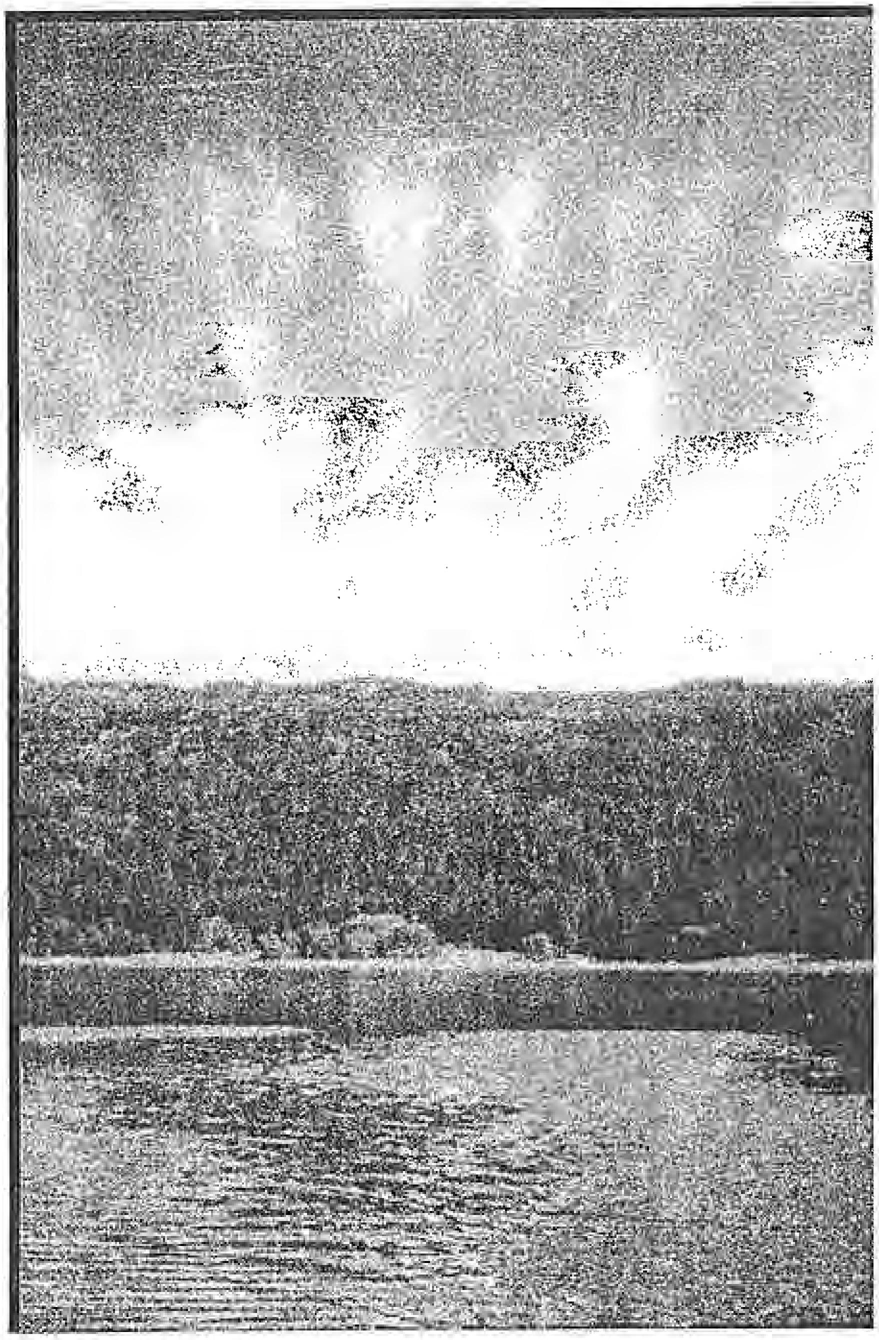
# Cascade Reservoir
# Phase 1
# Watershed Management Plan



Idaho Division of Environmental Quality
Southwest Idaho Regional Office
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# CASCADE RESERVOIR
# Phase I
# Watershed Management Plan

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## Foreword

This Watershed Management Plan is a Total Maximum Daily Load and provides a phased solution to water quality degradation in Cascade Reservoir and its tributaries. This plan was developed by the Southwest Idaho Regional Office of the Division of Environmental Quality (DEQ) and is consistent with Idaho Code 39-3611 which concerns the "Development and Implementation of Total Maximum Daily Loads or Equivalent Processes." The objective of the plan is to restore water quality in Cascade Reservoir and its tributaries to a level that protects beneficial uses. The plan identifies who will implement the plan, ongoing assessment of the success of the plan and how implementation will achieve the objectives of the plan.

It is important to note that correction of the water quality problems in Cascade Reservoir will not happen overnight. Successful implementation of this plan requires a coordinated effort of planning and best management practice implementation involving the concerned governmental agencies and land owners in the watershed over the next several years.

**Acknowledgements**

A very large portion of the land in the watershed is forest land and is managed as national forest or is privately owned by Boise Cascade Corporation. The efforts of the Boise and Payette National Forests and Boise Cascade Corporation in the project are critical to its success. Their continuing support is very much appreciated.

We would like to acknowledge the Idaho Soil Conservation Commission, the Idaho Department of Fish & Game, the Natural Resource Conservation Service, the Bureau of Reclamation, the Valley Soil and Water Conservation District, Valley County, the City of Cascade and the Cascade Reservoir Association for their participation in meetings, contributions of important background information and their assistance with management and implementation of the project.

On behalf of the Southwest Idaho Regional Office of DEQ, we wish to expressly acknowledge the Cascade Reservoir Coordinating Council, the Technical Advisory Committee and all the subwatershed work groups for their support in this effort.

Finally, we thank the citizens of the State of Idaho and surrounding states for putting Cascade Reservoir on the map by continually supporting it for its existing recreational attributes and for being strong advocates for its restoration. This continued support has helped maintain the reservoir as an essential fishery in the state.

