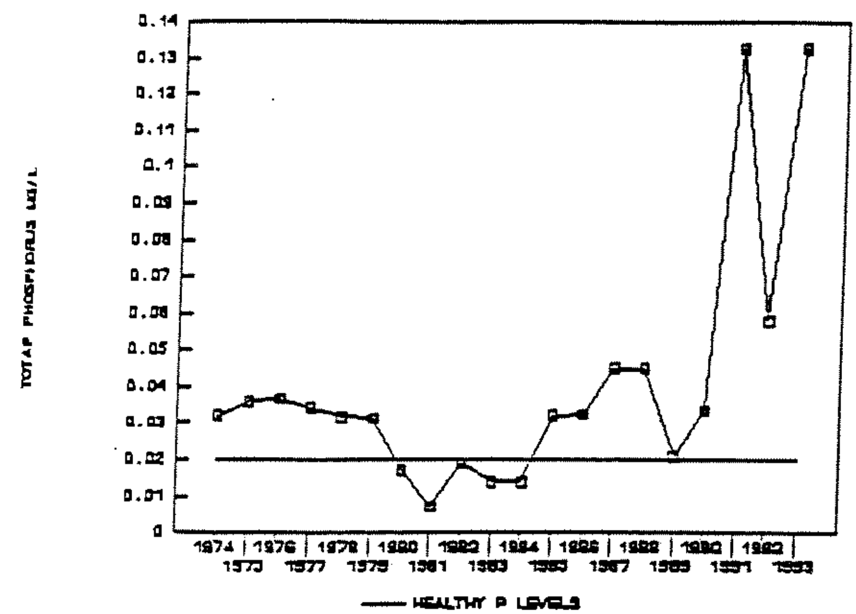
Long term monitoring indicates phosphorus concentrations within the reservoir have increased during the past decade (1984 -1994) with a corresponding increase in algal production (Figure 1). Although the phosphorus loading to the reservoir varies greatly depending on the annual rainfall and snowfall patterns, a comparison of the P budgets (inflow - outflow) indicates that 80-90% of P load is retained within the reservoir (Worth, 1993; 1994). As a result, much of the P loading accumulates in the reservoir sediments and provides a secondary source of enrichment for algal growth. Reducing the amount of phosphorus in runoff entering Cascade Reservoir is critical for long term improvement of water quality.

The transport of phosphorus in runoff is dependent on the desorption, dissolution, and extraction of P from soil and plant material (Lal and Stewart, 1994; Sharpley and Halvorson, 1994). These processes are further regulated and influenced by rainfall and moisture conditions. Leaching of P from plant material varies depending on species composition and rate of decay. Loss of P from soils is regulated by the ion exchange capacity of the soil complex, pH, amount of organic material and the presence and type of other minerals with a high affinity for P (Brobergand and Persson, 1988).

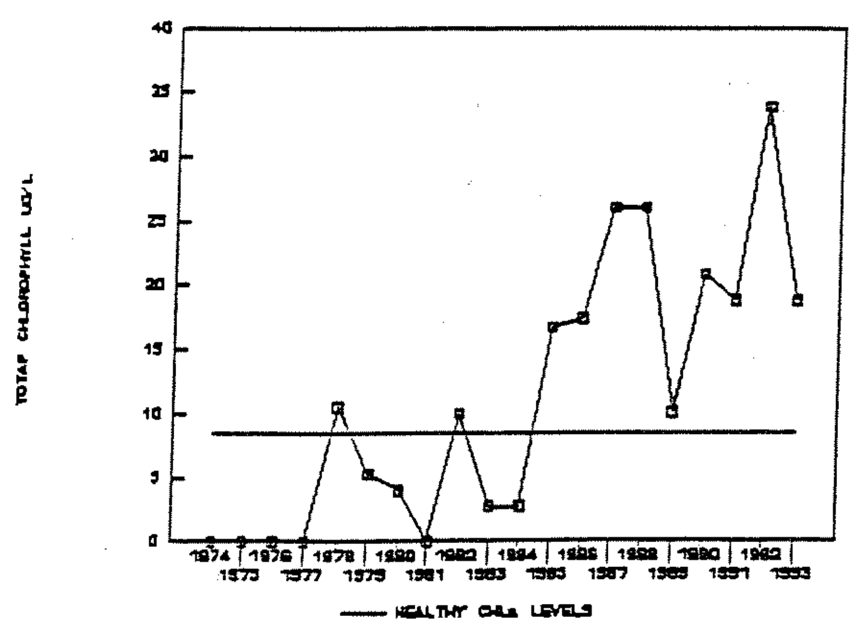
Soluble forms of phosphorus (SP) are more readily available for algal uptake and have a potential to stimulate growth (Bostrum, Pearson and Broberg, 1988). Particulate forms of phosphorus (PP), P bound to organic particles and sediments, generally comprise the largest source of P enrichment. Although PP is kinetically less available for algal uptake, mineralization and microbial activity can convert significant portions of this P to more soluble forms over time, further enhancing the pool of P available for algal uptake and growth.

Figure 1. Trends in TP and CHLA concentrations measured at Sugarloaf Island. Values represent average surface conditions. Horizontal lines in graph indicates target criteria for phosphorus and chlorophyll that reflect improved reservoir conditions. (Data adapted from sources provided by Bureau of Reclamation, citizen monitoring and DEQ).

SUMMER PHOSPHORUS LEVELS NEAR SUGARLOAF



SUMMER CHLOROPHYL LEVELS NEAR SUGARLOAF



MONITORING OBJECTIVES

To achieve the desired improvements in water quality, quantitative cause and effect relationships must be established between the efforts to reduce nutrient loading (implementation of waste load allocations) and any incremental changes in watershed nutrient contributions based on rigorous scientific data. These relationships and associated data will help define baseline conditions and document reservoir responsiveness to changes in water quality. This document recommends projects and studies that would 1) determine related environmental health of the contributing watersheds, 2) provide a generally comprehensive analysis of the reservoir condition, and 3) develop/modify a predictive reservoir response model to evaluate changes in water quality resulting from future decreases in nutrient loading.

Objective 1.0 - Evaluation of Watershed Nutrient Sources and Reservoir Loading

To quantify watershed nutrient sources and transport mechanisms that influence reservoir water quality. Hydrology, land use and soil characteristics of the watershed greatly influence potential water yield (runoff) and associated nutrient export. These yields vary annually with climatic conditions and result in variable rates of nutrient loading to the reservoir. Development of effective nutrient reduction strategies will be critical to improving reservoir water quality. Monitoring of watershed nutrient yields will be an important performance measure in the assessment of best management practices (BMP's) or other strategies to reduce nutrient and sediment loading of the reservoir.

Objective 2.0 - Evaluation of Reservoir Condition

To characterize baseline conditions of the reservoir. Measures of ecological condition will include assessment of the trophic status of the reservoir, internal and external nutrient relationships affecting trophic conditions and internal nutrient recycling mechanisms that may impede restoration.

Objective 3.0 - Reservoir Modeling

To refine and develop better predictive models that will forecast ecosystem response to changes in reservoir nutrient loading. Lake and reservoir systems often respond slowly to changes in nutrient inputs. As a result, it will be difficult to determine whether nutrient reduction strategies have achieved the desired improvements in reservoir water quality in the near term. Computer models will be used to simulate potential changes in the ecosystem based on different P reduction amounts. Other reservoir modifications such as changing the amount and timing of water storage and selective withdrawal of water for power plant operation will also be evaluated.

MONITORING APPROACH

Objective #1

1.1 Evaluation of Mass Balance Budget of Nutrients and Water Entering the Reservoir

Rationale: Eutrophication of lakes and reservoirs can be directly related to the quantity and quality of runoff contributed by the surrounding watershed. Cascade Reservoir receives runoff from a watershed area of approximately 1,579 km^2 (390,200 ac.) and retains more than 85 % of the nutrients and ____% of the water draining from the watershed. These external inputs have been linked to a decline in reservoir water quality due to excessive nutrient loading and the growth of noxious algae blooms. Based on monitoring data collected by DEQ in 1993, an interim TMDL allocation has been adopted that would reduce current contributions of phosphorus by 30% for point and non-point sources. An accounting of total nutrients and water entering Cascade Reservoir is required to identify sources, quantity and quality of watershed runoff. Information from this effort has been used to target specific sub-watersheds for implementation of Best Management Practices (BMPs) and other land management changes to reduce nutrient loading. Continued monitoring of inflow quality and quantity is required to 1) verify annual contributions and 2) determine overall effectiveness of state, federal and local efforts to achieve load reduction goals.

Background: Currently, only outflows from Cascade Reservoir (USGS gauging site 13244500; U.S. Bureau of Reclamation gauging site CSC) and inflows from Boulder Creek are monitored routinely to determine daily flow rates. Inflows for other major tributaries are estimated biweekly or monthly by DEQ and the U.S. Forest Service using manual flow measurements. A gross annual estimate of inflows is calculated by the U.S. Bureau of Reclamation using the change in storage method for Cascade Reservoir. Water quality data for inflows have been infrequently monitored by various agencies. Outflow water quality has also been infrequently monitored by USGS and others. DEQ initiated a monitoring program to evaluate quantity and quality of reservoir inflows and outflow in 1992. The quantity and quality of ground water entering the reservoir is also largely unknown, although some quality data exists related to review and development of individual septic tank installations by the Idaho Central District Health Department.

Scope: Nine major watersheds have been identified that directly drain to Cascade Reservoir (Figure 2). Bulk nutrient contributions of each watershed are monitored at the lower ends of each tributary (Figure 3). Tributary sampling sites were selected to minimize slack-water affects with rising reservoir water levels. Inflows from major tributaries and contributing watersheds will be monitored biweekly during spring-early summer runoff and monthly during late summer through winter freeze (Table 3; **Data Collection and Analysis**). Channel flows will be measured using EPA guidelines for

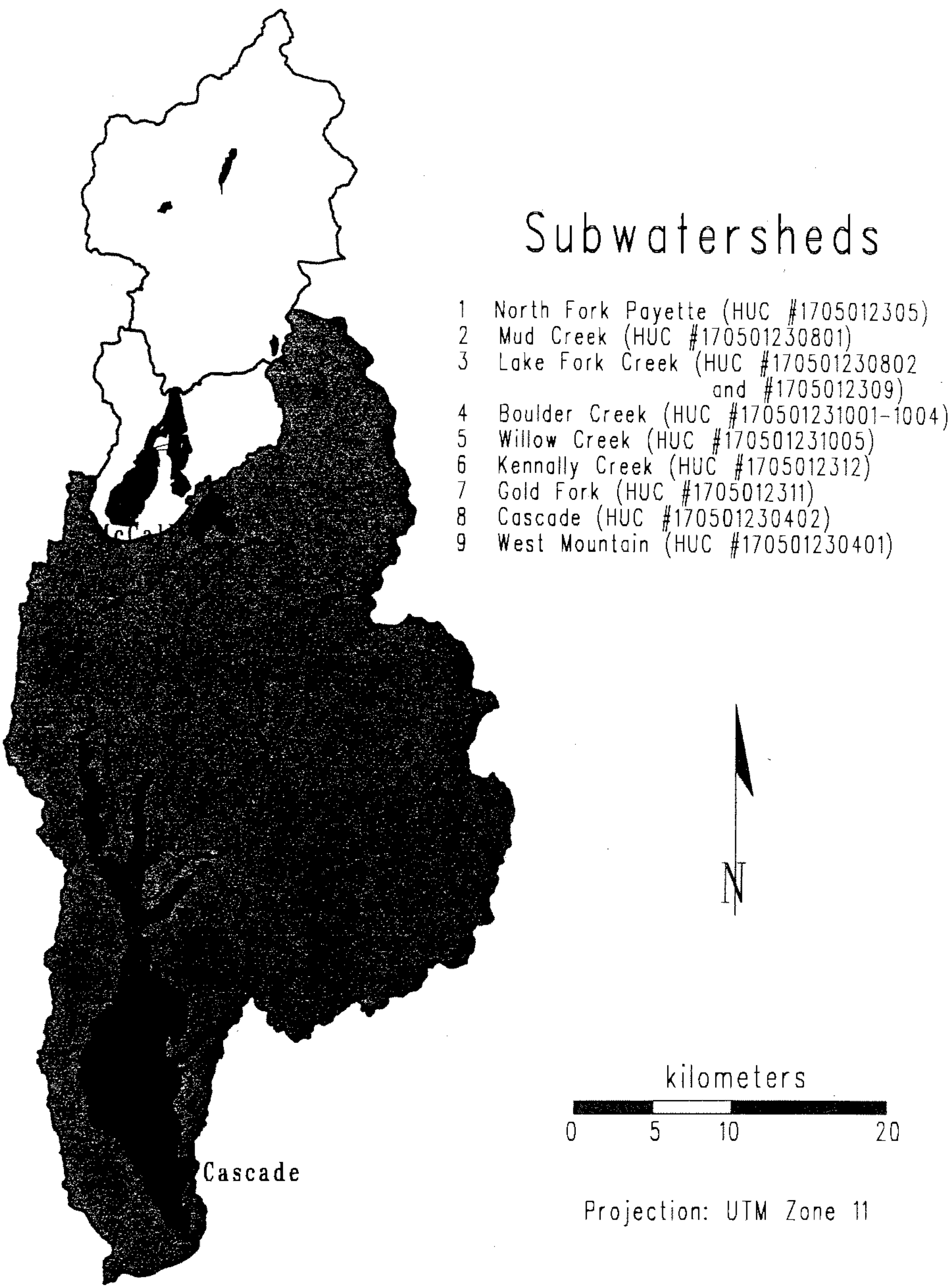
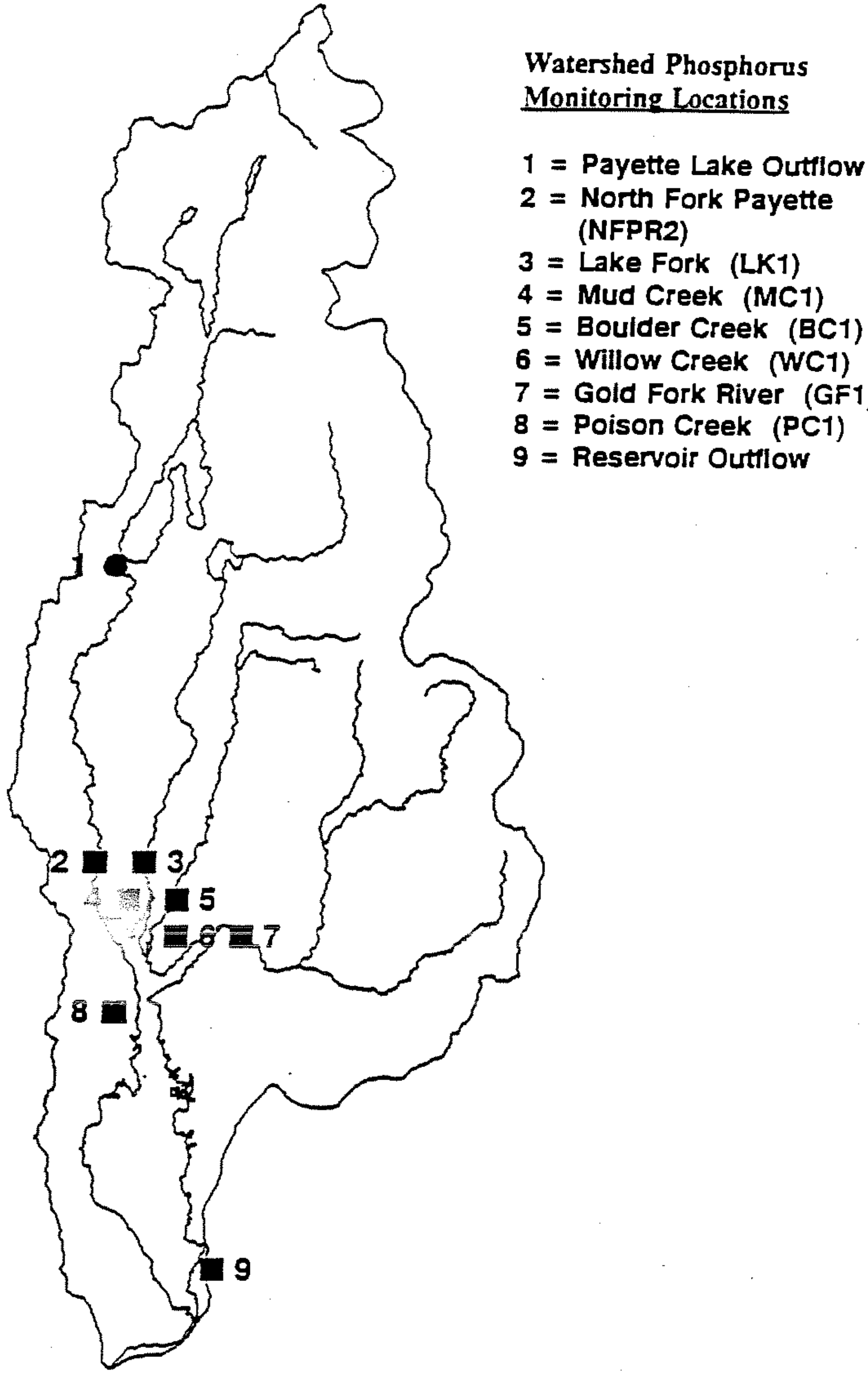

Subwatersheds
1 North Fork Payette (HUC #1705012305)
2 Mud Creek (HUC #170501230801)
3 Lake Fork Creek (HUC #170501230802 and #1705012309)
4 Boulder Creek (HUC #170501231001-1004)
5 Willow Creek (HUC #170501231005)
6 Kennally Creek (HUC #1705012312)
7 Gold Fork (HUC #1705012311)
8 Cascade (HUC #170501230402)
9 West Mountain (HUC #170501230401)
N
kilometers
0 5 10 20
Projection: UTM Zone 11
Cascade

Figure 3. Monitoring sites for measurement of watershed bulk nutrient loading.



monitoring stream for open channel flow measurements (Table 4; **Data Collection and Analysis**). Cross-section velocities will be measured using Marsh/McBirney water current meters. Associated water quality will be collected during each site visit in conjunction with stream flows. Routine water quality parameters are listed in Table 5 (**Data Collection and Analysis**). Water sampling protocols (Table 6; **Data Collection and Analysis**) will specifically address phosphorus as a major pollutant of concern. Additional tributaries in the West Mountain and Gold Fork watersheds will be monitored for flows and water quality by the Forest Service. Quality of outflow from Cascade Reservoir will be monitored at the same frequency as inflows. Information on outflow quantity will be obtained by the Bureau of Reclamation (BOR).

Nutrient loading attributed to rainfall will be measured by storing rainfall accumulated in the rain gage at the BOR Cascade Dam. Rainwater will be automatically drained to a collection bucket housed inside an enclosed shelter. Composite rainfall over a two week interval will be analyzed for total nutrients. Some meteorological data related to wind speed and rainfall amount is currently collected at the BOR dam and the McCall airport. Data sets will be averaged to estimate a basin rainfall amount. Rainfall water quality will be collected by DEQ personnel at the BOR monitoring station.

1.2 Wet Detention Phosphorus Removal Monitoring

Rationale: Very little quantitative data exists confirming the efficiency of standard best management practices (BMPs) to remove nutrients in glacial till soils that are prevalent throughout the Cascade watershed. Typical strategies utilize a Resource Management System (RMS) in which a combination of BMPs such as grazing management, chiseling and subsoiling and riparian fencing are implemented to reduce sources of sediment or nutrient generated by a farm or ranch. These treatments (BMPs) are typically applied over a significant portion of the watershed before a measurable change can be detected in the quality of the source water. Under this scenario, it is difficult to determine a specific reduction efficiency until a substantial investment has already been made.

Other studies (Entranco Engineers, 1991; Zimmer, 1983; Worth, 1993 and 1994) indicate a key source of nutrients entering the reservoir occur as a pulse or slug flow during snow melt. The timing and distribution of this source water has not been previously addressed under the current State Agricultural Water Quality Program BMP guidelines. As an alternative, construction of wet detention ponds have been proposed under a 319 grant as an interim means of reducing nutrients at a reduced cost and time frame while efforts continue to implement other longer term source controls. The BOR has also initiated construction of impoundment wetlands to accomplish similar goals and provide additional wildlife habitat. Efficiency of constructed ponds and wetland systems to trap and remove phosphorus will be monitored and documented.

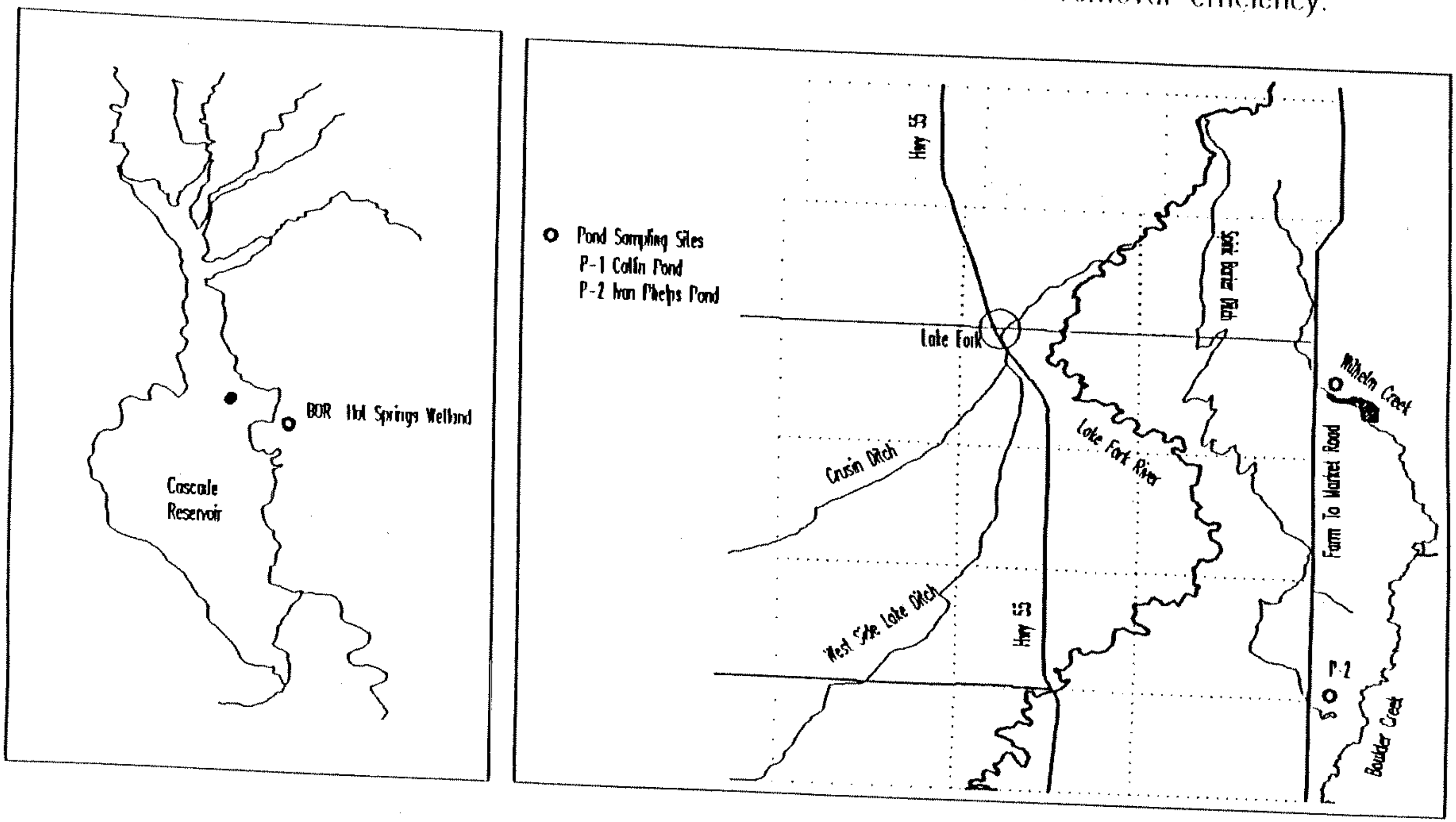
Background: Valley Soil and Water Conservation District (VSWCD) is currently implementing BMPs within the 6,826 acre Boulder Creek watershed draining to Cascade Reservoir. The Cascade Water Quality Management Plan (Entranco Engineers, 1991) identified this watershed as a major contributor of phosphorus loading from extensive cattle grazing and related damage to riparian habitat. BMPs are implemented through a cooperative program between DEQ, VSWCD and the U.S. Natural Resources Conservation Service (NRCS). The long term objective of the BMPs are to reduce phosphorus export from Boulder Creek by 50% over a five year period. Wet detention basins will be incorporated in this sub-watershed as an additional source control to improve water quality. Literature (Olson, 1993) pertaining to wet detention ponds and wetland impoundments suggest 30-60% nutrient removal can be attained through this single treatment option.

The project design includes construction of several wet detention basins in the Boulder Creek Watershed and modification of a third detention pond that will be replanted with wetland plants to increase uptake of nutrients. These facilities will utilize an existing network of irrigation and drainage channels to divert water directly to a detention pond or wetland. Each detention system will have variable quality of source water, water residence times, different design characteristics dictated by the local topography and varying amounts of aquatic macrophyte vegetation. Quality of the source water was monitored at two irrigation supply canals in 1993. Results show a wide range in variability of phosphorus and flows (Figure 4). Several older established ponds will initially be used as a control to compare efficiency rates for removal of sediments and phosphorus as compared with those of newly constructed ponds. Wetland plants will be incorporated in the design after the first year of comparisons are complete. Plantings will be made in consultation with the Fish and Wildlife Service and Idaho Fish and Game. Two ponds proposed for construction by the Bureau of Reclamation (Duck Creek and Hotsprings) will additionally be monitored.

Project design, construction and monitoring will be a cooperative effort among the NRCS, VSWCD, local irrigation districts, BOR, the local agricultural community, and the Division of Environmental Quality.

Scope: Monitoring will be conducted as an integral process in the assessment of project success toward reduction of total watershed nutrient contribution to Cascade Reservoir. The monitoring design will quantitatively determine reduction in the export of phosphorus and sediments using a paired upstream and downstream sampling design. Monitoring will consist of mass balance measurements (inflow - outflow) of nutrients and deposition of P as sediment within detention ponds or wetlands over a 3 year wet/dry hydrologic cycle (October - September). The proposed duration is necessary to segregate transient changes in nutrient uptake efficiency resulting from construction/disturbance and more stable post-construction conditions.

Figure 4. Pond and wetland sampling sites for measurement of P removal efficiency.



Monitoring will be initiated within 60 days after completion of construction (October 1994), continue bi-weekly until winter freeze and resume each spring. Parameters monitored are listed in Table 7 (**Data Collection and Analysis**). Monitoring of flows ar water quality will be accomplished using conventional methods and automated techniques for measurement of water flow and quality. Automated sampling devices will be installed (Isco) for measurement of continuous flow and collection of composite wate samples (see **Data Collection and Analysis**). This data will be calibrated with instantaneous measures of flow using conventional measurement methods. Annual sediment deposition will be measured using sediment traps or cross-section surveys to estimate the amount of sediment deposited. Phosphorus associated with this deposited sediments will be estimated by phosphorus fraction techniques (see **Data Collection and Analysis** - Sediment Analysis Monitoring).

Baseline estimates of potential pond efficiency will be obtained by monitoring several existing ponds (Figure 4). Protocols for field sampling are identical as described above. Samples will be collected monthly during the 1994 irrigation season. Additional samples will be collected biweekly during spring snow melt (1995). Parameters monitored are listed in Table 7 (**Data Collection and Analysis**).

Cross-section area and volumes will be calculated for each of the above monitoring sites (constructed and existing older ponds). This information will be used to compare differences among ponds in P removal based on water residence calculations.

THIS SECTION MAY BE DELETED

1.3 Boulder Creek Hydrography Delineation and Monitoring

Rationale: Valley County Soil Conservation District is currently implementing BMPs within the 6826 acre Boulder Creek watershed draining to Cascade Reservoir. The Cascade Water Quality Management Plan (1991) identified this watershed as a major contributor of phosphorus loading from extensive cattle grazing and related damage to riparian habitat. BMPs are implemented through a cooperative program between DEQ, Valley County Soil Conservation District and the U.S. Soil Conservation Service. The long term objective of the BMPs are to reduce phosphorus loading by 50% within the Boulder Creek drainage area. While DEQ has committed funds for implementation of BMPs, the cost effectiveness in reducing nutrient export from this watershed can be greatly enhanced if these efforts are more directly targeted at those areas of the watershed where potential nutrient sources are greatest.

Hydrology of the landscape within this watershed is extremely complex due to natural geologic features, presence of extensive wetlands and man made canals that enhance drainage of the watershed to Cascade Reservoir (Figure 5). These physical features create a patchwork of different land uses and hydrologic conditions that affect runoff and related water quality throughout the watershed. These intra-basin differences, however, are not readily distinguished by current methods of estimating nutrient loading by monitoring water quality as a single aggregate outflow. Consequently, the resulting loading estimates may provide little information concerning which portions of a heterogenous landscape within a watershed actually contribute a greater proportion of nutrients.

Effectiveness in the selection and implementation of BMPs can be greatly enhanced through identification of smaller sub-basins that can be linked to high sources of nutrients within the context of the larger watershed. Identification of critical sub-basins will be accomplished by partitioning the larger watershed based on hydrologic boundaries (natural and man made), landscape features and land use practices. Water management practices and related water quality will be identified within these smaller scale basins and evaluated based on priority of their individual contribution to the net export of watershed nutrients. BMPs can then be targeted in smaller scale hydrologic units that have a proportionately larger impact on total watershed export of nutrients.

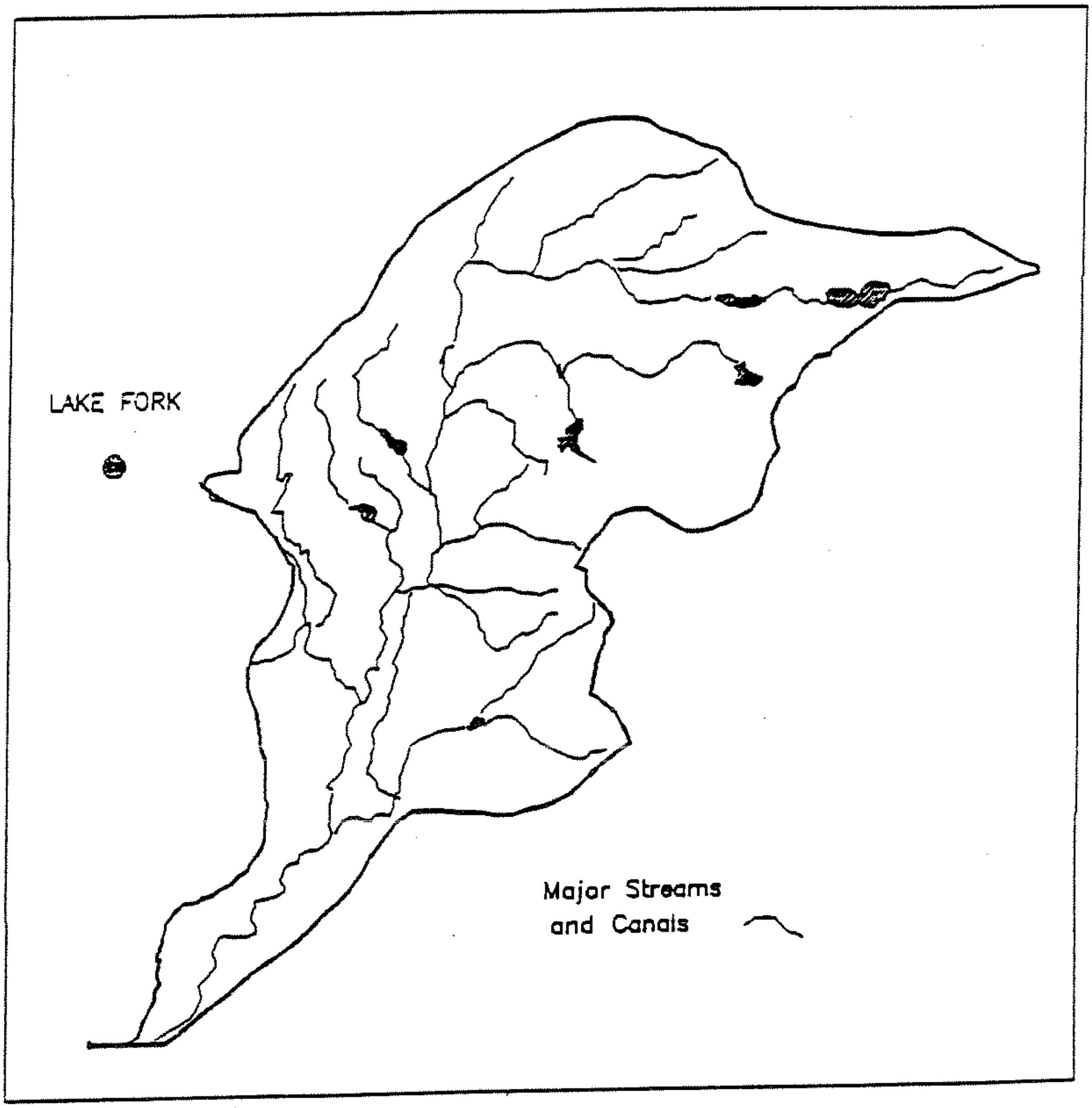
Background: A portion of an existing Phase II 314 Clean Lakes grant has been directed to evaluation of BMP effectiveness at the individual farm level in Boulder Creek (see BMP Effectiveness Monitoring). Implementation of agricultural BMPs are voluntary, requiring a 25% match by the local land owner and generally take several years to implement.

Scope: Integrated remote sensing and GIS will be used to define a high resolution hydrography map of the watershed with related nutrient loading estimates for discrete hydrologic units. All existing canals, ditches, and water control structures will be identified, as well as, the direction of drainage affected by these features. This information and other information layers (land use, topography and water management practices) will be used to define smaller scale hydrologic units. Field measurements will then be made to quantify amount and quality of surface drainage at critical water control structures located at these sub-basin boundaries and will be incorporated as a GIS information layer. All drainage features and control structures will be geographically fixed and referenced to a base map using GPS technology.

Development of these information layers will be synthesized into map products describing the smaller scale hydrologic basins, nutrient loads, direction of water conveyance and other land use/management. These products will be used to improve documentation of BMP effectiveness by more accurately defining areas of potential influence, help to control costs by targeting limited resources more efficiently and maximize efforts to improve lake water quality by selection and implementation of the appropriate BMPs to reduce nutrient loading.

Products of this project will provide valuable data for the improved review, selection and monitoring of BMPs currently being implemented under Phase II. In addition, several wet detention projects will be constructed and evaluated for their efficiency in the

Figure 5. Boulder Creek watershed.



removal of phosphorus under a complimentary 319 project. Establishing the functional relationships between these phosphorus detention facilities, the smaller hydrologic units contributing surface runoff and the importance of these efforts in context with the larger scale watershed will be critical.

A second component of this study will focus on the evaluation and selection of critical riparian habitats, wetlands, other drainage features and land cover types impacted by grazing cattle. These features will be evaluated to determine the relative importance of restoration of these habitats based on their geographic density and potential influence on drainage. They will also be used to monitor the progress of BMP implementation designed to improve these habitats and associated water quality. BMPs implemented to protect and restore riparian habitats will be monitored annually by comparison with a basemap depicting the critical features described above. These annual comparisons will show incremental progress in rates of vegetation regrowth and habitat stability in relation to previous year baseline conditions. Analysis will be correlated and ground truthed with on-going field studies. The resulting water quality databases, imagery analysis and other spatial data will be integrated to assist in the optimization of best management practices and other restoration efforts to improve riparian habitats.

Field monitoring of canal flows and water quality will be conducted as an integral process in the assessment of critical sub-basins and their importance to total watershed nutrient contribution. This proposed sub-basin analysis will be complimented by other on-going efforts of the state (Boulder Creek BMP project, Cascade Reservoir Mass Balance Budget and Boulder Creek 319 Riparian enhancement projects). Sub-basin monitoring will be conducted for one year. Protocols for flow measurements and water quality sampling are listed in Table 4 and 6, respectively (**Data Collection and Analysis**). The number of sites sampled will be determined based on the selection of a sub-watershed. Sampling will be conducted biweekly during spring snow melt and monthly during the irrigation season.

Results of analysis will be used to develop new priority of BMP implementation and accelerate field placement of nutrient control strategies.

THE ABOVE SECTION MAY BE DELETED

1.4 Watershed Soil Nutrient and Erosion Characteristics

Rationale:

Local soil characteristics and erosion of surface materials can have a significant impact on the phosphorus loading rates of a watershed. Sediment bound phosphorus may contribute more than 60% of the estimated phosphorus load to Cascade Reservoir.

Local citizens and land managers have expressed concern that soils are a naturally high source of phosphorus. Efforts to reduce phosphorus should be targeted to only those areas where phosphorus loads exceed natural background levels contributed by soils. Data sources, however, describing erosion rates and the content of phosphorus associated with local soils is not available.

Background:

Soil erosion estimates were initially made by the U.S. Soil Conservation Service based on a field survey in 1988. This survey focused on some of the larger tributary rivers to Cascade Reservoir. No additional data on rates of erosion have been collected since this initial survey. Potential phosphorus loads associated with these sediments were not quantified.

Scope:

Soil transects will be established at roughly 1.0 mile intervals along several of the major tributaries (Table 8; **Data Collection and Analysis**). Each transect is oriented perpendicular to the axis of the stream floodplain and positioned to intersect as many of the local soil series (USDA, Valley County Soil Survey) as possible. Major soil series that will be sampled include Archabal, Gestrin, Roseberry, Donnel, and Melton. Soil surveys will be used to locate and identify a soil series in the field. Soil scientist from the U.S. Soil Conservation Service will provide technical support. Since many of the rivers floodplains are on private property, final orientation will be dependent on local land owner cooperation. All landowners will be contacted for approval to access private lands before samples are collected.