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## 1.0 Introduction

The purpose of this plan is to establish an approach to improve water quality in Cascade Reservoir. Cascade Reservoir has been identified as water quality limited because it is not in compliance with Idaho water quality standards. Specifically, designated beneficial uses for the reservoir, including fishing, swimming, boating and agricultural water supply, are impaired because of excessive algal growth. The cause of these existing conditions has been identified as excessive phosphorus loading to the reservoir from the surrounding watershed. The water quality of Cascade Reservoir has been identified as impaired as specified under Section 303(d) of the Clean Water Act (CWA). Section 303(d) requires each state to submit a biennial list to the Environmental Protection Agency (EPA) which identifies those waters throughout the state that are not achieving state water quality standards in spite of the application of technology-based controls in National Pollutant Discharge Elimination System (NPDES) permits and Best Management Practices (BMPs) for nonpoint source. Such water bodies are known as "water quality-limited." After identification of a water quality limited segment, the state must then develop a total maximum daily load (TMDL) for each pollutant that is impairing protected uses. TMDLs are first developed on water quality limited segments identified by the state as high priority waters. Once the state has identified the actual pollutant load discharged from both point and nonpoint source activities, controls can be implemented to reduce the daily load of pollutants until the water body is brought back into compliance with water quality standards. Once developed, TMDLs are submitted to the EPA for approval. Congress mandated that the EPA identify water quality limited segments and develop TMDLs if the state does not fulfill its responsibilities under Section 303(d) of the CWA. The Idaho Department of Health and Welfare (IDHW), Division of Environmental Quality (DEQ) is directed by state statute (*see* Idaho Code Section 39-3601 *et seq.*) to develop TMDLs.

### 1.1 History

The water quality of Cascade Reservoir has been monitored periodically over the past twenty years (Clark & Wroten, 1975; Klahr, 1988; Klahr, 1989; Entranco, 1991; Ingham, 1992; Worth 1993 and 1994). Past monitoring has indicated that water quality within Cascade Reservoir is clearly impaired from an abundance of nutrients entering the reservoir through the many streams and from overland runoff. Phosphorus is the pollutant of concern that stimulates the growth of noxious aquatic weeds and algae blooms. In 1975, Clark & Wroten reported that water quality within the reservoir was good yet slightly eutrophic, noting that orthophosphate was conducive to algal growth. Later reports demonstrated that phosphorus was entering the reservoir from nonpoint sources, primarily from spring runoff and irrigation returns, and from point sources. Continued input of phosphorus and fluctuations in water level within the reservoir have led to eutrophic conditions in the reservoir.

## 1.2 Major Water Quality Concerns and Priority Issues

### *1.2.1 Issues of Concern*

Dense mats of blue-green algae on Cascade Reservoir in the summers of 1993 and 1994 signaled a further decline in water quality. In September 1993, twenty-three cattle died by ingesting toxins produced by blue-green algae from the reservoir, and public health advisories were issued by IDHW, Division of Health suggesting that contact with the reservoir should be avoided. These events and the surrounding media attention have fostered renewed efforts by public interest groups and resource management agencies to correct long standing water quality problems in Cascade Reservoir.

The reservoir experienced poor water quality in 1993, a normal runoff year, due to increased input of phosphorus which encouraged the growth of excess algae as measured by chlorophyll a concentrations. Even though phosphorus loads decreased in 1994, the reservoir continued to experience poor water quality due to low flows, decreased dissolved oxygen (DO), warm water temperatures and internal recycling of nutrients. These conditions placed tremendous stress on the reservoir's fish population. A substantial fish kill occurred and a fish salvage effort was initiated. For these two water years, all beneficial uses were impacted.

Several other factors are major concerns for Cascade Reservoir. The reservoir is a shallow man-made water body with a mean depth of 25 feet at full pool. As such, it is highly susceptible to eutrophication due to nutrient loading and elevated summer water temperatures within the watershed.

Internal recycling of existing phosphorus in the reservoir is a concern. This source is estimated to contribute about 19% of the annual phosphorus load to the reservoir. Reduction of this source is accomplished in smaller systems by dredging. Dredging the shallower portions of a reservoir the size of Cascade would be very costly and may cause significant water quality problems through disturbance of the sediments.

Drawdown of the reservoir is another concern. A minimum conservation pool of 300,000 acre-feet is currently in place for the reservoir. The pool was administratively established by the U. S. Bureau of Reclamation (BOR) to provide a sufficient zone of oxygenated water for winter fish survival. There is evidence that this volume is not sufficient to protect fish populations during the summer months. In addition, summer water quality concerns were not adequately considered in establishing the pool. BOR, DEQ and the Idaho Department of Fish and Game (IDFG) will study pool elevations in relation to DO and nutrient concentrations in the future to determine a suitable conservation pool to protect the fishery and other beneficial uses throughout the year.

Cascade Reservoir has been identified as water quality limited due to violations of water quality standards for DO, temperature and pH. Adequate DO is a fundamental measure of the waterbody's ability to support aquatic life. Ambient water quality monitoring indicates that

Cascade Reservoir experiences periodic low DO levels during the summer months. Elevated temperatures and algal productivity influence DO levels.

Water quality data collected by DEQ in 1993 and 1994 reveal a significant phosphorus load during spring runoff. The condition of the some parts of the watershed, especially riparian areas, may be contributing to this situation. As spring flows increase, degraded riparian areas contribute to increased phosphorus loads with accelerated runoff due to inadequate holding capacities.

Phosphorus is often the most important nutrient which limits growth of algae in lakes and reservoirs. However, nitrogen is also an important nutrient which affects the growth of algae. The balance of these two nutrients can influence the type of algae species that grow and dominate a lake or reservoir. Although water quality data from Cascade Reservoir suggest that phosphorus supply is largely responsible for the prevalence of algae, the quantity and concentrations of nitrogen entering the reservoir contribute to the growth of algae blooms.

### *1.2.2 Tributaries to the Reservoir*

Two tributaries of Cascade Reservoir are listed as Special Resource Waters under the IDHW Rules, IDAPA 16.01.02, Water Quality Standards and Wastewater Treatment Requirements, Lake Fork Creek and Gold Fork River. The criteria for special resource waters are discussed in Section 2.2.3. Both of these streams contribute elevated phosphorus loads during the water year. Diversion of a significant portion of these streams during the irrigation season reduces potential fish habitat, increases water temperatures, and decreases DO as flows reach the reservoir. The condition of the riparian areas of these tributaries varies from poor to excellent.

In Water Year (WY) 1994, Boulder Creek contributed about 3% of the water volume of the reservoir, but it also had the highest average concentration of phosphorus in the watershed. Boulder Creek is almost totally diverted for irrigation during the summer months. Degraded riparian areas contribute to increased sediment loading from this watershed.