Table 9 (**Data Collection and Analysis**) lists the chemical analysis to be analyzed from each core. Estimates of labile and non-labile fractions of phosphorus will be determined using methods as described. Soils representing a range of in-situ moisture conditions will be analyzed for differences in the proportion of labile and non-labile phosphorus present.

Changes in channel cross-section profile will be measured annually. These measures will provide an estimate of the amount of stream bank material eroded or re-deposited from upstream erosion. A cross-section profile of each stream channel and floodplain will be determined for representative channel types. At least 2 channel sites will be measured for each stream reach. Channel types will be classified using the Rosgen Stream Classification system (Rosgen, 1994). Protocols for the channel measurements and stream sediment sampling are listed in Table 10 (**Data Analysis and Collection**).

1.5 BMP Effectiveness Monitoring

Rationale: Many of the nutrient BMP phosphorus reduction coefficients, the amount of phosphorus a particular BMP will reduce, expressed as a percentage of load generated, are based on national literature searches or specific research results. Since none of this kind of research has taken place in Valley County there exists some degree of uncertainty as to the accuracy of these reduction coefficients. It remains to be seen whether or not the BMPs perform as predicted. To address this problem specific BMPs implemented in the Cascade area must be monitored to see if they are meeting the expected removal efficiencies. Once this body of information has been accumulated more accurate phosphorus load production and removal numbers can be established, which will bring the estimated phosphorus loads attributed to specific land uses and their reductions closer to actual monitored results. Another aspect of BMPs once implemented, is to evaluate whether or not they are having the desired affect in terms of load reductions in the reservoir and subwatersheds.

Background: To arrive at more accurate site-specific phosphorus load and removal coefficients, a certain number of each structural and managerial BMPs will have to be monitored. Once monitored, the actual coefficients can then be compared to the predicted values and removal strategies adjusted accordingly. Monitoring of both in-reservoir conditions and tributaries should be conducted to demonstrate if all BMPs implemented though out the watershed are achieving the estimated phosphorus load reductions. If not modifications to the Plan will be made through the feedback loop.

Scope: It is impractical to monitor each BMP implemented in the Cascade watershed for purely logistical reasons. Acknowledging this fact, it is clear that a certain number of each BMP will have to be monitored and the results applied against all similar BMPs. This strategy holds regardless of the agency conducting the BMP effectiveness monitoring. The agency responsible for implementing a BMP, is generally also responsible for ensuring some level of BMP effectiveness monitoring. DEQ will be conducting some of this BMP effectiveness monitoring unilaterally and cooperating in some others, such as the SAWQP and IDFG projects. VSWCD, in their SAWQP Operation Plan commit to monitor at least one structural and one management practice in Willow, Boulder and Mud Creeks annually (Appendix G).

Pages 12 and 31 of this plan detail DEQ's strategy and frequency for BMP effectiveness monitoring of wet detention removal projects (ponds). Page 15 and 17 detail how BMP effectiveness monitoring will occur at the individual farm level and for riparian grazing management changes. Tributary BMP effectiveness monitoring is described on page 8, locations are shown in Figure 3 and dates in Table 3. BMP effectiveness (goal attainment) is described on page 19, locations on Figure 6 and dates in Table 3.

Objective #2

2.1 Quantify and validate water column chlorophyll a (CHLA) and total phosphorus (TP) relationships, monitor changes in TP and CHLA response to reductions in external TP loading and document that frequency and severity of algal blooms and the presence of noxious aquatic weeds are reduced.

Rationale: Cascade Reservoir has been classified eutrophic based on phosphorus loading data and measures of plankton productivity (chlorophyll standing crop). The rate and quantity of nutrients entering the reservoir can radically alter the balance of available nutrients and algal production leading to nuisance growth of algae blooms and aquatic vegetation. Target goals for lower concentrations of water column phosphorus (20 µg/L TP) and chlorophyll a (8.5 µg/L) have been established that will result in significant improvements in water quality. Computer simulations indicate these objectives can be achieved with a 30% reduction in the current phosphorus loading. Monitoring of the reservoir response to the reduction in phosphorus loading is required to ascertain if water column concentrations in phosphorus are reduced to the desired amount. Monitoring data will additionally be used to relate standards for phosphorus with biological criteria defining nuisance growth for algae and aquatic vegetation.

Background: Early studies of Cascade Reservoir (Clark and Wroten, 1975; Klahr, 1990; Ingham, 1992) indicated water quality conditions decline along a north to south gradient. Four reservoir stations along this gradient have been sampled annually since 1985 by volunteer groups (Cascade Reservoir Association), the Bureau of Reclamation (BOR) or DEQ. Historical trends in water column phosphorus concentrations and corresponding measures of chlorophyll a suggest these indicators may be increasing in concentration over time (Figure 1). Additional monitoring stations were established in 1992 to evaluate spatial aspects of phosphorus and chlorophyll distribution within the reservoir and related trophic status.

Scope: A network of 8 stations will be routinely monitored annually May - October (Figure 6). Surface and bottom water quality samples are collected every three weeks. Protocols for reservoir sampling are listed in Table 11 (**Data Collection and Analysis**). Field samples will be collected to determine spatial variation in phosphorus and chlorophyll distribution in relation to trophic indices. Station data will be averaged by discrete depth and concentrations in TP and CHLA compared over time to determine effectiveness of efforts to reduce external sources of phosphorus loading. Information will additionally be used to partition sources of internal recycling of nutrients. Samples of phytoplankton are also collected for enumeration of dominant taxa.

OBJECTIVE #3

3.1 Refinement of Existing Predictive Reservoir Model

Rationale: Predictive models are frequently used to evaluate potential impacts of nutrient loading and estimate how increases or decreases in supply of nutrients could result in changes in the biological productivity of a receiving lake or reservoir. Models are often used in the TMDL process as a guide to determine feasibility of mitigation efforts and whether efforts are adequate to achieve a desired standard for improvement of water quality. These models are also useful in establishing a frame of reference for estimating how quickly water quality improvements may occur in response to reductions of external loading. Several modeling efforts are needed for Cascade Reservoir to further address questions concerning affects of power plant operation on water quality (selective withdrawal), importance of internal recycling of nutrients, and predict changes in water quality related to annual variability of water inflows, nutrient loadings and reservoir drawdown.

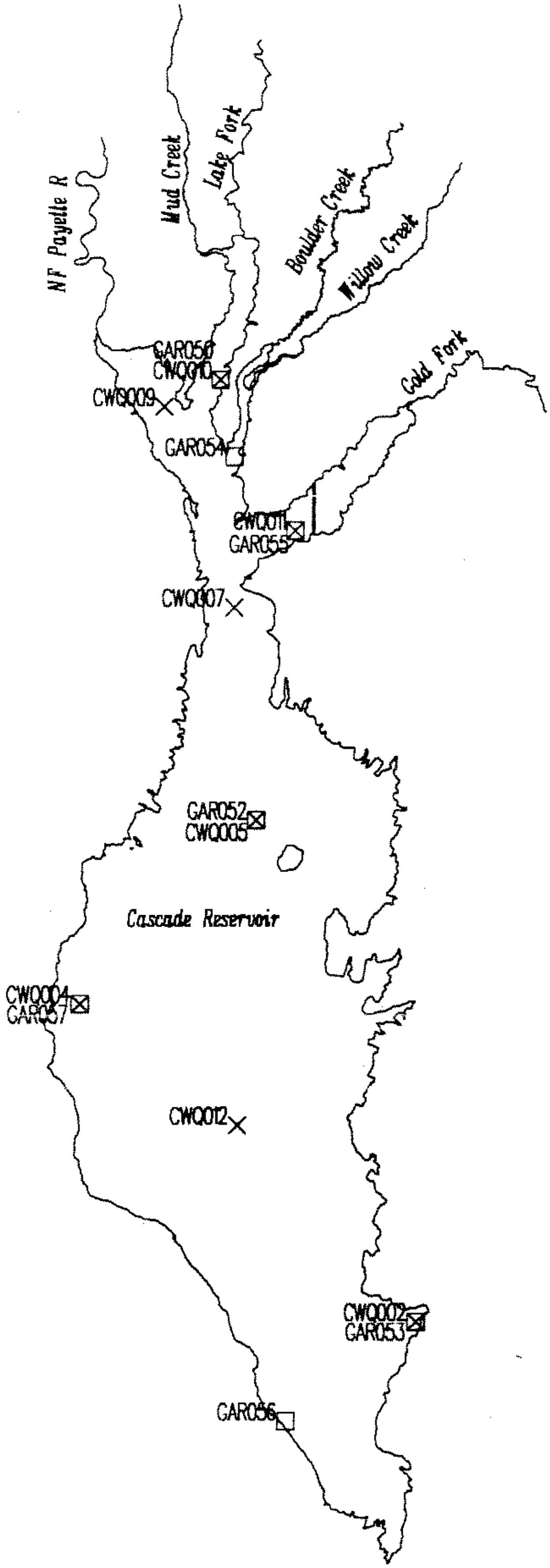
Background: A computer simulation model was developed for Cascade Reservoir through a private consultant in 1990. This model provides some simulation capability to evaluate reservoir water quality in response to external nutrient loading. Utility of the model has been limited due to the lack of available information required to refine aspects of the model dealing with reservoir operation, sediment dynamics and variability in annual loading rates.

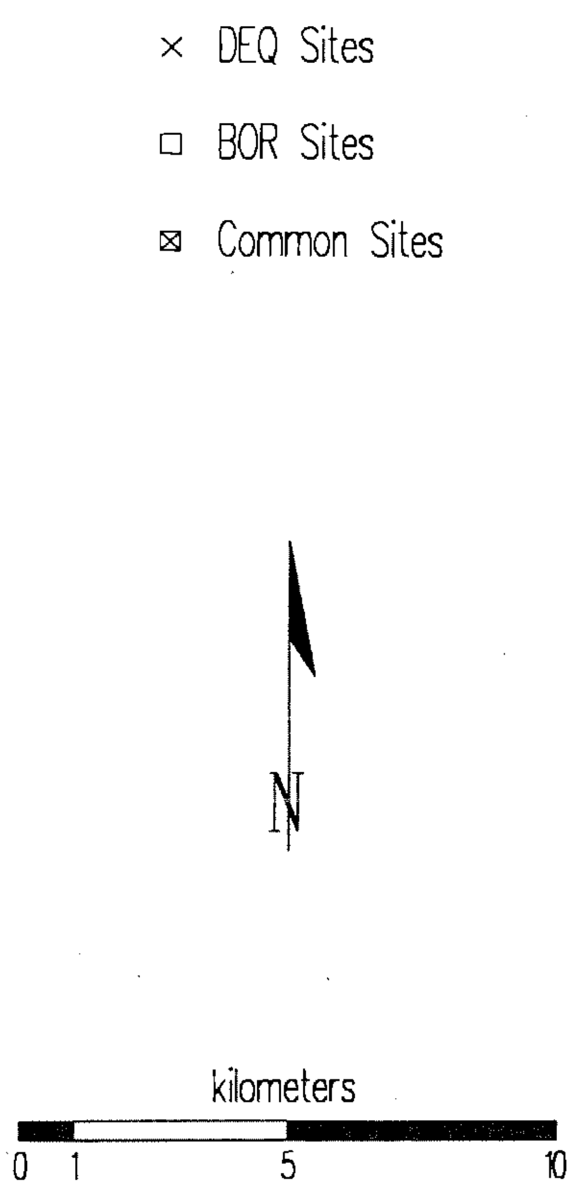
Additional modeling capabilities are needed to assess changes in hydrology and nutrient transport within the watershed. An expanded capability to simulate watershed nutrient and water transport would provide better information to analyze and characterize effectiveness of various best management practices.

Scope: The objective of this task is to adapt an existing 2-dimensional reservoir model developed by the Tennessee Valley Authority (BETTER MODEL) for use with Cascade Reservoir. A second component of this task will modify and enhance capabilities of a 1-dimensional model previously developed for Cascade Reservoir (Cascade Model; Chapra, 1990). Each of these models have specific merits in simulation of the reservoir response to nutrient loading. Independent simulations from these respective models will be used as a point of reference for co-validation of the model results. Simulations will be run for different levels of phosphorus removal and annual variations in-flow.

In-lake studies outlined in section 2.0 will be used to provide background data concerning the amount and distribution of nutrients, exchange of water and nutrients among epi and hypolimnion within the reservoir and physical-chemical gradients of temperature and dissolved oxygen. This information will be used by the model to make inferences about relationships between internal lake water quality and external nutrient

Water Quality Monitoring Sites





Projection: UTM Zone 11

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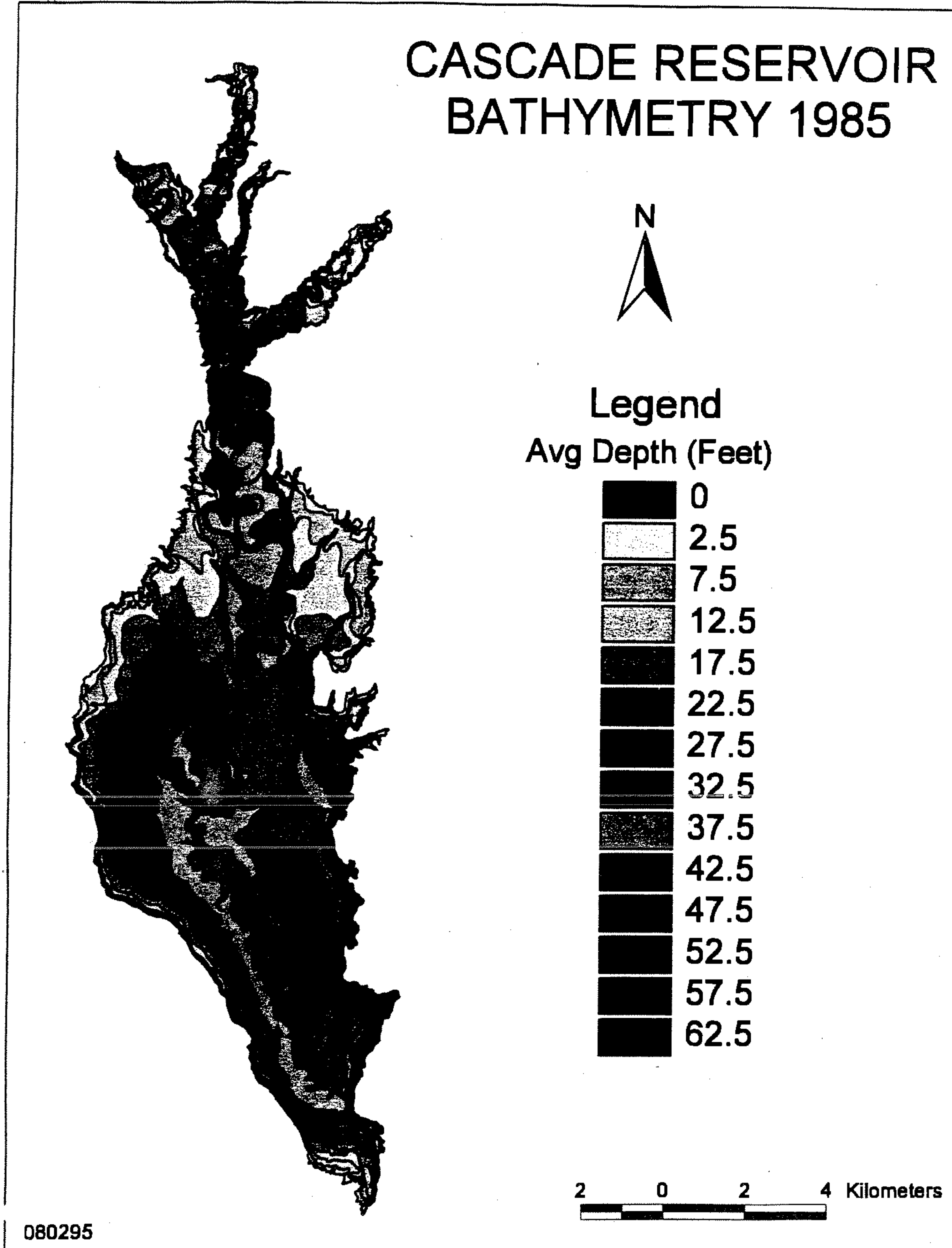
inputs. Other code modifications will be made to integrate sediment feedback mechanisms associated with internal recycling of nutrients. Modifications to model codes will be contracted to a university with specific expertise in computer simulations of reservoir sediment dynamics.

Additional field data sets would be required to adapt the Better model for use with Cascade Reservoir. These data sets include an update of the reservoir geometry to reflect changes in volume storage caused by sedimentation and winter profiles of vertical temperature and oxygen concentrations. An updated map of reservoir depth profiles will be generated from transects spaced at roughly 1.0 km intervals (Figure 7). Depth will be recorded at fixed points using a high resolution depth finder and GPS for horizontal positioning. A three dimensional profile will be generated from transect points to calculate cross-section volumes for various portions of the reservoir. These revised volume estimates will be used to calibrate reservoir storage volume and estimates of epi and hypolimnetic volumes of nutrients. Winter dissolved oxygen profiles will be conducted at 4 sites (CWQ-07, CWQ-05, CWQ-12, and CWQ-02; see Figure 6) to monitor oxygen depletion during ice covered conditions. This information will be critical in determining minimum fish habitat requirements.

Figure 7


CASCADE RESERVOIR
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080295

DATA COLLECTION AND ANALYSIS

The following sections provide descriptions and tables of the specific collection and analysis techniques that will be followed for each monitoring project. A summary of the scheduled sampling is listed in Table 3.

Table 3. Schedule of field sampling for Cascade Reservoir watershed.

MONITORING SCHEDULE	INFLOWS	INFLOW BACTERIA	IN-LAKE WQ	IN-LAKE BACTERIA	PONDS
3/12/95	X				
3/26/95	X				
4/9/95	X		X		
4/23/95	X				
5/7/95	X	X	X	X	X
5/21/95	X	X			X
6/4/95	X	X	X	X	X
6/18/95	X	X			X
7/2/95	X	X	X	X	X
7/16/95					X
7/30/95	X	X	X	X	X
8/13/95					X
8/27/95	X	X	X	X	
9/10/95					
9/24/95	X	X	X	X	
10/8/95					
10/22/95	X		X		
11/5/95					
11/19/95	X		X		
12/3/95					
12/17/95	X				
12/31/95					
1/14/96	X				
1/28/96					
2/11/96	X				
2/25/96					
3/10/96	X				
3/24/96	X				
4/7/96	X		X		X
4/21/96	X				X
5/5/96	X	X	X	X	X
5/19/96	X	X			X
6/2/96	X	X	X	X	X
6/16/96	X	X			X
6/30/96	X	X	X	X	X

Methods:

Stream Flow and Water Quality Sampling

Stream site descriptions and frequency of measurement/collection are listed in Table 3. Protocols for field measurement are outlined in Table 4. Stream flow is a function of water velocity and the amount of water passing through a known cross-section area of a stream channel. These measurements are normally taken at several increments across a stream width. Each increment gives a sub-total of the measured flow, and the whole is calculated by summing the increments. For water depths of less than 4 feet, estimates of water of water velocity are made using the six tenths estimate (0.6 %) of the average stream depth from water surface. At water depths greater than 4 feet, estimates of water velocity should be made using the 2 point method (velocity is the average of measurements taken at 0.2 and 0.8 of the depth from water surface). Under very high flow conditions when stream wading is not possible, a bridge board is used to obtain estimates of flow velocity.

Water quality sampling includes in-situ measurement of physicochemical parameters and collection of samples for nutrient and sediment analysis (Table 5 and Table 6). Samples for nutrient analysis and sediment analysis are stored in plastic cubitainers on ice and returned to an EPA certified laboratory for analysis within 24 hours. Dissolved nutrients are determined by filtering samples through a disposable 0.45 µm glass fiber filter. All reusable filter holders must be washed with 1.0 molar HCL and triple rinsed with distilled water prior to use. Only new cubitainers are used for storage and transport of water samples.

Table 4. Tributaries and other sources monitored for bulk watershed loadings.

Tributary or Sources Monitored	Associated Watershed	Sample Frequency	Site Descriptions	GPS[3]-Location
<u>Inflow Stations</u>				
N. Fork Payette River	Payette River	1, 2	N. Fork Payette River at Hartzel Bridge	-116°08'26.09"W/ 44°47'23.83"N
Gold Fork River	Gold Fork	1, 2	Gold Fork River at HWY 55	-116°03'04.58"W/ 44°41'56.32"N
Lake Fork Creek	Lake Fork	1, 2	Lake Fork R near Scheline Rd crossing	-116°05'03.45"W/ 44°46'29.75"N
Boulder Creek	Boulder Creek	1, 2	Boulder Ck west 150' from HWY 55	-116°00'32.29"W/ 44°37'18.43"N
Mud Creek	Mud Creek	1, 2	Mud Ck at Norwood Rd crossing near reservoir	-116°06'31.42"W/ 44°43'39.69"N
Willow Creek	Willow Creek	1, 2	Willow Ck at Old State HWY	-116°04'03.04"W/ 44°43'02.13"N
Poison Creek	West Mountain	1, 2	Poison Ck at West Mountain Rd crossing	-116°06'40.12"W/ 44°39'58.85"N
<u>Other Sources</u>				
N.F. Payette @ Dam Outflow	Reservoir	2	North Fork Payette River at Cascade Dam	-116°00'59.63"W/ 44°46'43.73"N
N.F. Payette @ Payette Lake Dam	Payette Lake	2	North Fork Payette River at @ Payette Lake, McCall	-116°02'19.13"W/ 4°49'34.88"N
BOR Office	Rainfall	2	Rainfall Quality	

1 = Biweekly April - July (see attached schedule Appendix 1)
2 = Monthly August - March (see attached schedule Appendix 1)
3 = GPS coordinates in Degrees, Minutes, Seconds of Latitude and Longitude

Table 5. Field Procedures for stream flow measurement - wadable conditions. (Procedures adapted from EPA Stream Monitoring Guidelines, EPA 1993.)

Meter Check - Marsh McBirney operation

1). Check calibration of Marsh-McBirney flow meter operation. Meter readout should approximate 100 with function dial set to calibrate and probe connected, exposed only to air. Handle probe with care. The probe is pressure sensitive and can be damaged by shock due to collision with other objects.

2). Check zero value by placing probe in a bucket of water and allow probe to operate for 10 minutes. The probe should record 0.0 velocity ± 0.1.

Water depth < 1.0 meters

1). Identify a stable bank area to take measures of flow velocity. Look for armored sections of the channel with well defined banks and uniform bottom profiles if possible.

2). Determine the distance between bank wetted edges by stretching a meter tape perpendicular to the stream axis. Use rebar or other stake material to identify location and secure measuring tape.

3). Right wetted edge is determined by looking upstream. Always set dead end of tape or zero end on right bank.

4). Take measurements of flow velocity at 0.6 times the water depth from a minimum of 15 equally spaced points along the measurement tape between the right and left wetted edges of the stream channel (i.e., wetted width is 4.5 meters take measurements at every .3 m intervals). Record the water depth and flow velocity at the meter mark of the left and right wetted edges (LWE or RWE) and at each measuring point along the channel cross-section.

5). With probe attached to measurement rod, record the maximum depth at the measuring point, then set depth of the flow meter with probe oriented parallel to the direction of stream flow. You may need to rotate measuring rod slightly right or left to get maximum velocity reading. Record the highest average flow reading observed over a 15-30 second interval. Record if any plant material or other obstructions such as bars or logs that may modify flow in the immediate area of the flow measurement.

6). Repeat step (5) for each distance increment across the stream.

Water depth > 1.0 meters

1). Follow procedures 1 - 6 above except that velocities are measured at two depths for each measurement increment.

2). With probe attached to measurement rod, record the maximum depth at the measuring point, then set depth of the flow meter probe at 0.8 times the depth and oriented parallel to the direction of stream flow. Record highest average velocity after 15-30 seconds. Re-adjust depth of probe to 0.2 times the depth and record highest average velocities. You may need to rotate measuring rod slightly right or left to get maximum velocity reading. Record if any plant material or other obstructions such as bars or logs that may modify flow in the immediate area of the flow measurement.

3). Repeat step (2) for each distance increment across the stream.

Table 5. (continued) Field Procedures for Stream Flow Measurement during high flow conditions.

	Water depth > 1.0 meters
1).	Follow procedures 1 - 6 above except that velocities are measured at two depths for each measurement increment.
2).	With probe attached to measurement rod, record the maximum depth at the measuring point, then set depth of the flow meter probe at 0.8 times the depth and oriented parallel to the direction of stream flow. Record highest average velocity after 15-30 seconds. Re-adjust depth of probe to 0.2 times the depth and record highest average velocities. You may need to rotate measuring rod slightly right or left to get maximum velocity reading. Record if any plant material or other obstructions such as bars or logs that may modify flow in the immediate area of the flow measurement.
3).	Repeat step (2) for each distance increment across the stream.
	Bridge Board Measurements
1).	This method is used for high flow conditions when streams can not be measured by conventional wading methods. Measurements are usually taken from a bridge or other stable structure. Flows are measured using the 0.2 and 0.8 method. **See 1 and 2 above.**
2).	With probe attached to cable and weight, lower weight to bottom of stream channel and record the maximum depth at the measuring point, then set depth of the cable weight and flow meter probe at 0.8 times the depth and oriented parallel to the direction of stream flow. Record highest average velocity after 15-30 seconds. Re-adjust depth of cable weight and probe to 0.2 times the depth and record highest average velocities. You may need to rotate cable weight and probe slightly right or left to get maximum velocity reading. Record if any plant material or other obstructions such as bars or logs that may modify flow in the immediate area of the flow measurement.
3).	Repeat step (2) for each distance increment across the stream.

Table 6. Water Quality Parameters Monitored

PARAMETERS	STORET #	MDL[1]-UNITS	METHODS
NO_2+NO_3 as N	00631	.005 mg/L Methods	EPA Method 353.2
NH_4 as N, Total	00610	0.005 mg/L	EPA Method 350.1
TKN	00625	0.05 mg/L	EPA Method 351.2
Tot.Phosphorus	00665	0.005 mg/L	EPA Method 365.4
Ortho-Phos.	00671	0.001 mg/L	EPA 365.2
Suspended Sediment	80154	<2 mg/L	EPA 160.2
Total Solids	00500	<2 mg/L	EPA ?
Chloride	00940	<0.9 mg/L	EPA Method 325.3
Fecal Coliform	31625	#/100 ml	Standard Methods
Fecal Strep	31673	#/100 ml	Standard Methods
Field Parameters			
Flow	00060	cfs	Electronic measurement for instantaneous flow measurement
Temperature	00010	°C	Point and continuous
Oxygen, Diss.	00300	mg/L	DO meter
Specific Conductivity	00095	µmhos	Conductivity meter
pH	00403	SU	pH meter

[1] = Minimum Detection Limits

Table 7. Protocols for Water Quality Sampling

Nutrient, Ions, Total Solids, and Suspended Sediment Sampling

1). Prepare sample bottles and filters 24 hours prior to collection of samples. Two one liter (1.0 l) cubitainers will be used for bulk sample storage, one unpreserved and one acid preserved with 2.0 ml concentrated H_2SO_4. Cubitainers come collapsed. You need to expand the bottles prior to adding acid or a water sample. Do not blow air into the bottle to expand the volume for acid addition or a water sample. Use a clean blunt object made of plastic to reshape and expand the bottle. If it is necessary to blowup the container, rinse the bottle with DI water before adding acid (make sure as much of the bottle is empty as possible before adding acid. Place a yellow piece of tape on the acid preserved bottle top. Dissolved nutrients will be filtered into a 200 ml autoclave plastic container with no preservative. Cubitainers with acid should not be allowed to sit for more than three days prior to use.

2). In the field, water samples are collected with the model DH48 sediment sampler. Remove the glass collection bottle and triple rinse the container with the local stream water. Also triple rinse the churn splitter and top with local stream water. A depth integrated cross-section of the stream is subsampled by slowly lowering the sampler from the surface to the bottom at randomly selected points across the stream width. Begin collecting samples on one edge of the stream channel and include subsamples from representative areas of the stream profile, i.e., main channel and any shallow areas or side channels. Make sure the inlet to the sample bottle on the DH48 is oriented into the stream current and the sampler is located upstream away from turbulence caused by your body or feet.

3). As the collection bottle in the DH48 fills, empty the bottle into the churn splitter.
Move to the next collection point along the stream width. Repeat steps 2 and 3 until a complete cross-section of the stream channel has been subsampled.

4). Fill the two 1.0 liter cubitainers from the churn splitter spout while continuously mixing the churn splitter. Fill cubitainers to the top and try to eliminate any air. Be careful not to overfill the acid preserved bottle. If this occurs, discard sample and use a new bottle with acid.

5). Dissolved nutrients are sampled from the churn splitter using a large volume plastic syringe. Mix the churn splitter and draw a sample of water into the syringe. Make sure the volume of the syringe is filled. Discard this sample and repeat this process 2 additional times. Place filter holder on the end of the syringe and force sample through the filter into the autoclave plastic vile. Rinse the vile with the filtered water and discard. Fill the vile to the top with filtered sample water and replace top.

Physicochemical Parameters pH, Conductivity, Dissolved Oxygen, Temperature

1). Physicochemical parameters are normally measured using electronic probes such as a HydroLab H20 (ph, Conductivity, D.O., Temp), YSI Model 54 Oxygen Meter (Temp, D.O.) or YSI Conductivity meter (Temp, Conductivity) and/or Orion pH meters (Temp, pH).

2) All instruments will be calibrated using manufacture guidelines prior to use in the field (see calibration procedure for YSI Oxygen probes Appendix Table 1).

3). Additional on-site calibration will be made for measurement of dissolved oxygen by comparisons using a winkler titration method. This step is normally completed at the first sample station.

4). In the field, place probes in the main flow channel and allow to equilibrate for ten minutes. Probes should be completely submerged. Record readings on data sheets or to a computer file (HydroLab).

Pond and Wetland Monitoring - Phosphorus Detention

Pond and wetland monitoring sites will be sampled by automated samplers programmed to collect a composite of water quality over a two week period. Samples will be removed from the automated samplers, stored in a cooler and transported to the office for consolidation of sample bottles. Bottles representing discrete samples will be combined in a churn-splitter, thoroughly mixed and the appropriate aliquot stored in cubitainers for laboratory analysis. Samples requiring preservation will be acid preserved after sub-sets have been combined.

Composite samples will be analyzed for total constituents (Table 7). Component nitrogen species will be analyzed to obtain estimates of total nitrogen. Addition of spikes will be utilized at the beginning of each two week interval of automated sample collections. These spikes will remain inside the automated sampler and will be removed with the following batch of samples submitted for analysis. Analysis of these spikes will provide an estimate of the change in recovery due to on-site holding conditions.

Table 8. List of wet detention pond sample parameters and estimates of collection numbers. Estimates are for annual monitoring (April - November).

Parameter	# Inflow* Water Sites	# Outflow* Water Sites	# QA/QC	Freq. Annual	Total Annual
Total P	3	3	2	12	96
TKN	3	3	0	12	72
No_3+No_2	3	3	2	12	96
NH_3	3	3	2	12	96
Susp. Solids	3	3	0	12	72
Total Solids	3	3	2	12	96

* Monitoring sites include
  - (1) BOR ponds
  - (1) Existing Ponds (Control)
  - (1) DEQ/SCS Constructed Ponds

Watershed Soil Transects and Stream Sediment Analysis

Replicate samples will be collected from each soil series encountered along a numbered soil transect. Table 8 lists the soil transects completed in 1995 and transects to be sampled in 1996. The number of sites sampled will vary according to the number of soil series found along each transect. Each sample site will be numbered sequentially and identified by transect number (i.e. T2-5 designating transect 2 sample site number 5).

Soil cores from dry areas of the floodplain and upland terraces will be collected from the surface 10 cm depth after removal of the sod or vegetation layer. Samples will be extracted using a piston soil sampler and stored in plastic bags for laboratory analysis. Location of the sample site and transect will be identified on the soil series map and by GPS coordinates. Field conditions will be noted such as proximity of sample site to irrigation ditches, amount of ground cover present, type of cover, and relative grazing intensity.

Submerged soils in streams will be collected with a PVC core and driven into the substrate to a depth of approximately 150mm. The intact soil core will be placed into a single plastic bag and labeled. If distinct soil horizons are present, each horizon will be measured for depth of horizon, separated into an individual bag and labeled accordingly. Analysis of soils will include estimates of the percent sand, silt and clay present in each core (Bouyoncos, 1951; 1962). This analysis will be contracted to the University of Idaho analytical services laboratory.

Dry bulk density will be computed from percent dry weights of the soil sub-sample, wet weight and volume of the original soil core for both stream and land transects. Percent dry weight will be extrapolated to determine dry weight of the depth increment. Bulk density will be expressed as g dry weight/cm^3 of soil for each depth increment.

Table 9 lists the chemical analysis to be analyzed from each core. Estimates of labile and non-labile fractions of phosphorus will be determined using methods as described. Soils representing a range of in-situ moisture conditions will be analyzed for differences in the proportion of labile and non-labile phosphorus present.

Changes in channel cross-section profile will be measured annually. These measures will provide an estimate of the amount of stream bank material eroded or re-deposited from upstream erosion. A cross-section profile of each stream channel and floodplain will be determined for representative channel types. At least 2 channel sites will be measured for each stream reach. Channel types will be classified using the Rosgen Stream Classification system (Rosgen, 1994). Protocols for the channel measurements are listed in Table 10.

Table 9 . Watershed Soil Transects

Watershed	Transect Numbers	Soil Series
Boulder Creek	T-3, 4, 5, 6, 7, 8	Roseberry-Donnel/Archabal-Gestrin
Willow Creek	Not Completed	Roseberry-Donnel
Lake Fork	T-1, 9, 10, 11, 13	Roseberry-Donnel/Archabal-Gestrin
Mud Creek	T-12, 14	Roseberry-Donnel/Archabal-Gestrin
N. Fork Payette	Not completed	Melton-Jurvannah/Roseberry-Donnel/Archabal- Gestrin/Swede-Donnel
Gold Fork River	Not completed	Melton-Jurvannah/Roseberry-Donnel/Archabal-Gestrin/Swede-Donnel

Table 10. Soil chemistry analysis for stream and land transect samples.

Parameter	Method
ph	measured by adding 10.0 gm dry weight equivalent of soil sub-sample mixed with 20 ml deionized water. This soil/water mixture will be allowed to settle and pH obtained from the liquid after 30 minutes.
Extractable Inorganic N	known sample extracted with 1M KCL solution (1:100 soil to extractant on a soil dry basis), shaken for 1 hour, and then filtered (0.45 um pore membrane filter). Filtered extract analyzed for ammonium -N using an automated salicylate-nitroprusside method 351.2 (EPA, 1983).
HCL Extractable Cations	1M HCL extract prepared as in HCL extractable P and analyzed for Ca, Mg, Fe, and Al using inductively coupled argon plasma (ICAP) spectrometry method 200.7 (EPA,1983).
Bicarbonate Extractable P	1 g dry weight equivalent of wet soil extracted with 25 ml of 0.5M $NaHCO_3$ solution (pH=8.5), shaken for 30 minutes, soil suspension filtered (0.45 um pore membrane filter) and analyzed for soluble reactive P (SRP) and total P. A sub-sample of the extract (10 ml) is digested using a potassium persulfate digestion method 4500-P (APHA, 1989). Digested volume is analyzed using automated ascorbic acid method 365.1 (EPA, 1983). P fractions will be reported as P^i(inorganic P or soluble reactive P) and P_o (organic P).
HCL Extractable P	5.0 g of dry soil extracted with 25 ml of 1M HCL for three hours, filtered (0.45 um pore membrane filter) and analyzed for SRP using method 365.1 (EPA, 1983) and total P using block digestion and automated ascorbic acid method 365.4 (EPA,1983). HCL-P_i represents the Ca bound P fraction.
Total P	1.0 g dried weight combusted at 550°C for 4 hours in a muffle furnace. Ash residue dissolved in 20 ml of 6M HCL, then heated to evaporate to dryness. Residue redissolved in 2.25 ml 6M HCL, heated again and filtered (Whatman #42 filter) and brought to 50 ml volume and analyzed for total P using method 3050 (EPA, 1983).
Total N	finely ground (100 mesh) samples analyzed for total N and C using a Leco Combustion Analyzer

Table 11. Field Protocols for stream cross-section profiles (Methods adapted from EPA, 1993; Bauer and Burton, 1993; Wolman, 1954; Rosgen 1994; Ray and Megahan, 1979)

1. Select a representative stream reach based on stream slope and Rosgen channel type. Make sure culverts, bridges or other obstructions are not present within or near the channel reach to be measured. A minimum 100 meter length of channel will be measured. A greater length may be required based on the channel width characteristics.

2. At site, determine Bank Full Width (BFW). Multiply BFW by 20 to get total distance of reach to be surveyed. A minimum 100 meter length of stream reach will be measured. Divide total distance by 10 to get transect spacing (i.e a 100 meter length of stream will be divided into 10 equally spaced cross-section transects numbered 1-10).

3. Establish initial point with flagging. Take flow, pH, conductivity and dissolved oxygen measurements at T-1 location, which should be transect number 1.

4. At transect (T-1) 1, 2, 5, 7, 8, 10 do channel cross sections measurements for wetted width (WW) only. Try and get at least 14 measurements across transect i.e. if WW is 4.5 meters in width take measurements at every .3 m intervals. Determine BFW and depth to water surface. Measure WW and water depth at prescribed intervals. Take bank angle for both banks by laying a measurement rod on the bank and measure angle in degrees deviation from horizontal. Measure length and angle of bank undercut.

5. At T-3, 6, and 9 do a Wolman pebble count along with channel cross section, bank angle and sediment cores in channel and at wetted edge of stream <u>if possible</u>. If sediment cores are taken, note which type of PVC pipe used, clear or white, length of core in PVC in mm, date and stream name. <u>If T-3, 6, 9 do not fall on riffle move transect to nearest upstream riffle, note distance on field sheet.</u>

6. Right bank is determined by looking upstream. Always set dead end of tape or zero end on right bank. Estimate stream slope with clinometer.