### *1.2.3 Geographic Areas of Special Concern*

Water quality conditions in Cascade Reservoir and the surrounding watershed are of great concern to the residents of Valley County because the watershed contains many popular hiking, bicycling, camping, boating, water skiing, fishing, hunting, snowmobiling, cross country skiing and other outdoor opportunities. The reservoir was once the state's most popular fishery, but today ranks ninth in the state in angler hours. It also provides storage for downstream irrigation needs.

The community's commerce, tourism, jobs, and the beauty of the area around Cascade Reservoir as a vacation retreat depend upon the quality of the water in the reservoir and its watershed. Valley County is one of the fastest growing areas in Idaho. The national compounded growth rate in the last three years has been 1.0%, Idaho's growth rate has been 2.7%, and Valley

County's growth rate has been 3.7%. At this rate, Valley County will have 4,030 more residents by the year 2000, and that doesn't include the transient population related to tourism. The University of Idaho estimates that in 1993 one million people in the category "travel & tourism" (which includes everyone not a resident of the area) passed through or stopped in Valley County. This far exceeds that of a decade ago and will surely increase as more people discover Cascade Reservoir and its watershed.

Habitat of the Bald Eagle, a threatened species, is another important consideration. There are several pairs which nest around the reservoir and rely upon the surrounding ecosystem, including fish in the Reservoir, for their source of food. Bald Eagles cycle through two stages of habitat use. During the spring and summer, they are widely dispersed and often associate with family groups. The distribution of Bald Eagles changes in the winter as they migrate and concentrate at specific sites within the winter range (United States Fish and Wildlife Service, 1986).

Bald Eagle nests are usually located in uneven aged, multi-storied stands with old growth components. Bald Eagles usually nest in the same areas each year and often use the same nests repeatedly. Large cottonwoods, Ponderosa pines and Douglas firs are used. Snags, trees with exposed lateral limbs, or with dead tops are often present in nesting territories and are used for perching or as access points to and from the nest. Forests with suitable nest and perch trees are critical to Bald Eagle populations. Bald Eagles are particularly intolerant of human disturbance during the breeding season (late February to May). They are generally more sensitive to disturbance during courtship, egg laying, and incubation. Their sensitivity decreases as young develop.

Nest sites are distributed around the periphery of the reservoir, usually within 2.4 miles of shore. The eagles use shallow areas, gently sloping shorelines and wetlands. Important prey for eagles include fish, birds and mammals.

### *1.2.4 Plan Goals and Objectives*

To improve the quality of water in Cascade Reservoir and its tributaries, the current contribution of phosphorus from external sources must be reduced by 37% and this reduction must be maintained for a period of five years (see Section 4). This target reduction will be used as the preliminary goal for Cascade Reservoir. The goal includes a 7% margin of safety. The reduction level was established through the use of a model designed specifically for Cascade Reservoir (Chapra, 1990). A 37% reduction in loading was selected because it is anticipated to result in water quality improvements that reach the desired criteria of 10 $\mu$g/l chlorophyll a and 0.025 mg/l total phosphorus in the reservoir. The model suggests that these concentrations are needed to reduce excessive algae growth in the reservoir. Additional data analysis and modeling planned for Phase II may indicate a need to change the reduction goal.

The goal of this plan is to achieve state water quality standards in Cascade Reservoir and its tributaries. This goal will be accomplished by focusing efforts on reducing the source and transport of nutrients throughout the watershed. Reduction in the quantity of nutrients entering the reservoir will, in time, modify chemical and biological processes and result in improved water quality. Key components of this plan are:

- establishment of measurable objectives (load reductions) for improvement of water quality;
- timely implementation of specific management actions to achieve load reductions;
- monitoring assessment of the success of load reduction goals;
- ensuring meaningful public involvement in implementation of the plan through the local coordinating council and subwatershed work groups;
- identification of a comprehensive watershed management plan that effectively expresses to the public and policy makers the rationale, approach and long-term strategies for water quality problem solving, and pollution prevention;
- consolidation of various state and federal assessment and reporting requirements into a single plan to improve efficiency in resource use; and
- identification of innovative management approaches that both protect Idaho's surface and ground water and allow for sound economic planning and growth.

### *1.2.5 Watershed Approach*

This plan utilizes a watershed approach to address water quality concerns because pollutant sources throughout the geographic area drain into the reservoir (watershed) and contribute to water quality problems. Each subwatershed affecting the reservoir is being managed to address its own individual characteristics and the needs of those who live, recreate and work there. The watershed approach is holistic and encourages community-based problem solving. This Watershed Management Plan (plan) constitutes the equivalent of a TMDL and is consistent with Idaho Code 39-3601.

The plan will have three phases:

Phase I — Establish initial nutrient reduction goal and implementation strategy.

Phase II — Further evaluation of phosphorus reduction goals and possible alternatives and development of a more detailed implementation plan.

Phase III — Plan evaluation and modification.

#### *Total Maximum Daily Load*

The TMDL process is described in Section 303(d) of the CWA (40 CFR 130.7. TMDLs are plans designed to direct management actions so that polluted water bodies are restored to a level that achieves state water quality standards. A TMDL is a mechanism for determining how much pollutant a waterbody can safely assimilate (the loading capacity) without violating state water quality standards. An essential component of a TMDL is identifying the current volume and sources of pollutants discharged to the waterbody. Thereafter, a determination can be made identifying the amount of pollutants each source may discharge (the allocations). Point sources of pollution, those discharges from discrete pipes or conveyances, will receive a wasteload allocation (WLA) which specifies how much of the pollutant each point source can release to the waterbody. Nonpoint sources of pollution, all other activities causing pollution in the reservoir, will receive a load allocation (LA), which specifies how much pollutant can be released to a waterbody.

$$\text{TMDL} = \text{WLAs} + \text{LAs} + \text{margin of safety}$$

Loading capacity is established taking into account seasonal variations and a margin of safety, which accounts for any lack of knowledge concerning the relationship between pollution control mechanisms and water quality. Calculating the exact pollutant load for pollutants running off the land (nonpoint sources) is difficult and often dependent on weather conditions. Therefore, a phased TMDL is necessary which identifies interim load allocations, with further monitoring to gauge the success of management actions in achieving load reduction goals and the affect of actual load reductions on the water quality in the reservoir.

# 2.0 General Watershed Description

## 2.1 Physical/Geographic/Features

Cascade Reservoir is located in the Payette River Basin in Valley County, Idaho (See Figure 2.1). Upper Payette Lake forms the headwaters of the basin, followed by Big Payette Lake, the North Fork Payette River and Cascade Reservoir. The North Fork Payette River eventually discharges into the main Payette River near Banks, Idaho, 35 miles downstream. The watershed is approximately 357,000 acres. Major tributaries to the reservoir include the North Fork Payette River, Mud Creek, Lake Fork, Boulder Creek, Gold Fork River, and Willow Creek.