7. Throughout the entire stream reach, approximate the linear meters of stream bank stability according to the following:

   <u>Covered & Stable (non-erosional)</u> - more than 50% of bank surfaces are covered by vegetation in rigorous condition or covered by armored materials (large rocks). Stream banks appear stable and no evidence of cutting, breakdown, shearing or slumping.

   <u>Covered & Unstable (vulnerable)</u> - over 50% covered of bank surfaces are covered by vegetation in rigorous condition or covered by armored materials (large rocks). Streambanks appear unstable with evidence of breakdown, cracking, sloughing, cutting or slumping. Recent evidence of erosion is typified by vertical or near vertical banks with little or no regrowth.

   <u>Uncovered & Stable (vulnerable)</u> - less than 50% of streambank surfaces are covered with vegetation in vigorous condition or covered by armored materials. Stream banks appear stable and no evidence of cutting, breakdown, shearing or slumping. Banks may be bare but they appear to be holding together and are not vertical.

   <u>Uncovered & Unstable (eroding)</u> - less than 50% of banks are covered by vegetation in vigorous condition or by armored materials. Streambanks appear unstable with evidence of breakdown, cracking, sloughing, cutting or slumping. Recent evidence of erosion is typified by vertical or near vertical banks with little or no growth.

Reservoir Water Quality Sampling

Chemical and physical parameters monitored at each station are listed in Table 11. Nutrient samples are collected with a Kemmerer sampler and stored in 1.0 liter cubitainers. All samples are stored on ice until delivered to the State Lab for analysis. Site characteristics are listed together with GPS coordinates in Table 12. Several of these stations are identical to sites monitored by the Bureau of Reclamation .

Procedures for field sampling are listed in Table 13. Chlorophyll samples are collected by Kemmerer sampler at the secchi depth (SD; approximately 2 m). Samples are transferred to cubitainers or filtered on-site through a glass fiber filter for concentration of phytoplankton. Sufficient sample volume is filtered so that a green tint can be seen on the glass filters (approximately 250 - 1000 ml depending on density of algae). Filter papers are preserved with addition of calcium carbonate solution (adding 3-5 drops of a solution 5 gm $CaCO_3$/100 ml DI water), folded into quarters and sealed in tin foil. The volume of water filtered is recorded on the outside of the foil. Any samples stored in cubitainers will be filtered for CHLA analysis within 12 hours of collection.

Representative phytoplankton samples are collected by Kemmerer bottle or by towing an 80 micron mesh plankton net at the surface for five minutes. Samples are transferred to plastic bags or cubitainers and preserved with lugols preservative. The type of collection, discrete grab or time integrated net sample, is recorded on the field sheets and phytoplankton bottles.

Table 12. List of reservoir sample parameters and estimates of collection numbers. Estimates are for annual monitoring (April - November).

Parameter	# Surface Water Sites	# Bottom Water Sites	# QA/QC	Freq. @ 3 week	Total Annual
Total P	8	8	2	9	162
Ortho-P	8	8	2	9	162
Dissolved P	8	8	2	9	162
TKN	8	8	2	9	162
NO_3+NO_2	8	8	2	9	162
NH_3	8	8	2	9	162
Susp. Solids	8	8	0	9	144
CHLA	8	0	0	9	72

Table 13. Cascade Reservoir water quality sampling site locations and descriptions. Adjacent sites previously monitored by the Bureau of Reclamation are listed.

Site Name	Location		Description
	Longitude	Latitude	
CWQ 02	-116°03'09.61"	44°31'22.70"	West 100' from eastern shoreline above dam (approximately 100' south of buoy line)
CWQ 04	-116°08'26.48"	44°35'04.65"	North and east 1000' from Hurd Creek on western shore.
CWQ 05	-116°05'34.80"	44°38'36.50"	West 300' from westernmost tip of Sugarloaf Island
CWQ 07	-116°05'59.10"	44°39'35.90"	In the center of the Reservoir, 1000' below the Poison Creek boat ramp
CWQ 09	-116°07'05.23"	44°41'54.46"	Near western shore, 500' above North Fork Payette River/Lake Fork confluence
CWQ 10	-116°06'11.70"	44°42'12.46"	Center of Lake Fork arm 1000' north of the North Fork Payette River/Lake Fork confluence
CWQ 11	-116°05'00.20"	44°40'28.43"	Center of the Gold Fork arm, 500' west of old Railroad grade
CWQ 12	-116°05'00.20"	44°32'32.50"	Center of Reservoir, above Van Wyck Creek

Table 14. Cascade Reservoir Sampling Procedures.

1). Calibrate the DO/Temp meter or Hydrolab unit (see calibration procedures appendix A).

2). Locate the sample sites using GPS (see coordinates listed in Table 7).

3). Anchor boat. Record any unusual conditions i.e., presence of blooms.

4). Take DO/Temp/Conductivity/pH profile at each station location at 1 m intervals. Begin by placing the probes on the bottom of the reservoir and take measurements from bottom - up. Record maximum depth.

5). Record Secchi Disk Depth - lower unit over side and record depth at which the disk disappears. Record to nearest tenth meter.

6) Lower the Kemmerer to SDD; divide sample into;

a) 1-liter nutrient cubitainer (with H_2SO_4)
b) 1-liter alkalinity/hardness/nutrient cubie (this is the unpreserved sample)
c) 250 ml bottle for algae identification (with Lugol's)
d) 1-liter cubitainer for chlorophyll

SDD Replicate Samples - Replicate samples of the above parameters are taken at two randomly selected stations.

7). Lower the Kemmerer to 1 m off bottom; divide sample into:

1) 1-liter nutrient cubitainer (with H_2SO_4)
2) 1-liter alkalinity/hardness/nutrient cubitainer (this is the unpreserved sample)

Bottom Replicate Samples - Replicates are taken at two randomly selected stations.

8). Store samples in cooler on ice. Record weather and lake conditions on data sheet. Make sure all bottles, tags, etc.., are clearly marked for date, time on ID.

9). Record weather and lake conditions on data sheet. Make sure all bottles, bags, etc.. are clearly marked for date, time and station I.D.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC):

All sample analysis will follow approved EPA or Standard Methods procedures. Laboratory facilities conducting chemical analysis will be EPA certified. Any deviations from standard or approved methods will be documented.

Automated Water Quality Samplers: QA/QC

Addition of spiked samples will be utilized at the beginning of each two week interval of automated sample collections for monitoring. These spikes will remain inside the automated sampler and will be removed with the following batch of samples submitted for analysis. Analysis of these spikes will provide an estimate of the change in recovery due to on-site holding conditions. A second set of containers will be spiked at the time of sample retrieval and submitted for analysis with remaining samples to measure laboratory analytical precision. These results will be used to determine percent recovery of a specific analyte by analytical method and the potential loss due to absorption to bottle surfaces during the two week sample storage period.

Water Quality Grab Samples

All water quality samples will be fixed and filtered in the field as required at the time of collection. Addition of spikes and duplicate sample results from selected stations will be used for assessment of field and laboratory techniques. Samples will be spiked by addition of a known amount of analyte and submitted with each sample collection or at a projected rate equal to 10% of the total samples collected. Duplicate samples will be collected at a single sample location for each monitoring program to determine media variability. Overall precision of the sampling and analytical methods will be evaluated by analyzing duplicate samples collected at the same time and location. Average relative range and average coefficient variation will be reported.

Blank samples will be used to determine laboratory equipment accuracy and precision and to assess sample handling errors and biases. Blank samples will be submitted with each sample batch and treated as other collected samples to duplicate handling, storage, and transportation methods.

Physical-chemical Parameter Measurement:

Physical-chemical parameters will be measured in the field using electronic meters as described below:

pH: Orion Model 230A pH Meter

Conductivity: Yellow Springs Instrument Model 33

Dissolved Oxygen: Yellow Springs Instrument Model 54A

Instantaneous Temperature: Yellow Springs Instrument Model 54A

Hydrolab Multi-probe: Model H20; dissolved oxygen, conductivity, pH, temperature

Field instruments will be maintained and calibrated according to manufacture's specifications and as outlined in Appendix Table 3. Meters used to measure pH, conductivity, temperature and dissolved oxygen will be calibrated each day of sample collection. Calibration logs will be maintained to record errors and trends in equipment operation.

Inter-laboratory Comparisons

As part of the quality assurance program, independent verification of laboratory results will be conducted with a third party laboratory. Comparisons of analytical results will be obtained through analysis of split samples from a designated sample site. A sufficient sample volume will be collected and analyzed for the identical constituents from each laboratory. Comparisons will include analysis of duplicate raw water samples, addition of spikes with known concentrations of a specific analyte, and comparisons of blanks. These comparisons will be made during scheduled sampling in the spring and winter months. Any discrepancies in test comparisons exceeding ten percent will be repeated during the next scheduled sampling event. Should the results continue to exceed acceptable errors, a review of field and laboratory methods will be initiated to correct potential problems.

DATA MANAGEMENT

Designated field crew(s) will be responsible for the accuracy and completeness of all field collection efforts. Field notes and other pertinent data will be recorded on pre-printed field sheets. Any deviations from standard sampling procedures will be recorded on the field sheets at the time the specific sampling is conducted. All field sheets should be reviewed for completeness prior to leaving a sample site. Any scheduled sampling of a particular parameter that can not be completed due to equipment problems, weather or other factors will be noted on the field sheets. This will avoid confusion and prevent unnecessary attempts to locate missing data. Copies of field sheets will be retained in the Cascade Satellite Office and in the Boise Regional Office.

Field data and laboratory results will be transferred to electronic spreadsheets. Current information will be entered into the appropriate spreadsheets and checked for accuracy of data entry. Any changes in the spreadsheet entries will be checked and verified. Copies of these spreadsheets will be maintained in the Cascade Satellite Office and in the Boise Regional Office.

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APPENDIX 1

LABORATORY SHEETS

PROJECT ACCOUNT CODE: 84-82310E92-000-5017

STATE OF IDAHO
Department of Health & Welfare
BUREAU OF LABORATORIES
WATER QUALITY REPORT
CHEMICAL REPORT

Lab Name (Check One):
- [x] Boise
- [ ] Coeur d Alene
- [ ] Idaho Falls
- [ ] Lewiston
- [ ] Pocatello
- [ ] Twin Falls

STUDY NAME: CASCADE LAKE INFLOW SAMPLING

STORET NO.

EPDES NO.:

Date of Collection (Yr., Mo., Day) ______

Time of Collection (If No Clock: Circle One) Depth (Meters)

Sampling Point Location: ______

Date Submitted (Yr., Mo., Day) ______

Submitted by: D. WORTH

PURPOSE OF SAMPLING (Check One)
- [x] Intensive Survey
- [ ] Trend
- [ ] Compliance
- [ ] Other ______

TYPE OF SAMPLES (Check appropriate boxes)
- [ ] Wastewater
- [ ] Raw
- [ ] Flow
- [ ] Chlorinated
- [ ] Grab
- [x] Cross Composite
- [ ] Depth Integrated
- [ ] Composite Begin End

SAMPLES TAKEN FROM (Check one)
- [ ] Spring
- [ ] Creek
- [x] River
- [ ] Reservoir
- [ ] Well
- [ ] Lake
- [ ] Lagoon
- [ ] STP
- [ ] Industry
- [ ] Drain

PRESERVED SAMPLES SUBMITTED
- [x] Cooled, 4 C
- [ ] HNO3
- [x] H2SO4
- [ ] NaOH
- [ ] Other

DEMAND (mg/L)

STORET CODE		
(00310)	[ ]	BOD5 (Est ______
(00335)	[ ]	COD Low Level / High Level
(00680)	[ ]	TOC ______

NUTRIENTS (mg/L)

(00610)	[x]	T. Ammonia as ______
(00615)	[ ]	T. Nitrite as ______
(00620)	[ ]	T. Nitrite as ______
(00630)	[x]	T. NO2 + NO3 as N ______
(00625)	[x]	T. Kjeldahl Nitrogen ______
(00665)	[x]	T. Phosphorus as P ______
(00669)	[ ]	T. Hydrolyzable Phosphorus as P ______
(70507)	[x]	Ortho Phosphate as P ______
(00671)	[x]	Dissolved o-Phosphate ______

MINERALS (mg/L)

(00095)	[ ]	Sp. Conductance (umhos/cm) ______
(00900)	[ ]	Hardness as CaCO3 ______
(00410)	[x]	T. Alkalinity as CaCO3 ______
(00425)	[ ]	Bicarbonate Alk. as CaCO3 ______
(00430)	[ ]	Carbonate Alk. as CaCO3 ______
(00916)	[ ]	Calcium ______
(00927)	[ ]	Magnesium ______
(00929)	[ ]	Sodium ______
(00937)	[ ]	Potassium ______
(00940)	[x]	Chloride ______
(00951)	[ ]	Floride ______
(00945)	[ ]	Sulphate as SO4 ______
(00956)	[ ]	Silica as SiO2 ______

Miscellaneous

(00076)	[ ]	Turbidity (NTU) ______
(00403)	[ ]	pH (SU) ______
(00720)	[ ]	Total Cyanide (mg/L) ______
(00116)	[ ]	Intensive Survey No. ______

RESIDUE (mg/L)

STORET CODE		
(00500)	[x]	Total Residue ______
(00530)	[x]	Non-Filterable Residue (105 C) (Suspended Solids) ______
(70300)	[ ]	Filterable Residue ______
(80154)	[ ]	Non-Filterable Residue (110 C) (Susp. Sediments) ______
( )	[ ]	Other Residue ______

TRACE METALS (ug/L)

DISSOLVED METALS

(01000)	[ ]	Arsenic, Dissolved ______
(01020)	[ ]	Boron, Dissolved ______
(01025)	[ ]	Cadmium, Dissolved ______
(01030)	[ ]	Chromium, Dissolved ______
(01040)	[ ]	Copper, Dissolved ______
(01046)	[ ]	Iron, Dissolved ______
(01049)	[ ]	Lead, Dissolved ______
(01056)	[ ]	Manganese, Dissolved ______
(71890)	[ ]	Mercury, Dissolved ______
(01065)	[ ]	Nickel, Dissolved ______
(01075)	[ ]	Silver, Dissolved ______
(01090)	[ ]	Zinc, Dissolved ______
( )	[ ]	Other ______
( )	[ ]	Other ______

TOTAL METALS

(01002)	[ ]	Arsenic, Total ______
(01022)	[ ]	Boron, Total ______
(01027)	[ ]	Cadmium, Total ______
(01032)	[ ]	Chromium, + 6 ______
(01034)	[ ]	Chromium, Total ______
(01042)	[ ]	Copper, Total ______
(01045)	[ ]	Iron, Total ______
(01051)	[ ]	Lead, Total ______
(01055)	[ ]	Manganese, Total ______
(71900)	[ ]	Mercury, Total ______
(01067)	[ ]	Nickel, Total ______
(01077)	[ ]	Silver, Total ______
(01092)	[ ]	Zinc, Total ______
( )	[ ]	Other ______
( )	[ ]	Other ______

RETURN TEST RESULTS TO

Name: DEWEY WORTH

Address: P.O. Box 247

City: CASCADE State: IDAHO Zipcode: 83611

Date Completed ______ Date Reported ______

Chemist ______

Remarks: LOW DECTION LIMITS FOR PHOSPHORUS

PROJECT ACCOUNT CODE:
84-8231E92-000-5017

STATE OF IDAHO
Department of Health & Welfare
BUREAU OF LABORATORIES
WATER QUALITY REPORT
CHEMICAL REPORT

Lab Name (Check one): [X] Boise [ ] Coeur d Alene [ ] Idaho Falls [ ] Lewiston [ ] Pocatello [ ] Twin Falls

STUDY NAME: CASCADE LAKE

STORET NO.

NPDES NO.:

Sampling Point Location:

SURFACE

Date of Collection (Yr., Mo., Day)

Date Submitted (Yr., Mo., Day)

Time of Collection (24 Hr Clock) 12:38 Depth (Meters) BOTTOM (Circle one: DH DBH OVR)

Submitted By: D. NORTH

TYPE OF SAMPLES (Check appropriate boxes)

[ ] Wastewater [ ] Raw [ ] Flow [ ] Chlorinated
[X] Grab [ ] Cross Composite [ ] Growth Integrated
[ ] Composite Begin End

SAMPLES TAKEN FROM (Check one)

[ ] Spring [ ] Creek [ ] River [X] Reservoir [ ] Well
[ ] Lake [ ] Lagoon [ ] STP [ ] Impound [ ] Drain

PRESERVED SAMPLES SUBMITTED

[X] Cooled, 4 C [ ] HNO3
[X] H2SO4 [ ] NaOH [ ] Other

PURPOSE OF SAMPLING (Check One)

[X] Intensive Survey [ ] Trend
[ ] Compliance [ ] Other

RESIDUE (mg/L)

STORET CODE			
(00500)	[X]	Total Residue	
(00530)	[X]	Non-Filterable Residue (105 C) (Suspended Solids)	
(70300)	[ ]	Filterable Residue	
(00534)	[ ]	Non-Filterable Residue (110 C) (Susp. Sediments)	
( )	[ ]	Other Residue	

DEMAND (mg/L)

STORET CODE			
(00310)	[ ]	BOD5 (Est.	
(00335)	[ ]	COD Low Level / High Level	
(00680)	[ ]	TOC	

NUTRIENTS (mg/L)

(00610)	[X]	T. Ammonia as	
(00615)	[ ]	T. Nitrite as	
(00620)	[ ]	T. Nitrate as	
(00630)	[X]	T. NO2 + NO3 as N	
(00625)	[X]	T. Kjeldahl Nitrogen	
(00665)	[X]	T. Phosphorus as P	
(00669)	[ ]	T. Hydrolyzable Phosphorus as P	
(70507)	[X]	Ortho Phosphate as P	
(00671)	[X]	Dissolved o-Phosphate	

MINERALS (mg/L)

(00095)	[ ]	Sp. Conductance (umhos/cm)	
(00900)	[ ]	Hardness as CaCO3	
(00410)	[X]	T. Alkalinity as CaCO3	
(00425)	[ ]	Bicarbonate Alk. as CaCO3	
(00430)	[ ]	Carbonate Alk. as CaCO3	
(00916)	[ ]	Calcium	
(00927)	[ ]	Magnesium	
(00929)	[ ]	Sodium	
(00937)	[ ]	Potassium	
(00940)	[X]	Chloride	
(00951)	[ ]	Fluride	
(00945)	[ ]	Sulphate as SO4	
(00956)	[ ]	Silica as SiO2	

Miscellaneous

(00076)	[X]	Turbidity (NTU)	
(00403)	[ ]	pH (SU)	
(00720)	[ ]	Total Cyanide (mg/L)	
(00116)	[ ]	Intensive Survey No.	