The reservoir is located in the lower end of a moderately high elevation (4,800 feet) valley between West Mountain to the west and the Salmon River Mountains to the east. The watershed is transitional ecologically with the western half of the valley found within the Blue Mountains ecoregion (Omernik & Gallant, 1986), which is characterized by mountain ranges separated by fault valleys and synclinal basins. The eastern and northern sections of the watershed are found within the Northern Rockies ecoregion with geology and soils typical of the northern portion of the Rocky Mountains. The geology and coarse-textured soils of the region are influenced primarily by the crystalline igneous rock of volcanic origin known as the Idaho Batholith. Natural vegetation in the watershed includes spruce/fir forests, mountain grass/forb meadows and various riparian/wetland complexes.

### *2.1.1 Project Area*

The project area is represented in Figure 2.2. There are twelve subwatersheds in the Cascade Reservoir watershed. Nine of these subwatersheds are addressed in this plan. They are the North Fork Payette River, Mud Creek, Lake Fork Creek, Boulder Creek, Willow Creek, Gold Fork River, Kennally Creek, Cascade (east side of the reservoir) and West Mountain. For the purposes of this plan, Kennally Creek is included in the Gold Fork River subwatershed because it does not drain directly into Cascade Reservoir. Lake Fork Creek above Little Payette Lake is combined with the lower portion of that subwatershed. Big Payette Lake contains two subwatersheds and is being addressed in a separate project coordinated by the Big Payette Lake Water Quality Council. Therefore, this plan will reference eight subwatersheds.

## 2.2 Land Use/Demography

### *2.2.1 Population*

There are several towns and villages located along State Highway 55 which parallels the North Fork Payette River through most of the watershed. These towns include McCall, Lake Fork, Donnelly, Roseberry and Cascade. A thriving tourist and recreational industry exists within the watershed. This accounts for a significant transient (non-county resident) population. The most popular destinations include Ponderosa State Park near McCall, Big Payette Lake, Cascade Reservoir and Brundage Ski Area. There is extensive vacation home development around both the lake and the reservoir.

Figure 2.1.