TRACE METALS (ug/L)

DISSOLVED METALS

(01000)	[ ]	Arsenic, Dissolved	
(01020)	[ ]	Boron, Dissolved	
(01025)	[ ]	Cadmium, Dissolved	
(001030)	[ ]	Chromium, Dissolved	
(01040)	[ ]	Copper, Dissolved	
(01046)	[ ]	Iron, Dissolved	
(01049)	[ ]	Lead, Dissolved	
(01056)	[ ]	Manganese, Dissolved	
(71890)	[ ]	Mercury, Dissolved	
(01065)	[ ]	Nickel, Dissolved	
(01075)	[ ]	Silver, Dissolved	
(01090)	[ ]	Zinc, Dissolved	
( )	[ ]	Other	
( )	[ ]	Other	

TOTAL METALS

(01002)	[ ]	Arsenic, Total	
(01022)	[ ]	Boron, Total	
(01027)	[ ]	Cadmium, Total	
(01032)	[ ]	Chromium, + 6	
(01034)	[ ]	Chromium, Total	
(01042)	[ ]	Copper, Total	
(01051)	[ ]	Iron, Total	
(01051)	[ ]	Lead, Total	
(01055)	[ ]	Manganese, Total	
(71900)	[ ]	Mercury, Total	
(01067)	[ ]	Nickel, Total	
(01077)	[ ]	Silver, Total	
(01092)	[ ]	Zinc, Total	
( )	[X]	Other CHLOROPHYLL a	
( )	[ ]	Other	

RETURN TEST RESULTS TO

Name
DEWEY NORTH

Address
1420 N. HILTON

City	State	Zipcode
BOISE	IDAHO	83704

Date Completed   Date Reported

Chemist

Remarks: LOW DETECTION LIMITS FOR PHOSPHORUS

WATER FILTERED FOR CHL a -

Water Quality Sampling Field Data Sheet

Sample Site Information

Name of Water Body: ____________ Site No. ____________

Sampling Date: ___/___/___ Time: ____________

Site Water Depth (m): ____________

Hydrolab Filename: ____________

Field Data

Depth (m)	Temp (°C)	pH	Cond	D.O. (ppm)	%Sat	Secchi (m)
(Surface) 0						
(Bottom*) 1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Lab Request

	Chl A	Phyto. ID	Nutrients	Nut & acid	Bac-t	Algae tox
Surface:						
Rep. #1						
Rep. #2						Sent: / /
Bottom:						
Rep. #1						
Rep. #2						

*or two-point readings only

Watershed ____________________ Site: ____________________

Date ____________________ Time ____________________

Hydrolab Filename ____________________ .HYD (Laptop use only)

Manual (or Scout 2) Physical Parameter Readings

T (°C)	pH	Cond. (µS)	% DO Sat.	DO (ppm)	Depth (m)	Battery (V)

Discharge Measurement Notes

STORET No.		Notes:
Crew	Meter Type	

Dist. From Initial Point	Width (ft)	Depth (ft)	Obs. Depth	Revo-lutions	Velocity At Point	Velocity Mean in Vertical	Area	Discharge

Page:	Compiled by:	Checked by:	Q Total: cfs

PROJECT ACCOUNT CODE:
34-91004P00-000-5019

STATE OF IDAHO
Department of Health & Welfare
BUREAU OF LABORATORIES
WATER QUALITY REPORT
CHEMICAL REPORT

Lab Name (Check One)
- [x] Boise
- [ ] Cour d Alene
- [ ] Idaho Falls
- [ ] Lewiston
- [ ] Pocatello
- [ ] Twin Falls

STUDY NAME: CASCADE LAKE INFLOWS

STORET NO.

NPDES NO.:

Date of Collection (Yr., Mo., Day): ______

Time of Collection: Depth (Meters) SURFACE
(24 Hr Clock) Circle one: CM CBM DVM

TYPE OF SAMPLES (Check appropriate boxes)
- [ ] Wastewater
- [ ] Raw
- [ ] Final
- [ ] Chlorinated
- [ ] Grab
- [x] Cross Composite
- [ ] Depth Integrated
- [ ] Composite Begin End

SAMPLES TAKEN FROM (Check one)
- [ ] Spring
- [ ] Creek
- [ ] River
- [x] Reservoir
- [ ] Well
- [ ] Lake
- [ ] Lagoon
- [ ] STP
- [ ] Industrial
- [ ] Drain

PRESERVED SAMPLES SUBMITTED
- [x] Cooled, 4 C
- [ ] HNO3
- [x] OTHER Lugol's Iodine
- [ ] H2SO4
- [ ] NaOH

Sampling Point Location: ______

Date Submitted (Yr., Mo., Day) ______

Submitted By: DON LEE

PURPOSE OF SAMPLING (Check One)
- [x] Intensive Survey
- [ ] Trend
- [ ] Compliance
- [ ] Other ______

( ) [x] Other Phytoplankton I.D. & Percent Composition

( ) [ ] Other ______

Date Completed ______ Date Reported ______

Chemist ______

Remarks:

RETURN TEST RESULTS TO

Name
DON LEE

Address
1445 NORTH ORCHARD

City	State	Zipcode
BOISE	IDAHO	83706

Idaho Department of Health and Welfare
BUREAU OF WATER QUALITY · BUREAU OF LABORATORIES

COLIFORM DENSITY TESTS

See Back For Instructions

LAB NAME (Check One)
- ☐ Boise
- ☐ Caldwell
- ☐ Coeur d'Alene
- ☐ Idaho Falls
- ☐ Lewiston
- ☐ Pocatello
- ☐ Twin Falls

TYPE OF SAMPLE (Check Appropriate Boxes)
☐ Wastewater ☐ Raw ☐ Final ☐ Chlorinated ☐ Grab
☐ Composite: Begin ________ End ________
☐ Surface Water ☐ Cross Composite ☐ Depth Integrated

PURPOSE OF SURVEY
☐ Intensive Survey ☐ Trend
☐ Compliance ☐ Other

PRESERVED SAMPLES SUBMITTED
☐ Cooled, 4° C ☐ Sodium Thiosulfate

* 1 - TOTAL COLIFORM (MF) STORET Code (31501)
2 - FECAL COLIFORM (MF) STORET Code (31616)
3 - FECAL STREP (MF) STORET Code (31679)

Date Submitted (Yr.Mo.Day)

Collected By

SAMPLE TAKEN FROM (Check Appropriate Boxes)
☐ Spring ☐ Creek ☐ River ☐ Reservoir ☐ Lake
☐ STP ☐ Industrial ☐ Well ☐ Drain ☐ Lagoon

LOCATION	STORET NO.	NPDES NO.	DATE (Yr.Mo.Day)	TIME 24 Hr. Clock	DEPTH Meters Circle	*	Est. Count	DIL	NO. MLS	COUNT	OFFICE USE
* 00116–						1					
						2					
					OM OBMI OVMI	3					
* 00116–						1					
						2					
					OM OBMI OVMI	3					
00116–						1					
						2					
					OM OBMI OVMI	3					
00116–						1					
						2					
					OM OBMI OVMI	3					
* 00116–						1					
						2					
					OM OBMI OVMI	3					
* 00116–						1					
						2					
					OM OBMI OVMI	3					
* 00116–						1					
						2					
					OM OBMI OVMI	3					
00116–						1					
						2					
					OM OBMI OVMI	3					
00116–						1					
						2					
					OM OBMI OVMI	3					
* 00116–						1					
						2					
					OM OBMI OVMI	3					
* 00116–						1					
						2					
					OM OBMI OVMI	3					

COPIES OF RESULTS TO

Set Up Date | Set Up Time | Date Completed | Date Reported

Name

Remarks

Microbiologist

Address

City, State, Zip

*Intensive Survey Section

APPENDIX 2

D. O. METER CALIBRATION PROCEDURES

Field Instrument Calibration Procedures:

Dissolved Oxygen Meters

YSI Model 50

Air Calibration with Pressure Correction:

1) Place plastic bottle with water sponge or other wet material over end of probe (a wet rag can also be used covering the membrane)

2) Switch control knob to **Temp** °C

3) Allow temperature to stabilize and record reading

4) Look up solubility of oxygen in the enclosed table at the specified temp value

5) Multiply the above table value by the local altitude correction value (Boise is roughly 2200 ft msl) and divide this number by 100 ; this gives the correct D.O. value for water saturated air corrected for the local altitude and temperature.

example: suppose meter temp = 22°C at an elevation of 2200 ft msl (Boise)

computed D.O. = (8.74 mg/L * 92)/100] = 8.04 mg/L

6) Switch selection knob to **mg/L**. Compare the meter reading with the calculated D.O. value in step 5 above. If the meter reading is off by more than 5% of the computed air value, correct the calibration as described in step 7 below.

7) Switch function knob to **mg/L CAL**. Using the key pads under the display digits, set the calibration value for D.O. as determined in step 5 above.

8) Switch function knob to **mg/L**. The display should read **CAL**. A tone will sound in a few seconds followed by the calibration value entered in step 7 above. Observe the reading to see how much drift is recorded in the value. Repeat calibration if displayed value varies greatly.

YSI Model 54

Air Calibration with Pressure Correction:

1) Place plastic bottle with water sponge or other wet material over end of probe (a wet rag can also be used covering the membrane)

2) Switch control knob to **Temp** ° C

3) Allow temperature to stabilize and record reading

4) Look up solubility of oxygen in the enclosed table at the specified temp value

5) Multiply the above table value by the local altitude correction value (Boise is roughly 2200 ft msl) and divide this number by 100 [example: (8.92 mg/L * 95)/100]; this gives the correct D.O. value for water saturated air corrected for the local altitude and temperature.

6) Switch selection knob to appropriate **PPM** range. Compare the meter reading with the calculated D.O. value in step 5 above. If the meter reading is off by more than 5% of the computed air value, adjust the calibrate knob until the meter reads the corrected D.O. value computed in step 5. Wait two minutes to verify calibration stability.

APPENDIX E

BOISE NATIONAL FOREST, PAYETTE NATIONAL FOREST, AND INDUSTRY WATERSHED MANAGEMENT PLANS

(Complete document available upon request)

Requested Input to Idaho Department of Health and Welfare
Division of Environmental Quality for
Cascade Reservoir Watershed Management Plan
Phased Total Maximum Daily Load (TMDL)
January 16, 1996

Documentation for the U.S.D.A. Forest Service

Boise National Forest
Cascade Ranger District
Cascade, Idaho

and

Payette National Forest
McCall Ranger District
McCall, Idaho

Boise and Payette National Forest - Interim Phased TMDL Plan
January 16, 1996 - Version 2.0

Description

This is the Interim Phased TMDL Plan for the Boise and Payette National Forests in response to a request for a plan to meet the interim 30 percent reduction goal for National Forest System Lands. This document contains the information the forests feel is important to give a clear picture of where we are and where we need to go to improve water quality flowing into Cascade Reservoir. This format was determined at the meeting held on December 14, 1995 by the Environmental Protection Agency, Idaho Department of Health and Welfare-Division of Environmental Quality (DEQ), U.S. Forest Service (Boise and Payette NF) and Boise Cascade, Corp. at the DEQ office in Boise.

There are three sections to this document.

Part I
- Watershed Setting
- Monitoring and Analysis (water quality and soils)
- Results Background and current phosphorus levels measured on National Forest Systems Lands.
- Future - Monitoring and Analysis.
- Schedule to Achieve 30% Reduction Goal.

Part II
- Methods and Assumptions
- List of Projects Completed
  - Summary of completed projects by the Boise and Payette National Forest, with estimates of Phosphorus reduction and cost of projects.
- List of Future Projects to be Completed
  - Future projects to be implemented by the Boise and Payette National Forest, with estimates of Phosphorus reduction and cost of projects.
- Schedule of Implementation
- Monitoring (BMP, Effectiveness, Implementation)

Appendix
- References
- Calculations
- Monitoring Project Summary Forms
- Monitoring Results Summary Reports

Part I

Watershed Setting

The Boise National Forest ownership falls within three subwatershed: Gold Fork River, North Fork Payette River and West Mountain. Both the Gold Fork and North Fork Payette River/West Mountain subwatersheds will be addressed with this document. The Gold Fork subwatershed discussions will focus on the upper portion of the subwatershed with discussions covering Boise National Forest ownership.

The Payette National Forest ownership falls within three subwatersheds: Gold Fork, Lake Fork, and, Upper North Fork Payette River. Only the Gold Fork Watershed will be addressed with this document and will focus on the Kennally Creek portion. Lake Fork has not been monitored due to lack of activity. The Upper North Fork Payette Watershed is being monitored in conjunction with DEQ and the Big Payette Lake Water Quality Council. At present nutrient loads collected at the lake outlet are within background levels. A full report and management plan is scheduled to be completed in 1997-98.

Monitoring and Analysis

Both the Boise and the Payette National Forests have been involved in monitoring water quality in cooperation with the Idaho Department of Health and Welfare, Division of Environmental Quality (DEQ) and Boise Cascade in the Cascade Reservoir watershed for the past few years. Monitoring protocols have been discussed by all groups and results shared.

The following is a summary of the monitoring completed that will aid in establishing background and current phosphorus load levels from National Forest System lands. Information collected includes a combination of discharge, total phosphorus (TP), and dissolved ortho-phosphate (O-PO4) concentrations, fecal coliform, dissolved oxygen (DO), total suspended sediments (TSS), water temperature, bank stability and soils. Monitoring Summary Reports are located in the Appendix.

Water Quality

West Mountain/North Fork Payette River Sub-Watersheds

Water quality monitoring on the southwest side of Cascade Reservoir, has occurred over the past 4 years (1991-1995) by the Boise National Forest. Nine streams have been monitored above and below the Cascade Reservoir Allotment (grazing) which also reflect upslope activities such as: roads, timber harvest, fire suppression and natural wildfires. Three streams monitored are ungrazed, which also reflect land uses such as roading, harvest, and fire. Sample parameters include: total phosphorus, ortho-phosphate, fecal coliform, fecal strep and total suspended sediments (1 year only), discharge, and temperature. Analysis completed includes a summary by water year with the average phosphorus concentration, phosphorus load and flux, and comparison to the state standards and EPA recommended criteria.

Stream Name	Flow	Temp	DO	Fecal Strep.	Fecal Coli	TP	O-PO4	TSS
2TN Gibson Creek	91-95	-	92	92	92,94-95	91-95	91-95	94-95
Wolf Pasture	91-95	-	92	92	92	91-95	91-95	94-95
Deer Creek	91-95	91,94-95	92	92	92,94-95	91-95	91-95	94-95
Silver Creek	91-95	91,94-95	92	92	92-94-95	91-95	91-95	94-95
TS Silver Creek	91-95	-	92	-	95	91-95	91-95	94-95
Van Wyck Creek	91-95	91,94-95	92	92	92-94-95	91-95	91-95	94-95
2TN Hazard Creek	91-95	-	92	92	92	91-95	91-95	94-95
Hazard Creek	91-95	-	92	92	92	91-95	91-95	94-95
2TN Cambell Ck	91-92	-	-	92	92	91-92	91-92	
Campbell Creek	91-95	91,94-95	92	92	92	91-95	91-95	94-95

Water quality sampling and flows were not continuous over the 1991 year.

Gold Fork River Sub-Watershed

Water quality monitoring within the Gold Fork River watershed, has occurred over the past three years (1992-1995) by the Boise National Forest. Four stations within the Gold Fork River watershed reflect land used such as roads, timber harvest, natural fires, and un-managed areas. Monitoring is specifically related to the Spruce Creek Timber Sale. Sample parameters include: total phosphorus, ortho-phosphate, fecal coliform and dissolved oxygen (1 year only), total suspended sediments, discharge, and temperature. Analysis completed includes a summary by water year with the average phosphorus concentration, phosphorus load and flux, and comparison to the state standards and EPA recommended criteria.

Stream Name	Flow	Temp	DO	Fecal Strep.	Fecal Coli	TP	O-PO4	TSS
Gold Fork River	92-95	92-94	92	-	92	92-95	92-95	94-95
North Fork Gold	92-95	92-94	92	-	92	92-95	92-95	94-95
South Fork Gold	92-95	92-94	92	-	92	92-95	92-95	94-95
Spruce Creek	92-95	92-94	92	-	92	92-95	92-95	94-95
Foolhen Creek		92-94	-	-	-	-	-	-
Lodgepole Creek		92-94	-	-	-	-	-	-

Gold Fork River/Kennally Creek Sub-Watershed

Water quality monitoring within the sub-watershed has occurred during 1992-1995 on the Payette National Forest. Monitoring stations are located in Rapid Creek, Powelson Creek, Kennally Creek, and South Fork Kennally Creek. The South Fork Kennally station was added in 1993. Both SF Kennally and Powelson stations were discontinued in 1994. The Kennally Creek and Rapid Creek stations are located near the Payette National Forest border and represent amounts of phosphorus, and other parameters, being exported from the watershed that is managed by the Payette. Land-use in this sub-watershed includes timber harvest, road construction (construction, reconstruction, and maintenance), fire and suppression activities, and sheep grazing. Parameters measured include: discharge, temperature, total phosphorus (TP), and ortho-phosphate (O-PO4). Analysis completed includes a summary by water year with the average phosphorus concentrations, phosphorus load and comparison to the state standards and EPA recommended criteria.

Stream Name	Flow	Temp	DO	Fecal Strep.	Fecal Coli	TP	O-PO4	TSS
Rapid Creek	92-95	92-95	-	-	-	92-95	92-95	-
Powelson Creek	92-93	92-93	-	-	-	92-93	92-93	-
Kennally Creek	92-95	92-95	-	-	-	92-95	92-95	-
SF Kennally	93	93	-	-	-	93	93	-

Soils

One question raised during the TMDL process was, "How much phosphorus is in soil?" In answering this question, we asked Forest Service researchers for help. In-cooperation with the Forest Service Intermountain Research Station, (Mike Amacher-Logan, UT and Jim Clayton-Boise, ID), Boise Cascade Corp. and the Boise National Forest, in-channel sediment, reservoir edge soil, riparian areas and upland site soils samples were collected to be analyzed for bioavailble phosphorus. Bioavailable P measured by the Iron-strip (Fe-strip) method originates mostly from the organic and Fe and Al oxide fractions of sediments (Sharpley and Halvorson 1994; Amacher et al. 1995). This sampling was completed to give a baseline evaluation of phosphorus levels within the soils locally and to see if additional monitoring would be beneficial. Mike Amacher is currently completing a final report for this project.

<u>West Mountain/North Fork Payette River Sub-Watershed</u>

Soil sampling within the West Mountain sub-watershed was completed on a limited basis in 1995. Three locations were sampled. Two in-channel deposition sites were sampled in Silver Creek and in Wolf Pasture. One sediment sample was taken at the reservoir shoreline (below high water) in Silver Creek.

<u>Gold Fork River/Kennally Creek Sub-Watersheds</u>

Soil sampling within the Gold Fork River sub-watershed was completed on a limited basis in 1995. In-cooperation Boise Cascade Corp and Boise National Forest sampled: in-channel sediment, upland, and riparian area soil samples were collected to be analyzed for bioavailable phosphorus. On the Boise National Forest: 10 samples on upland/riparian sites and 4 in-channel sites were sampled. On the Payette National Forest: 7 upland/riparian sites were sampled.

Results

Water Quality

West Mountain/North Fork Payette River Sub-Watershed

Water quality summary reports are in the Appendix for 1992, 1993, 1994 and 1995 and contain additional information about analysis completed. Below is a brief summary of the trends.

Phosphorus Data Overtime

	Above Allotment				Below Allotment+			
Total Phosphorus Concentration (mg P/l)*								
Description	1992	1993	1994	1995	1992	1993	1994	1995
Grazed Streams	0.047	0.037	0.040	0.034	0.054	0.042	0.048	0.041
Ungrazed Streams	0.049	0.031	0.055	0.030	0.039	0.034	0.036	0.029
Ortho-Phosphate Concentration (mg P/l)								
Description	1992	1993	1994	1995	1992	1993	1994	1995
Grazed Streams	0.019	0.013	0.021	0.019	0.024	0.014	0.021	0.019
Ungrazed Streams	0.020	0.016	0.020	0.024	0.019	0.014	0.031	0.024
Total Phosphours Load (kg/year)								
Description	1992	1993	1994	1995	1992	1993	1994	1995
Grazed Streams	183	462	192	522	130	445	193	639
Ungrazed Streams	110	222	121	229	126	197	125	211
Average Total Phosphorus Flux (kg/km2-year)								
Description	1992	1993	1994	1995	1992	1993	1994	1995
Grazed Streams	11	28	12	36	8	28	12	45
Ungrazed Streams	11	24	14	20	11	19	13	17

+ Above and Below Allotment are relative locations on un-grazed streams. Below allotment stations are above the high water mark of the Reservoir.
* Highlighted and underlined values are those above the 0.05 mg/l EPA recommended criteria.

Over the past four years, statistical comparison using the Mann-Whitney t-test), have been made between grazed and un-grazed streams. Two out of the four years have a significant difference.

Fecal coliform levels in streams were sampled in 1992, 1994 and 1995. In each year, water quality was determined to exceed State of Idaho water quality standards for primary and secondary contact recreation, on grazed streams and seldomly on un-grazed streams. Grazed and un-grazed streams were significantly different for each year sampled.

For the past four years, average total phosphorus load from combining nine streams on the reservoir's south-west side was 590 kg/years. Of this amount, 265 kg/year was in the dissolved ortho-phosphate form (3 years only).

Gold Fork River Sub-Watershed

Water quality summary reports are in the Appendix for 1992, 1993, 1994 and 1995 and contain additional information about analysis completed. Below is a brief summary of the trends.

Description	1992	1993	1994	1995
Gold Fork River - Station # 4 (Boise NF at Boundary)				
Ave. Total Phosphorus Concentration (mg P/l)	0.042	0.036	0.026	0.026
Ave. Ortho-Phosphate Concentration (mg P/l)	0.017	0.014	0.014	0.016
Total Phosphorus Load (kg P/year)	882	2354	1026	3106
Ortho-Phosphate Load (kg P/year)	430	1093	513	1646
Total Phosphorus Flux (kg P/km2-year)	7	20	9	26
Ortho-Phosphate Flux (kg P/km2-year)	4	9	4	14
% OP of Total Phosphorus	49%	46%	50%	53%
North Fork Gold Fork - Station # 7				
Total Phosphorus Load (kg P/year)	549	1139	744	1245
Ortho-Phosphate Load (kg P/year)	290	410	318	692
Total Phosphorus Flux (kg P/km2-year)	5	10	6	10
Ortho-Phosphate Flux (kg P/km2-year)	4	9	4	9
South Fork Gold Fork - Station # 6				
Total Phosphorus Load (kg P/year)	235	384	239	595
Ortho-Phosphate Load (kg P/year)	98	168	135	288
Total Phosphorus Flux (kg P/km2-year)	7	12	7	13
Ortho-Phosphate Flux (kg P/km2-year)	3	5	4	9
Spruce Creek - Station # 10				
Total Phosphorus Load (kg P/year)	64	118	90	225
Ortho-Phosphate Load (kg P/year)	38	64	54	139
Total Phosphorus Flux (kg P/km2-year)	10	19	15	37
Ortho-Phosphate Flux (kg P/km2-year)	6	11	9	26

In a review of published and unpublished phosphorus data from the Pacific Northwest watersheds, Salminen and Beschta (1992) found mean background loads for total phosphorus to be 52 kg/km2-year but ranged from 26 to 100 kg/km2-year. Ortho-phosphorus loads averaged 23 kg/km2-year but ranged from 6 to 58 kg/km2-year. In their review they found in general, forest management practices have limited, if any effect on instream phosphorus levels.

Studies conducted in the Silver Creek watershed, similar geology to Cascade Reservoir, by Intermoutain Research Station (INT) measured phosphorus levels in un-disturbed forested watersheds. Total phosphorus flux levels ranged from 6 to 16 kg/km2-year, with ortho-phosphate ranging from 3 to 7 kg/km2-year (Clayton and Kennedy 1985).

From the data collected on the Boise NF (above table), a baseline total phosphorus flux rate ranged from 5 to 37 kg/km2-year, and ortho-phosphate rate ranged from 3 to 26 kg/km2-year. These levels fall well within the ranges considered to be background, when compared to the above research values.

Gold Fork River/Kennally Creek Sub-Watershed

Rapid Creek

Description	1992	1993	1994	1995
Ave. Total Phosphorus Concentration (mg P/l)	0.028	0.016	0.017	0.014
Ave. Ortho-Phosphate Concentration (mg P/l)	0.009	0.006	0.008	0.008
Total Phosphorus Load (kg P/year)	283	401	247	368
Ortho-Phosphate Load (kg P/year)	124	129	103	179
Total Phosphorus Flux (kg P/km2-year)	0.031	0.049	0.035	0.061
Ortho-Phosphate Flux (kg P/km2-year)	0.012	0.016	0.014	0.028
% OP of Total Phosphorus	44 %	32 %	42 %	49 %

Powelson Creek

Description	1992	1993	1994	1995
Ave. Total Phosphorus Concentration (mg P/l)	0.035	0.025		
Ave. Ortho-Phosphate Concentration (mg P/l)	0.017	0.013		
Total Phosphorus Load (kg P/year)	105	167		
Ortho-Phosphate Load (kg P/year)	52	74		
Total Phosphorus Flux (kg P/km2-year)	0.005	0.029		
Ortho-Phosphate Flux (kg P/km2-year)	0.002	0.011		
% OP of Total Phosphorus	50 %	44 %	%	%

Kennally Creek

Description	1992	1993	1994	1995
Ave. Total Phosphorus Concentration (mg P/l)	0.028	0.020	0.017	0.016
Ave. Ortho-Phosphate Concentration (mg P/l)	0.011	0.009	0.011	0.010
Total Phosphorus Load (kg P/year)	708	794	618	979
Ortho-Phosphate Load (kg P/year)	277	393	392	665
Total Phosphorus Flux (kg P/km2-year)	0.026	0.017	0.047	0.054
Ortho-Phosphate Flux (kg P/km2-year)	0.013	0.008	0.029	0.035
% OP of Total Phosphorus	39 %	50 %	63 %	68 %

SF Kennally Creek

Description	1992	1993	1994	1995
Ave. Total Phosphorus Concentration (mg P/l)	0.017			
Ave. Ortho-Phosphate Concentration (mg P/l)	0.010			
Total Phosphorus Load (kg P/year)	278			
Ortho-Phosphate Load (kg P/year)	109			
Total Phosphorus Flux (kg P/km2-year)	0.087			
Ortho-Phosphate Flux (kg P/km2-year)	0.044			
% OP of Total Phosphorus	39 %	%	%	%

Soils

West Mountain/North Fork Payette River Sub-Watershed

Two in-channel sediment sites were sampled within the Cascade Reservoir Allotment: Silver Creek and Wolf Pasture, and one shoreline soil sample was taken near Silver Creek. Phosphorus concentrations in soils ranged from 3.3 to 8.2 mg/kg of soil, with a median of 6.1 mg/kg of soil. This value will be used when calculating the amount of reduced phosphorus from forest management activities within this subwatershed.

Gold Fork River Sub-Watershed

In-channel sediments were sampled at four water quality stations on the Boise National Forest (Gold Fork, North Fork Gold, South Fork Gold and Spruce Creek). Phosphorus concentrations in soils ranged from 0.8 to 2.3 mg/kg of soil, with a median of 1.6.

Four upland sites were sampled in Foolhen, Lodgepole, upper North Fork Gold Fork, and in the South Fork Gold Fork watersheds on the Boise National Forest. Both a and c soil horizons were sampled separately. One riparian area soils site was sampled near Foolhen Creek. Overall Phosphorus concentrations in soils ranged from 1.3 to 22.0 mg/kg of soil, with a median of 4.2.

Two upland and three riparian sites were sampled on the Payette National Forest in Paddy, Rapid, Kennally Creek watersheds. One riparian site was selected to see if grazing use had an effect on phosphorus levels, levels found were at 3.0 mg/kg of soil result. Phosphorus concentrations in soils ranged from 1.7 to 29.5 mg/kg of soil, with an median of 3.5.

By combining all upland and riparian soil samples, a median value for all Boise and Payette Forest soil sites was 3.3 mg P/kg of soil. This value will be used when calculating the amount of reduced phosphorus from forest management activities within this subwatershed.

Future Monitoring and Analysis

There are some critical questions that need to be answered with this process to help determine if the interim 30 percent phosphorus reduction goal is realistic.

1) What specific activities contribute phosphorus and how?
2) What form of phosphorus is delivered to streams?
3) How can current and future management activities be modified to decrease an amount of phosphorus generated or transported to streams?
4) How much phosphorus is present in a given amount of sediment?

A group of agency representatives (EPA, DEQ, Boise and Payette National Forests and the Intermountain Research Station), convened to discuss the issue of phosphorus reduction and current management activities on September 29, 1995. The group concluded on two action items that need to be furthered studied.

These action items are:

The need for a coordinated effort to develop a method to determine sediment yields from problem areas and determine an amount of phosphorus (the most important forms) coming from that area. All agencies agreed a methodology would need to be developed and applied as a future phosphorus accounting mechanism, described in the Draft Phased TMDL and Watershed Management Plan.

Develop a list of BMP's and treatments with an effectiveness in reducing phosphorus (sediment).

Both the Boise and Payette National Forests feel these questions must be answered to validate that the 30% reduction goal is realistic.

West Mountain/North Fork Payette River Sub-Watershed

Monitoring Project Summaries are located in the Appendix, below is a list of projects that are planned for monitoring.

- Cascade Reservoir Allotment Management Plan
- Campbell Creek Boat Dock Project
- GTE Buried Cable Line Project
- Anderson Creek Road Improvement Project
- Phosphorus Bioavailability Study

Gold Fork River Sub-Watershed

Monitoring Project Summaries are located in the Appendix, below is a list of projects that are planned for monitoring.

Spruce Creek Timber Sale (1995-1998): (Appendix)

The Spruce Creek Timber Sale is an administrative sale that will study the effects of low tire pressure on logging trucks to reduce erosion rates from roads (Central Tire Inflation, CTI). The amount of sediment eroded from roads will be measured annually over a 3-year period (1995, 1996, 1997). The use of CTI has been shown have an 80% effectiveness in reducing sediment generated during hauling. The reduction of phosphorus from the sediment has not been determined. The cost of the project is funded by the Forest Service at $10,000/truck for the equipment and the project will be monitored by the Forest Service research station in Moscow, Idaho.

The use of BMP's for new road construction and timber harvest are to be monitoring following the enclosed plan. Specific BMP's will be monitored for the effectiveness in preventing the delivery of sediment to stream and the protection of riparian areas. Pre and post project monitoring is planned.

Soil resources will be monitored within the Spruce Creek Timber Sale area. Detrimental Disturbance and Total Resource Committment are the two parameters to be measured.

Phosphorus Bioavailability Study 1996: (Appendix)

Based on the final results of Mike Amacher's (INT-Logan) study, some additional soil and in stream sediment samples need to be collected. At a minimum, peak flow suspended sediment samples will be analyzed to determine the amount of bioavailable phosphorus present.

Radionuclides Study 1996:

Assist in the collection of samples in the radionuclides study, in cooperation with Boise Cascade and NASCI. The purpose of this study is to better define the temporal variability of erosion within the watershed.

Gold Fork Tributary Monitoring 1996:

Monitor other main tributaries to Gold Fork River during peak flow. These streams include Grouse Creek, Foolhen Creek, Lodgepole Creek and the main NFGF above the 402 Road). The objective of this study is to further define baseline levels of phosphorus loads in northern tributaries to the North Fork and South Fork of Gold Fork River. Sampling methods and protocol are the same as listed in the Spruce Creek Monitoring plan summary (Boise NF).

North Gold Timber Sale Project (Undetermined date): Appendix

Schedule to Achieve 30% Reduction Goal, with discussion of FS policy on TMDL.

The Boise and Payette National Forests agree a water-quality problem does exist in Cascade Reservoir and ongoing project action will result in continued acceptable water quality in streams leaving National Forest System (NFS) lands. We agree a feedback loop process, as used in other non-point source pollution control, is appropriate. The process will involve applying sediment and related phosphorus reducing practices to source areas and then monitoring to assure practices are implemented and are effective, based on onsite indicators. We concur that some instream effectiveness monitoring will be useful in assessing trends in tributaries to the Cascade Reservoir. Our primary concern is that a TMDL allocation process is not currently recognized by the Forest Service for nonpoint sources of sediment as related to phosphorus.

In an earlier letter, you requested a plan for meeting the interim 30 percent reduction goal for NFS lands. The 30 percent reduction goal may not be appropriate because it does not account for natural background phosphorus levels and variability. The values presented here are very rough estimates that relate sediment to phosphorus and should be refined as information becomes available. Phosphorus levels have been monitored on forested lands and are within undisturbed ranges.

Specific land uses cannot be held responsible to reduce the level of phosphorus load below what is determined to be a background level. The focus of all groups should be to reduce the amount of management-induced phosphorus from their current or past activities that may still be contributing accelerated levels of phosphorus.

The feedback loop is recognized as a critical part to achieving the goals set in this process. The Forests recommend a regular revisitation of the TMDL goals and progress of project implementation. Setting a specific time to evaluate the TMDL goal of 30% is a critical link. The Forests are concerned with the ability to achieve the 30% reduction goal on forested lands. We would like to maintain the flexibility to adjust the 30% between sub-watersheds and between various land uses. Several items that should be included in an annual review are:

- Contribution assumptions to be updated as additional information becomes available.
- Schedules
- Implementation Evaluation
- Peer review of methodologies used with researches and the Technical Advisory Committee.
- Discussions of use attainability.

Below is the summary of completed and future watershed improvement projects (as described in Part II) and an estimated phosphorus reduction amount. The values presented here may change as additional information becomes available, monitoring and/or research studies are completed and coordination between agencies continues overtime.

<u>West Mountain/North Fork Payette River Sub-Watershed</u>

Total of all completed projects = 93.3 kg P/year
Total of all future projects = 65.1 kg P/year

<u>Gold Fork River Sub-Watershed</u>

Total of all completed projects = 0.08 kg P/year
Total of all future projects = 0.02 kg P/year

<u>Gold Fork River/Kennally Creek Sub-Watershed</u>

Total of all completed projects = 0.002 kg P/year
Total of all future projects = 1.41 kg P/year

BOISE CASCADE CORPORATION

Gold Fork Watershed Analysis

The Forest Service and Boise Cascade Corporation (BCC) have entered into a joint watershed analysis in the Gold Fork subwatershed. This analysis is intended to describe existing conditions, identify factors affecting water quality and fish habitat, and develop approaches to reducing the effects of forest management practices.

The primary sources of phosphorus entering streams from forested lands are through the input of sediment containing phosphorus and grazing in the riparian zone. Background levels of sediment inputs and additional sediment inputs arising from logging, roads, and cattle on forest lands are being estimated as part of the project.

Bioavailable phosphorus content of surface and subsurface soils associated with the various geologies in the basin have also been sampled. Preliminary results show very low levels of bioavailable phosphorus that tends to be stable in situ but degrades in water. Therefore, the estimates of bioavailable phosphorus in soils may not be representative of the actual bioavailable inputs into Cascade Reservoir.

The analysis is near completion and results, including an implementation plan, will be available in March, 1996. Outputs for the analysis are scheduled as follows:

February 15, 1996	Draft Report
March, 1996	Development of plan to address identified forest practices effects
April, 1996	Final Report
June, 1996 through??	Plan implementation

Over the past two years, BCC has implemented many road improvements in the Gold Fork basin. These improvements include upgrading of road crossings, rocking of native surface roads, and improving road drainage systems which are designed to deliver sediment laden road runoff onto the vegetated forest floor thereby reducing the quantity of sediment delivered to streams. Modeling of road runoff conducted as part of the Gold Fork River watershed assessment indicate that these inputs have reduced the annual sediment input by approximately 4,800 tons per year which represents an approximate 29 percent decrease in the sediment runoff from roads. The relationship between sediment in the basin and phosphorus input to Cascade Reservoir remains unclear. If a direct correlation between sediment and phosphorus is assumed, this might be interpreted as a 29 percent reduction in the phosphorus loads input from forest roads.