# Cascade Reservoir Watershed

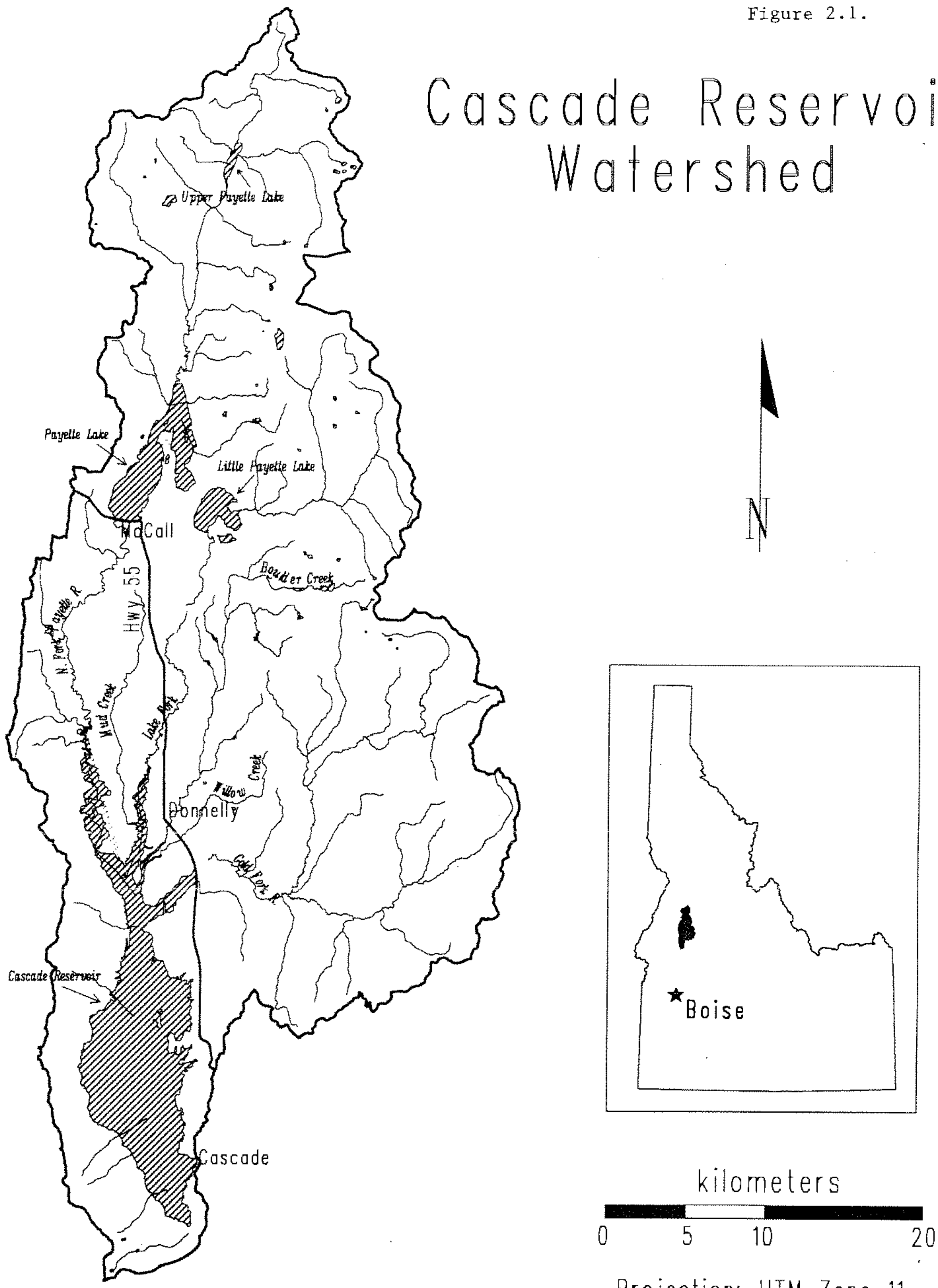


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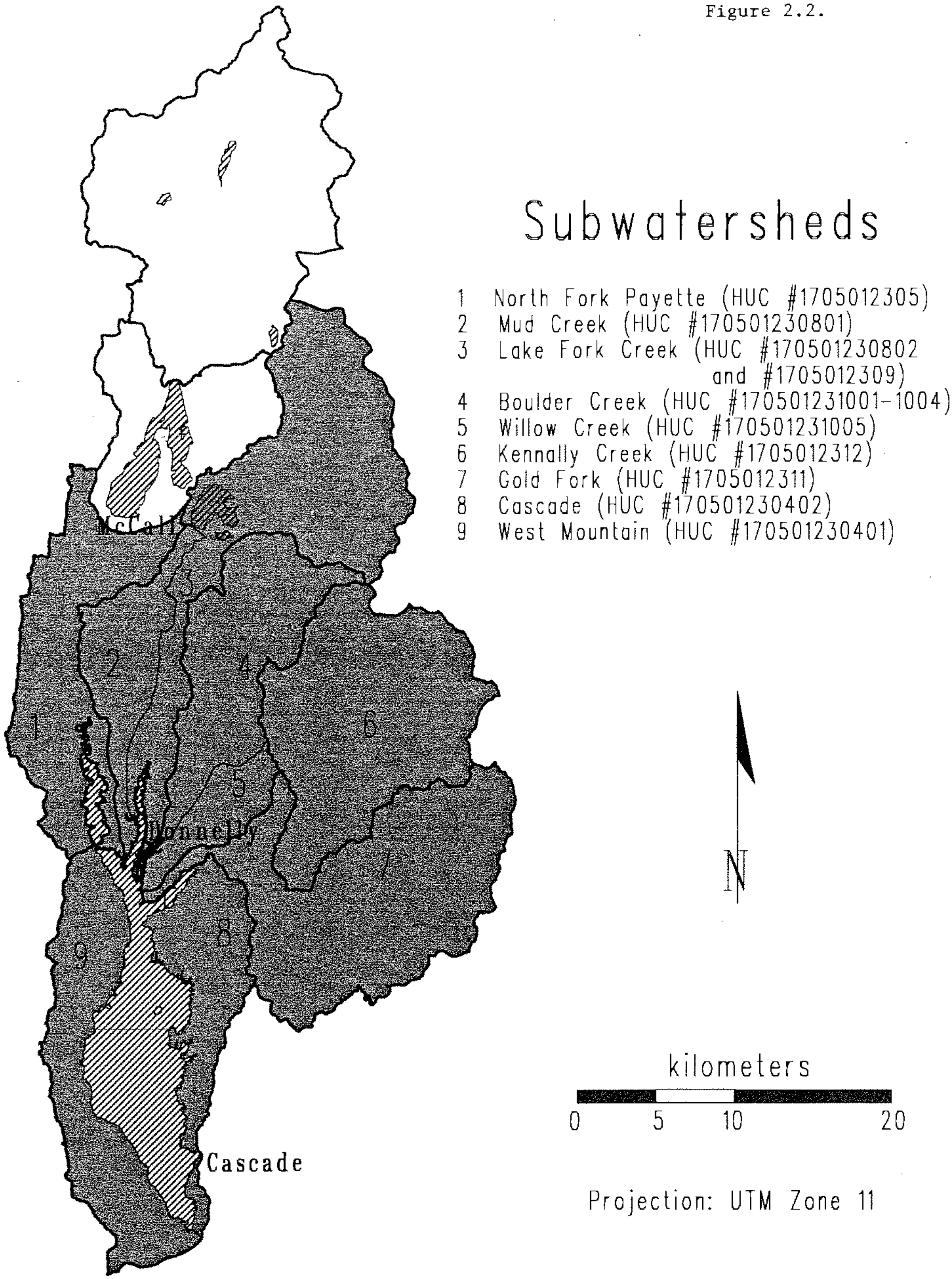
Figure 2.2.


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)
1
2
4
5
6
7
8
9
McCall
Donnelly
Cascade
N
kilometers
0
5
10
20
Projection: UTM Zone 11

The following population statistics for Valley County are from the Valley County Comprehensive Plan (1995).

| | Population |
|---|---|
| Total Unincorporated Areas in Valley County | 4,023 |
| City of McCall | 2,604 |
| City of Cascade | 1,120 |
| City of Donnelly | 173 |
| Total Valley County Population | 7,920 |

### *2.2.2 Land Use Characteristics*

The watershed is predominantly forested (approximately 71%), both public and private (Entranco, 1991). The three largest land owners are the Boise National Forest (BNF), Payette National Forest (PNF), and Boise Cascade Corporation (BCC). The state also owns a large piece of land north and east of Payette and Little Payette Lakes and smaller portions throughout the eastern side of the watershed. Most of the valley between Payette Lake and Cascade Reservoir is privately owned and used for agricultural purposes including irrigated and non-irrigated cropland (approximately 2%), and irrigated and non-irrigated pasture and rangeland (approximately 21%). The remaining 6% of the watershed consists of water bodies and urban/residential areas. The rate of construction of recreational homes in the watershed has increased in the last four years.

### *2.2.3 Special Designations and Listings*

#### *Numerical Water Quality Standards*

The Idaho Water Quality Standards and Wastewater Treatment requirements establish numerical criteria for water quality parameters based on designated beneficial uses. DO is a critical parameter for the protection of aquatic life. The State of Idaho water quality standards establish the following criteria for minimum concentrations of DO in lakes and reservoirs:

> "DO concentrations exceeding 6 mg/l at all times. In lakes and reservoirs this standard does not apply to:
>
> (1) The bottom 20% of water depth in lakes and reservoirs where depths are thirty-five (35) meters or less.
>
> (2) Those waters of the hypolimnion in stratified lakes and reservoirs."

### *Water Quality Standards*

The CWA requires each state to protect their surface waters from pollution. State waters are protected through adoption and enforcement of the Idaho water quality standards. A water quality standard defines the water quality goals of a particular water body by designating the use or uses to be made of the water and establishing numerical and narrative criteria (ambient conditions) necessary to protect the designated and "existing" uses. Existing uses are those surface water uses actually attained on or after November 28, 1975, whether or not they are designated uses. States are to take into account such uses as public, agricultural and industrial water supplies, protection and propagation of fish, shellfish and wildlife, and recreation in and on the water when establishing designated uses for water bodies. Idaho has adopted water quality standards, which are found under the IDHW Rules, IDAPA 16.01.02, Water Quality Standards and Wastewater Treatment Requirements.

Idaho has established the following uses and criteria for its water bodies:

> **All Waters:** Are protected through general surface water quality criteria. Narrative criteria prohibit ambient concentrations of certain pollutants which impair designated uses. Narrative criteria established in Idaho water quality standards include: hazardous materials, toxic substances, deleterious materials, radioactive materials, floating, suspended or submerged matter, excess nutrients, oxygen demanding materials and sediment (IDAPA 16.01.02.200).
>
> **Agricultural Water Supply:** Waters which are suitable or intended to be made suitable for the irrigation of crops or as drinking water for livestock (IDAPA 16.01.02.100.01.a). Criteria: Numeric criteria as needed derived from the EPA's Blue Book (IDAPA 16.01.02.250.03.b).
>
> **Domestic Water Supply:** Waters which are suitable or intended to be made suitable for drinking water supplies (IDAPA 16.01.02.100.01.b). Criteria: Numeric criteria for specific constituents and turbidity (IDAPA 16.01.02.250.03.a).
>
> **Industrial Water Supply:** Waters which are suitable or intended to be made suitable for industrial water supplies. This use applies to all waters of the state (IDAPA 16.01.02.100.01.c). Criteria: General surface water quality criteria (IDAPA 16.01.02.200).
>
> **Cold Water Biota:** Waters which are 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. (IDAPA 16.01.02.100.02.a). Criteria: Numeric criteria for pH, DO, gas saturation, residual chlorine, water temperature, ammonia, turbidity, and toxics (IDAPA 16.01.02.250.02.a and c).

**Warm Water Biota:** Waters which are suitable or are 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

(IDAPA 16.01.02.100.02.b). Criteria: Numeric criteria for pH, DO, gas saturation, residual chlorine, water temperature, ammonia, and toxics (IDAPA 16.01.02.250.02.a and b).

**Salmonid Spawning:** Waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes (IDAPA 16.01.02.100.02.c). Criteria: Numeric criteria for pH, gas saturation, residual chlorine, DO, intergravel DO, water temperature, ammonia, and toxics (IDAPA 16.01.02.250.02.a and d).

**Primary Contact Recreation:** Surface waters which are suitable or are 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 (IDAPA 16.01.02.100.03.a). Criteria: Numeric criteria for fecal coliform bacteria applied between May 1st and September 30th (recreation season) (IDAPA 16.01.02.250.01.a).

**Secondary Contact Recreation:** Surface waters which are suitable or are intended to be made suitable for recreational uses on or about the water 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 (IDAPA 16.01.02.100.03.b). Criteria: Numeric criteria for fecal coliform bacteria (IDAPA 16.01.02.250.01.b).

**Wildlife Habitats:** Waters which are suitable or are intended to be made suitable for wildlife habitats. This use applies to all surface waters of the state (IDAPA 16.01.02.100.04). Criteria: General surface water quality criteria (IDAPA 16.01.02.200).

**Aesthetics:** This use applies to all surface waters of the state (IDAPA 16.01.02.100.05). Criteria: General surface water quality criteria (IDAPA 16.01.02.200).

**Special Resource Water:** Those specific segments or bodies of water which are recognized as needing intensive protection to preserve outstanding or unique characteristics. Designation as a special resource water recognizes at least one of the following characteristics: a) the water is of outstanding high quality, exceeding both criteria for primary contact recreation and cold water biota; b) the water is of unique ecological significance; c) the water possesses outstanding recreational or aesthetic qualities; d) intensive protection of the quality of the water is in paramount interest of the people of Idaho; e) the water is a part of the National Wild and Scenic River System, is within a State or National Park or wildlife refuge and is of prime or major importance to that park or refuge; f) intensive protection of the quality of the water is necessary to maintain an existing but jeopardized beneficial use (IDAPA 16.01.02.054). Special resource waters receive additional point source discharge restrictions (IDAPA 16.01.02.054.03 and 400.01.b).

Designated uses are established for water bodies when it is determined that such use is attainable (except for Industrial Water Supply, Aesthetic and Wildlife uses which are applied to all water bodies in the state). For example, a particular water body may be designated for Domestic Water Supply, Cold Water Biota, and Primary Contact Recreation based on an assessment of the stream's physical, chemical, and biological (including habitat) characteristics although such uses may not be presently existing for that water body. If the water body is capable of supporting these uses based on the assessment, then the water body should be designated for those uses in the state's water quality standards. Once designated, the use is protected from impacts that may impair the use through application of numerical and narrative water quality criteria.

Currently, Idaho has classified all the major rivers and reservoirs in the state with specific designated uses. However, most tributaries to these water bodies are not classified. Unclassified waters are automatically designated for primary contact recreation unless the physical characteristics of the water body prevent primary contact recreation. In those cases, the water body is designated for secondary contact recreation.

Existing uses of waters that are not designated are also protected. Both federal and state rules protect existing uses through the antidegradation policy (*See* Idaho Code Section 39-3603 and IDAPA 16.01.02,051). Impacts to existing uses are best prevented through provisions in the water quality standards intended to protect designated uses.

Idaho has designated uses for water bodies within the Cascade Reservoir watershed as follows:

NORTH FORK PAYETTE RIVER - source to McCall.

> Domestic water supply, agricultural water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource water.

NORTH FORK PAYETTE RIVER - McCall to Cascade Dam (includes the reservoir).

> Domestic water supply, agricultural water supply, cold water biota, salmonid spawning, and primary and secondary contact recreation.

LAKE FORK OF THE NORTH FORK PAYETTE RIVER - source to mouth.

> Domestic water supply, agricultural water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource water.

GOLD FORK OF THE NORTH FORK PAYETTE RIVER - source to mouth.

Domestic water supply, agricultural water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource water.

NORTH FORK PAYETTE RIVER - Cascade Dam to mouth (Banks).

Domestic water supply, agricultural water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource water.

All other water bodies within the watershed are unclassified, thus, they are automatically designated for primary contact recreation only.

Idaho had included the Cascade Reservoir on its water quality limited list due to impairment from excess nutrients. The reservoir was listed as a high priority for TMDL development. A number of additional water bodies in the watershed were added to the water quality limited list. Table 2.1 lists water quality limited water bodies and pollutants within the watershed affecting the reservoir.