APPENDIX F

VALLEY COUNTY SOIL AND WATER CONSERVATION DISTRICT AGRICULATURAL BEST MANAGEMENT PRACTICES (BMP)

BOULDER, MUD AND WILLOW CREEK SAWQPs
LIST OF BMP Components
Adopted by VSWCD Board (revised 8/23/95)

PRACTICE DESCRIPTION AND SPECIFICATION NO.	COST SHARE RATE
1. Channel Vegetation (322)	75%
A. Willow/Alder Sprigs	75%
B. Willow Clumps	75%
C. Seeding with Fabric Mat	75%
D. Bank Shaping and Seeding	75%
2. Chiseling and Subsoiling (324)	75%
3. Conservation Cover (327)	N/C
4. Conservation Cropping Sequence (328)	N/C
5. Conservation Tillage (329)	
A. No Till	75%
B. Reduced Tillage	75%
6. Critical Area Planting (342)	
A. Seedbed Preparation	75%
B. Seed and Application	75%
C. Fertilizer and Application	75%
D. Straw Mulch and Application	75%
7. Deferred Grazing (532)	N/C
8. Fencing, Range and Pasture (382)	
A. Barbed Wire (includes let-down)	75%
B. HTS Permanent Electric (incl. Energizer)	75%
C. Temporary/Portable Electric	N/C
9. Grade Stabilization Structure (410)	
A. Loose Rock	75%
B. Earthwork	75%
C. Reinforced Concrete	75%
D. Reinforced Concrete (cold weather)	75%
10. Heavy Use Area Protection (561)	
A. Earthwork	75%
B. Rock and Hauling	75%
C. Fabric	75%
11. Irrigation Field Ditch (388)	50%

12. <u>Irrigation Land Leveling (464)</u>
    - A. Land Preparation
        1. Herbicide Treatment — 50%
        2. Rototilling — 50%
    - B. Land Leveling — 50%

13. <u>Sprinkler(442)</u>
    - A Sprinklers
        1. Hand Lines (includes sprinkler heads)
            - 3" Diameter — 75%
            - 4" Diameter — 75%
        2. Wheel Lines, 5' Wheels (Includes sprinkler heads and movers)
            - 4" Diameter — 75%
            - 5" Diameter — 75%
        3. Wheel Lines, 6' Wheels (Includes sprinkler heads and movers)
            - 4" Diameter — 75%
            - 5" Diameter — 75%
        4. Mover — 75%
        5. Big Gun
            - Full Circle — 75%
            - Part Circle — 75%
        6. Center Pivot — 75%
        7. Sprinkler Head — 75%
            - General Purpose Nozzle — 75%
            - Flow Control Nozzle — 75%
        8. Pumps (Diesel) 30 HP and hardware, etc. — 75%
        9. Pumps (Electric and hardware, etc.)
            - 5 HP — 75%
            - 10HP — 75%
            - 15HP — 75%
            - 30HP — 75%
            - 40HP — 75%
            - 50HP — 75%
            - 60HP — 75%
            - 75HP — 75%
            - 100HP — 75%
        10. Turbine Pumps
            - 30HP — 75%
        11. Phase Converters
            - 20HP — 75%
            - 30HP — 75%
            - 40HP — 75%
            - 50HP — 75%
        12. Electrical Panels
            - Size 2 for 15 HP Pump (Installed) — 75%
            - Size 3 for 30, 40, 50 HP Pump (Installed) — 75%
            - Size 4 for 60, 75, 100 HP Pump

(Installed)	75%
B. Irrigation Regulating Reservoir (552-B)	
1. Corrugated Metal Pipe	
30" x 8'	75%
36" x 8'	75%
2. Concrete	
Reinforced Concrete	75%
Reinforced Concrete (cold weather)	75%
C. Tailwater Recovery (447)	
1. Irrigation Pit (522-A)	75%
2. Pipeline (low Pressure) (430-EE)	75%
3. Pump	75%
D. Flowmeter	75%

14. Irrigation Water Conveyance

A. Pipeline, Low Pressure, Underground Plastic, Installed (430-EE)	75%
1 8" X 63# PSI/PVC	75%
2. 10" X 63# PSI/PVC	75%
3. 12" X 63# PSI/PVC	75%
4 15" X 63# PSI/PVC	75%
5. 18" X 63#PSI/PVC	75%
B. Pipeline, High Pressure, Underground Plastic, Installed (430-DD)	
1. 4" X 80# PSI/PVC	75%
2. 6" X 80# PSI/PVC	75%
3 8" X 80# PSI/PVC	75%
4. 10" X 80# PSI/PVC	75%
5. 12" X 80# PSI/PVC	75%
6. 15" X 80# PSI/PVC	75%
7. 18" X 80# PSI/PVC	75%
8. 4" X 100# PSI/PVC	75%
9. 6" X 100# PSI/PVC	75%
10. 8" X 100# PSI/PVC	75%
11. 10" X 100# PSI/PVC	75%
12. 12" X 100# PSI/PVC	75%
13. 15" X 100# PSI/PVC	75%
14. 18" X 100# PSI/PVC	75%
15. 4" X 125# PSI/PVC	75%
16. 6" X 125# PSI/PVC	75%
17. 8" X 125# PSI/PVC	75%
18. 10" X 125# PSI/PVC	75%
19. 4" X 160# PSI/PVC	75%
20 6" X 160# PSI/PVC	75%
21. 8" X 160# PSI/PVC	75%
22. 10" X 160# PSI/PVC	75%
23. 4" X 200# PSI/PVC	75%
24. 6" X 200# PSI/PVC	75%

25. 8" X 200# PSI/PVC	75%
26. 10" X 200# PSI/PVC	75%

C. Pipeline Underground Plastic Risers

1. 4" X 4" X 3" X 36" 160#	75%
2. 6" X 6" X 4" X 36" 125#	75%
3. 8" X 8" X 4" X 36" 125#	75%
4. 10" X 10" X 4" X 36" 125#	75%
5. 12" X 12" X 4" X 36" 125#	75%

D. Corrugated Metal Pipeline Installed (430-II)

1. 8"	75%
2. 10"	75%
3. 12"	75%
4. 15"	75%
5. 18"	75%
6. 24"	75%
7. 30"	75%
8. 36"	75%

E. Steel pipe installed (430-FF)

1. 4"	75%
2. 6"	75%
3. 8"	75%
4. 10"	75%
5. 12"	75%

F. Waterman Gate

1. 12"	75%
2. 15"	75%
3. 18"	75%
4. 24"	75%

15. Irrigation Water Management (449) — N/C

A. Meter	75%
B. Water Mark Sensors	75%
C. Controller Wire	75%
D. Terminal Boxes	75%

16. Land Smoothing (466) — 50%

17. Livestock Exclusion (472) — N/C

(See Planned Grazing System)

Riparian Exclusion (payment limit 3 years) — 75%

18. Nutrient Management (ID-590)

A. Fertilizer and Application	50%
B. Lime and Application (ID-304)	50%
C. Soil Test	50%

19. Pasture and Hayland Management (510) — N/C

(See Planned Grazing System)

A. Nutrient Management (D-590)	65%
B. Herbicide Treatment (510)	65%

C. Soil Moisture Monitoring	75%
20. <u>Pasture and Hayland Planting (512)</u>	
A. Herbicide Treatment (510)	65%
B. Nutrient Management (ID-590)	65%
C. Seedbed Preparation and Seed Appl.	65%
D. Seed	65%
21. <u>Planned Grazing System (556)</u>	75%
A. Deferred Grazing (532)	N/C
B. Livestock Exclusion (472)	N/C
C. Pasture and Hayland Management (510)	N/C
D Proper Grazing Use (528)	N/C
E. Proper Woodland Grazing (530)	N/C
22. <u>Pond, Excavated/Embankment (378)</u>	
A. Earthwork Excavation	75%
B. Earthwork Embankment	75%
C. Structure for Water Control	75%
23. <u>Proper Grazing Use (528)</u> (See Planned Grazing System)	N/C
24. <u>Proper Woodland Grazing (530)</u> (See Planned Grazing System)	N/C
25. <u>Pumping Plant for Water Control (533)</u>	
A. Electric (includes pressure tank)	75%
B. Solar	75%
26. <u>Streambank Protection (580)</u>	
A. Channel Armoring	75%
B. Barb-Rock	75%
C. Brush Revetment	75%
D. Tree Revetment	75%
E. Log Willow Revetment	75%
F. Gabion Revetment	75%
G. Rock Rip-Rap	75%
H Shape - Seeding	75%
I. Wire - Post Fence	75%
27. <u>Spring Development/Water Development (574)</u>	
A. Pipeline (516)	
1. 1 1/2" Diameter PVC 200#	75%
2. 2" Diameter PVC 200#	75%
3. 4" Diameter PVC (Drain)	75%
B. Rock	75%
C. Trough (614) Includes Labor	
1. Rectangular Galvanized	75%
2. Round Galvanized	75%
3. Rubber Tire (w/concrete)	75%
4. Plastic/fiberglass	75%
D. Float valves, fittings, misc.	75%

E. Excavation	75%
28. **Stream Channel Stabilization (584)**	75%
29. **Structure for Water Control (587)**	
A Field Ditch Turnout	
1. 8" Structure	
a. 8 ft. Or less pipe	75%
b. Greater than 8 ft. Pipe	75%
2. 10" Structure	
a. 8ft. Or less pipe	75%
b. Greater than 8 ft. Pipe	75%
3. 12" Structure	
a. 8 ft. Or less pipe	75%
b. Greater than 8ft. Pipe	75%
4. 15" Structure	
a. 8 ft. Or less pipe	75%
b. Greater than 8 ft. Pipe	75%
5. 18" Structure	
a. 8 ft. Or less pipe	75%
b. Greater than 8 ft. Pipe	75%
6. 18" X 16' Canal Structure with Head walls installed	75%
B. Water Control Check	75%
1. Reinforced Concrete	75%
2. Reinforced Concrete (cold weather)	75%
C. Turbulent Fountain Screen	
1. 48" - Nylon mesh screen	75%
2. 48" - Stainless steel screen	75%
3. 60" - Nylon mesh screen	75%
4. 60" - Stainless steel screen	75%
30. **Wildlife Wetland Habitat Management (644)**	N/C
31. **Wildlife Upland Habitat Management (645)**	N/C
32. **Woodland Improvement (666)**	N/C

Valley Soil and Water Conservation District Agricultural BMPs
Planned or Implemented as of October 1995

BMPs	Units Planned or Implemented		
	Boulder Creek	Mud Creek	Willow Creek
Chiseling, Subsoiling (ac)	146	58	
Critical Area Planting (ac)	6		
Channel Vegetation (lf)			500
Conservation Cover (ac)	28		
Conservation Tillage (ac)		499	
Conservation Cropping Sequence (ac)		539	10
Deferred Grazing (ac)	25		
Fencing (lf)	15,003	6,900	9,200
Fertilizer Application (ac)	94	1,062	
Heavy Use Area Protection (ea)	2	4	2
Irrigation System Sprinklers (ac)	257	1,050	81
Irrigation Water Conveyance (lf)	13,436	26,727	6,700
Irrigation Water Management (ac)	132	78	
Liming (ac)	217	1,044	
Livestock Exclusion (ac)	101		24
Nutrient Management (ac)	412	911	
Soil Tests (ea)	13	38	
Spring or Water Development (ea)	6	3	
Pasture and Hayland Management (ac)	412	1,182	106
Pasture and Hayland Planting (ac)	51	502	
Planned Grazing System (ac)	127	288	
Proper Grazing Use (ac)			511
Ponds (ea)	2	1	
Water Control Structures (ea)	3		
Woodland Improvement No cost share (ac)	5		
Wildlife Wetland Habitat Management No cost share (ac)	7		

APPENDIX G

COMMITTEE MEMBERS

- Cascade Reservoir Coordinating Council Members
- Technical Advisory Committee Members
- Subwatershed Work Group Committee Members
- Subwatershed Work Group Status Reports

CASCADE RESERVOIR COORDINATING COUNCIL
8/95

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Representing the Valley County Commission

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Representing the Cascade Reservoir Association

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Representing the City of Cascade

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Representing Sporting and Recreational Interest

CASCADE RESERVOIR RESTORATION PROJECT
1995-1996 TECHNICAL ADVISORY COMMITTEE (TAC) MEMBERS

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CASCADE RESERVOIR RESTORATION PROJECT
WATERSHED WORK GROUPS
8/95

Gold Fork/Cascade Watershed

Mike Little, Co-Chair
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Ken Roberts, Co-Chair
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Boulder Creek/Willow Creek Watershed

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Lake Fork/Mud Creek

Herbert Hatcher, member
Donnelly, Idaho 83615

Ralph Kangas, member
Donnelly, Idaho 83615

North Fork of Payette/West Mountain

Don Clark, member
Cascade, Idaho 83611

Subwatershed Workgroups Status Report

The subwatershed workgroups identified potential water quality control projects within their watersheds. Many of these projects were identified without the knowledge or consent of the landowners. The list of potential projects in no way obligates landowners to participate. As stated in the Watershed Management Plan, DEQ is seeking cooperation on a voluntary basis. The lists of potential projects has been provided to appropriate agencies for a determination of landowner interest. As an example, the VSWCD is making a concerted effort to secure landowner participation on agricultural lands through SAWQP projects in Boulder, Willow, and Mud Creek Subwatersheds.

Gold Fork/Cascade Watershed Work Group
Update, May 1995

The work group has met 12 times from May of 1994 through May of 1995. The work group agreed to spread the 30% load reduction amongst all the landowners equally. In August the committee toured the watershed looking at forestry and agricultural practices that could be used to treat water or reduce erosion as well as restoration projects.

After the tour the committee came back together and in a brain-storming session identified nearly 40 potential phosphorus or sediment reducing projects. These projects focus primarily on agriculture, but include control of streambank erosion and wetland creation. A sub-committee composed of landowners and professional scientists, evaluated the projects and prioritized them according to:

1. cost of phosphorus removal

2. efficiency of phosphorus removal

The prioritization was based on research, local experience and professional judgement. To date, two of the projects are under contract with Valley Soil and Water Conservation District (center pivot conversion and pipeline installation) with three applications pending.

The Division of Environmental Quality (DEQ) continues to coordinate a cooperative monitoring effort on the Gold Fork River, between both the Payette and Boise National Forests and Boise Cascade. There were approximately 20 separate monitoring events in the 1994 calendar year by DEQ alone. This cooperative monitoring effort will continue for 1995.

Below are some of the most recent measured phosphorus loads (calculated at Hwy. 55) for the Gold Fork drainage. Phosphorus loads have varied according to the amount of yearly precipitation. Thus some years loads were greater, while others were less.

Year	Phosphorus Load (kg/y)	Reporting Agency
1989	6,827	ENTRANCO
1993	12,208	DEQ
1994	5,424	DEQ

The Payette National Forest conducted a road inventory survey last year in Kennally Creek. Results of this inventory suggest that the bulk of the sediment in Kennally Creek is associated with erosion from open system roads. Boise Cascade plans on conducting a similar road inventory on their land this coming summer. Additionally, Boise Cascade is investigating the possibility of using naturally occurring radioactive elements to determine where erosion is originating from. They are also working with their grazing permittee to develop off-stream watering sites.

RECOMMENDATIONS FOR PHOSPHORUS REDUCTION PROJECTS: GOLD FORK/CASCADE WATERSHED WORK GROUP

November 2, 1994

PROJECT #	TITLE	P Removal Priority	Est. Total Cost for Implementation
33	Double Diamond: stockwater	1	$ 1,600
2A	Spring & pond for livestock watering and wetland	1	$ 79,000
3	Laffinwell Creek erosion control	1	$ 15,000
21	Hot Springs Ranch: expand sprinkler system	4	$ 132,000
21a*	Combine ditches; redirect runoff & add pumpback system; combine with Gestrin pumpback/sprinklers	1	$ 165,000
25**	H. Gestrin: erosion-drop structure	1	$ 10,000
27	Stonebreaker Ln to Hwy: canal collection and pumpback system	2	$ 40,000
5	G. Davis: Gold Fork erosion control	1	$ 15,000
10a	Buried irrigation mainline	2	$ 4,000
10b	G. Loomis: pivot sprinkler	4	$ 50,000
10c	R. Higgins: pivot sprinkler	4	$ 50,000
12	Wastewater pumpback system	2-3	$ 10,000
10	Gold Fork Wetland	2	Engineering Review
8	Add ponds to Gold Fork wetland system	2-3	Combine w/10
10d	Detention pond	2-3	$ 50,000
9	K. Roberts: Increase capacity of pumpback and sprinkler	2	$ 100,000
29	Wetland treatment site	3	BOR Funding
7	N. of Davis: pivot sprinkler	4	$ 100,000
1	New Long Valley reservoir	5	Engineering Review
2	Dredge sediment behind Gold Fork Diversion Dam	5	$ 100,000
Total Estimated Costs for Projects			$ 921,610

Priority Ranking 1 = High; 5 = Low

Shaded items are projects with some common treatment options for improving water quality. Economies may be achieved if implemented together.

21a may be in cooperation with Center Irrigation District.

RECOMMENDATIONS FOR COST SHARE PROJECTS WITH BUREAU OF RECLAMATION
November 2, 1994

PROJECT #	TITLE	Phosphorus Removal Priority	Est. State Costs for Implementation
19	Channel erosion controls incorporating wetlands and adding pumpback system	1	$ 32,000
16	Reservoir bank erosion control	1	BOR Lead Agency
17	Jasper: add rip rap to stop drain downcutting	1	$ 3,000
18	S. of Jasper: runoff/erosion control	1	$ 4,000
20	Old RR: erosion control on ditch failure	1	$ 5,000
22	BOR/DEQ wetland construction	3	$ 10,000
24	Old St Hwy: drop structure for erosion and water control	1	$ 10,000
25*	Streambank erosion: drop structure	1	$ 8,000
26	BOR wetland at Hembree Creek	3	BOR Lead Agency
30	Recreational runoff controls	4	BOR Lead Agency
31	Add impoundment to Gold Fork Ditch at reservoir entry	5	$ 20,000
32	BOR Land: add pond & dredge	2	BOR Lead Agency
Total Estimated Costs for Projects			$ 92,000

Priority Ranking 1 = High; 5 = Low

* In combination with Gestrin irrigation management.

Shaded items are projects with some common treatment options for improving water quality. Economies may be achieved if implemented together.

Boulder Creek/Willow Creek Watershed Work Group
Update, May 1995

Introduction

The Boulder Creek and Willow Creek watersheds were combined into one work group because of their proximity to each other, and the availability of State Agricultural Water Quality Program (SAWQP) funding in both watersheds. During the first few meetings in August and September many land owners attended and showed an interest in activity within the watersheds. At that time Bob Yelton accepted the chair position, and held it until resigning in January 1995.

Issues

Many landowners in the watershed who attended the meetings were concerned about how much of a reduction was expected of them. It was explained that an overall 30% reduction in phosphorus is needed to meet water quality criteria for the reservoir. The following target reductions were set for the Boulder Creek/Willow Creek watersheds:

Land Use	% Reduction
Irrigated Pasture	50
Non-Irrigated Pastures	10
Dry-Land Croplands	
Irrigated Croplands	50
Range Lands	
Urban	20
Forest Lands	20
Recreation	

Other concerns raised were:

1) how to determine background phosphorus loadings;
2) how will background phosphorus levels be factored into the reduction goals;
3) urban storm-water issues;
4) the 50% reduction in loads from irrigated pasture lands may be unrealistic, but the work group agreed to proceed with this goal in mind.
5) what changes are needed in some of the building codes in the county to address urban impacts; and
6) if the watershed meets its goal, would further reduction be required if other watersheds could not meet their goals?

Best Management Practices (BMPs)

BMPs recommended by the work-group include:

- storm-water management
- livestock management (buffer zones, animal numbers...etc.)
- tax relief for non-productive riparian areas
- management of population densities (parcel development size)

Projects were identified for possible BMP implementation and were then ranked based on estimated cost and potential for phosphorus removal. Most of the projects would be eligible for cost-share funding through Valley Soil and Water Conservation District's SAWQP program. Tom Lance (SCC-Valley SWCD) attended the work group meetings and has made arrangements to meet with landowners interested in implementing BMPs. The list of proposed BMP implementation projects is attached.

BOULDER CRE. /WILLOW CREEK WATERSHE. PROJECT RANKING

#	TITLE	COST & P REMOVAL RANK	SCS EST. P REMOVAL RANK	SCS FOTG#
1	Reservoir for settling silt	2-3	L-M*	638 378
2	Modify pond to direct water: detention	2-3	L-M	638 378
3	Convert to sprinkler irrigation	4	H	449 442 430
3A	Diversion structure: cattle crossing	1	H	587
3B	Add diversion dam	2	M	362
3C	Improve pumpback	2-3	H	442 449
3D	Add diversion dam	2	M	362
4	Pond on 5 ac. (Yelton)	2-3	L*	378 638
5	Diversion Structure Rebuild	4	L*	362
5A	Add diversion & cattle crossing (Irr. Co.)	1	H	362 587 575
5B	Revamp culvert & extend cattle crossing	1	H	430-FF 575
5C	Hardened surface for cattle crossing	1	H	410 580 584 575
5D	crossing & diversion (Irr. Co.)	1	H	587 575
5E	Hardened surface for cattle crossing	1	H	410 575 580 584
5F	Add rip rap to stabilize bank	1	H	410 580

6	Pumpback station	2	H	430 442 449
7	Second Impoundment structure	2-3	L*	378 ?
8	Structure to minimize erosion	1	H	410 580
9	Structure to impound water: trap slow erosion	1	H	378 410 580

*Ranking could be high depending on size and location.
FOTG = Field Office Technical Guide found at Soil Conservation Service or Valley Soil and Water Conservation District