Table 2.1. Water quality limited water bodies.

| Water Body | Boundaries | Pollutants | Potential Criteria |
|---|---|---|---|
| Mud Creek | source to reservoir | nutrients, sediment, pathogens, ammonia | General - nutrients, sediment. Numerical - DO, ammonia, turbidity, intergravel DO |
| Boulder Creek | source to reservoir | nutrients, sediment, thermal modification, flow alteration | General - nutrients, sediment. Numerical - DO, temperature, turbidity, intergravel DO |
| Gold Fork River | Flat Creek to reservoir | nutrients and sediment | General - nutrients, sediment. Numeric - turbidity, intergravel DO |
| Brown's Pond | on Lake Fork | habitat alteration | unknown |
| Campbell Creek | Boise National Forest | sediment | General - sediment. Numeric - turbidity, intergravel DO |
| French Creek | Boise National Forest | sediment | General - sediment. Numeric - turbidity, intergravel DO |
| Hazard Creek | Boise National Forest | sediment | General - sediment. Numeric - turbidity, intergravel DO |

The watershed management plan will be implemented to improve water quality in all of the water quality limited tributaries of Cascade Reservoir.

## 3.0 Inventory of Pollutant Sources and Loads

### 3.1 Major Categories and Types of Pollutants

#### *3.1.1 Point Source Pollution*

Only two point sources of pollution presently contribute nutrients and other constituents to Cascade Reservoir. Both facilities discharge wastewater directly to the North Fork Payette River upstream of Cascade Reservoir under NPDES permits. The City of McCall operates a wastewater treatment plant designed to treat 1.8 million gallons per day (MGD.) Average daily flow is approximately 0.7 MGD but peak flows have been reported at 2.3 MGD due to infiltration of ground water and snow melt. Ground water and snow melt sources contribute as much as 1.6 MGD on a seasonal basis to the base flow from domestic sources (J.U.B., 1995). A second facility is operated by the IDFG Fish Hatchery at McCall, Idaho. The hatchery utilizes approximately 20 cubic feet per second (cfs) (12.9 MGD) of water for maintenance and growth of Chinook Salmon stocks.

#### *3.1.2 Nonpoint Source Pollution*

Nonpoint sources of pollution affecting Cascade Reservoir include forest management practices, agricultural management (crop and grazing management), recreational impacts (campgrounds, parks, boat ramps), urban runoff, nutrient enriched ground water from septic tanks in close proximity to the reservoir shoreline or tributary streams, shoreline erosion, and internal recycling of nutrients. Studies performed by Clarke, 1995, indicate that stream channel erosion accounts for more than 40% of the total sediment yield to the reservoir.

*Forest Management Sources*

Major pollutants associated with forest management activities include sediment and nutrients. Related impacts are alteration of stream temperature and flow. Erosion associated with construction of roads (cut and fill), land slides on unstable slopes, erosion of road surfaces, and erosion of harvest areas are the primary sources of sediment. Material deposited in streams can be quickly transported to the reservoir during high stream flows. Sediment materials deposited in streams during low flow conditions may be re-suspended during the next high flow event. Additional sediment is produced by channel enlargement (bed and bank erosion)(Clarke, 1995). Virtually all of the forested lands within the Cascade Reservoir watershed have an extensive network of logging roads.

Geology of the forest lands may be conducive to erosion and production of sediments. Much of the Cascade Reservoir watershed is contained within the Idaho batholith (Schmidt and Mackin, 1970) which includes all forest lands east of the reservoir. Geology of forest lands west of the reservoir is about 6% basalt and related volcanics; 60% granitic rocks, gneiss and schist; 30% glacial moraine; and 4% glacial outwash (Clarke, 1995). Most of the forest lands in the Gold Fork River subwatershed (the largest forested subwatershed) are comprised of decomposing granitics. This material is highly erodible and surface soils often contain fine particulate materials that are easily transported. Natural sediment yields for Upper Kennally Creek have been estimated at 4 to 45 tons/mi$^2$/yr (average 400 tons/yr; PNF, 1994). Cumulative sediment yields for the Gold Fork River subwatershed have been estimated at 1,281 tons/yr (BNF,1993).

Grazing impacts (cattle and sheep) on forest lands are an additional source of nutrients and sediment due to stream bank disturbance and removal of riparian vegetation with associated increases in stream temperatures. Extensive portions of forest land within the Cascade Reservoir watershed are utilized for grazing, particularly lands on the west shore of the reservoir where steep mountain slopes grade to the valley floor. Many of the streams within forest lands have been impacted by grazing.

*Agricultural Sources*

Primary sources of pollutants associated with agriculture are sediment and nutrients. Related impacts are alteration of stream flows and temperatures. The predominant agricultural practice is cattle grazing. Each spring, large numbers of cattle are brought into the valley and remain until fall. Croplands (approximately 5,000 acres) comprise about 8% of the total agricultural land (63,150 acres).

Impacts from grazing include direct and indirect nutrient enrichment of streams, bacterial contamination, unstable stream banks due to trampling and increased sedimentation. One of the sources of sediment delivery to streams is sheet and rill erosion of pasture land. Improper grazing management can result in over utilization of pastures causing soil compaction and a reduction of ground cover. These conditions can reduce water infiltration and result in increased runoff and export of nutrients. The Valley Soil and Water Conservation District (VSWCD) reports that many grazing pastures have highly compacted soils. Local streams are the major source of water for livestock and a secondary source of forage. Access to these streams is generally unrestricted. As a result, banks have become unstable in many stream reaches. Bank erosion is accelerated and riparian vegetation has been removed or heavily grazed. Increased sedimentation of the streams and removal of vegetation can promote increased stream temperatures and export of nutrients associated with sediments.

Fertilizers are reportedly not used on pastures, although addition of fertilizer is practiced as a means to enhance establishment and growth of newly seeded pastures. Commercial fertilizers are applied in the production of oats and other grains.

Flood irrigation is the most common practice used to irrigate pasture land. Water is diverted from local streams through a series of extensive canals and ditches cut into the landscape along natural contours. Water is usually applied in excess, creating surface runoff which is diverted to local streams or returns as shallow ground water. These waters generally contain high concentrations of phosphorus and nitrogen compared to ambient concentrations of local streams (Klahr, 1988). These same irrigation systems funnel and accelerate delivery of runoff from snow melt during spring thaw.

### *Recreational Sources*

The U.S. Forest Service (USFS), the BOR and the City of Cascade operate and maintain public access to the lake for a variety of uses (boating and fishing are the most popular). Facilities include 17 boat ramps, 105 picnic areas, and 406 camping sites. Cascade Reservoir now ranks ninth in the state as measured by angler hours and fish landed by anglers. Economic value as a sport fishery has been estimated at over one million dollars annually by the IDFG. Due to its proximity to populated urban areas of the state, the reservoir is a major destination site.

Pollution effects from recreation include hydrocarbons from outboard motors, organic material from fish cleaning, potential bacterial contamination from human waste (improper sanitary disposal) and addition of nutrients, grease and oils from parking lot runoff at camp grounds and boat ramps. Sediments are also contributed by erosion of banks around popular beach areas and camping sites.

Physical carrying capacity of the reservoir for recreational boating has been established at 1,300 boats/day (BOR, 1992). Peak use during a weekend has been estimated at 150 to 200 boats.

### *Urban Runoff Sources*

There are only three major urban centers in the Cascade Reservoir watershed; the incorporated cities and associated impact areas of Cascade (population 1,120), Donnelly (population 173), and McCall (population 2,604). The transient (nonresident) tourist/recreation population will increase potential impacts from urban runoff. A significant increase in seasonal usage occurs during the summer (summer cottage use). A majority of the City of Cascade resides outside the hydrologic drainage area of Cascade Reservoir. Runoff from Donnelly enters Boulder Creek and Lake Fork Creek through a network of road swales and drainage ditches. Approximately half of the City of McCall runoff enters the North Fork Payette River through storm sewers, road swales and ditches. The McCall Airport serves a small commercial fleet and private planes. Runoff from this facility drains to the North Fork Payette River. Numerous residential developments of varying densities have been constructed around the reservoir.

Pollutant sources of concern associated with urban runoff include nutrients, sediment from erosion of conveyance systems, oils, pesticides and bacteria. Rural ranchettes, in addition to contributing the common urban pollutants, are a potential source of high nutrient loading and bacteria from hobby livestock such as horses, sheep and other domestic livestock. Animal densities are often greater than the available land can support, causing over utilization and problems with waste management. Poor drainage and runoff from snow melt can wash these materials into local streams.

### *Ground Water Enrichment Sources*

Phosphorus contributions from septic tank effluent have been estimated. Estimates are derived based on the number of installed systems, usage, and application of a phosphorus soil retention factor (Reckhow and Simpson, 1980). The soil retention coefficient is an estimate of how well the soil matrix functions in binding and reducing the transport of phosphorus through shallow ground water. The most important mechanisms responsible for immobilizing phosphorus are the formation of insoluble iron and aluminum phosphate compounds and the adsorption of phosphate ions onto clay particles (Tilstra, 1972).

Although binding capacity for soils in the Cascade Reservoir watershed is good for surface soils, phosphorus sorption declines rapidly with depth (McGeehan, 1995). Seasonally high ground water tables may increase mobilization of phosphorus and eventually transport all phosphorus from septic tank effluent to the reservoir.

*Reservoir Water Levels and Internal Recycling*

Availability of sediment-bound phosphorus and potential leaching into surface water can be affected by operational conditions controlling the water depth over the reservoir sediments. Fluctuating water levels that periodically expose lake sediments or alter the aerobic/anaerobic conditions at the sediment/water interface affect the sink/source characteristics of these sediments.

Under annual drawdown conditions, availability of phosphorus in sediment may be increased, further contributing to the enrichment of the water column and increased algal productivity. Improved understanding of the sediment interactions would facilitate development of operational guidelines to reduce recycling of nutrients and improve water quality.

## 3.2 Data Sources and Assessment Methods

### *3.2.1 Evaluation of Watershed Mass Balance Budget of Nutrients and Water Entering the Reservoir*

Based on a review of previous studies and available data, estimates of the amount and sources of nutrients can be derived for watershed point and nonpoint sources from information collected during WYs 1981 (Zimmer, 1983), and 1989 (Entranco, 1991), and monitoring conducted by DEQ during WYs 1993 and 1994. Each of these studies has collected data from the same general points of inflow to the reservoir (see Figure A.2). Bulk nutrient contributions of each subwatershed have been monitored at the lower ends of each major tributary. Stream flow and water quality has been measured at least monthly (EPA, 1977) or biweekly during spring snow melt (Zimmer, 1983, Entranco, 1991; DEQ, 1993;1994). A gross annual estimate of cumulative inflows to Cascade Reservoir is calculated by the BOR using the change in storage method. The above studies have used these BOR estimates to extrapolate missing flow data when direct stream measurements were not available.

Annual estimates of the point and nonpoint sources of phosphorus entering Cascade Reservoir through runoff are presented in Table 3.1. Annual estimates of phosphorus loading vary greatly from year to year. These differences may be related to differences in runoff conditions (Table 3.2) and errors in estimates of individual stream flow, concentration of nutrients, and frequency of measurement. Sample locations and frequency and methods of measurement are most consistent among surveys conducted in WY 1989, 1993, and 1994. Highest rates of phosphorus loading were observed in 1993 following several consecutive years of below normal precipitation (Figure 3.1). Precipitation in 1993 was 25.91 inches, slightly above the 50 year average of 21.8 inches. Phosphorus loading to the reservoir declined by more than 50% and runoff declined by 49% in the following water year in response to a decline in total precipitation (20.91 inches).

Table 3.1 Total annual phosphorus loading in kilograms (kg) to Cascade Reservoir.

| | Years | | | |
|---|---|---|---|---|
| **NONPOINT SOURCES** | 1981[a] | 1989[b] | 1993[c] | 1994[c] |
| Tributary Inflows | | | | |
| N.F.Payette River | 3,150 | 12,713 | 18,699 | 4,464 |
| Gold Fork River | 1,990 | 6,827 | 12,208 | 5,518 |
| Boulder Creek | 2,990 | 5,578 | 5,554 | 1,195 |
| Lake Fork Creek | 1,110 | 1,057 | 6,759 | 1,919 |
| Misc. Tributaries | 12,500 | | | |
| Mud Creek | | 466 | 1,104 | 637 |
| Willow Creek | | 969 | 1,257 | 962 |
| West Mountain | 2,440 | 1,056 | 3,023 | 1,149 |
| Septic Tanks | no data | 133 | 1,917 | 1,917 |
| Total | 24,180 | 28,799 | 50,523 | 17,672 |
| **POINT SOURCES** | | | | |
| McCall Wastewater Treatment Plant | 1,780[d] | 5,160 | 3,815 | 3,947 |
| Fish Hatchery | | 726 | 218 | 218 |
| Total | 1,780 | 5,886 | 4,033 | 4,165 |
| **PRECIPITATION** | 1,875[d] | 3,158 | 3,530 | 2,849 |
| Total Inflows | 27,835 | 37,843 | 58,086 | 24,776 |
| Outflows N.F. Payette River | 27,450 | | | |
| Retention | | | | |
| Net Retention | 385 | | | |
| Percent Inflows | 1.4 | | | |

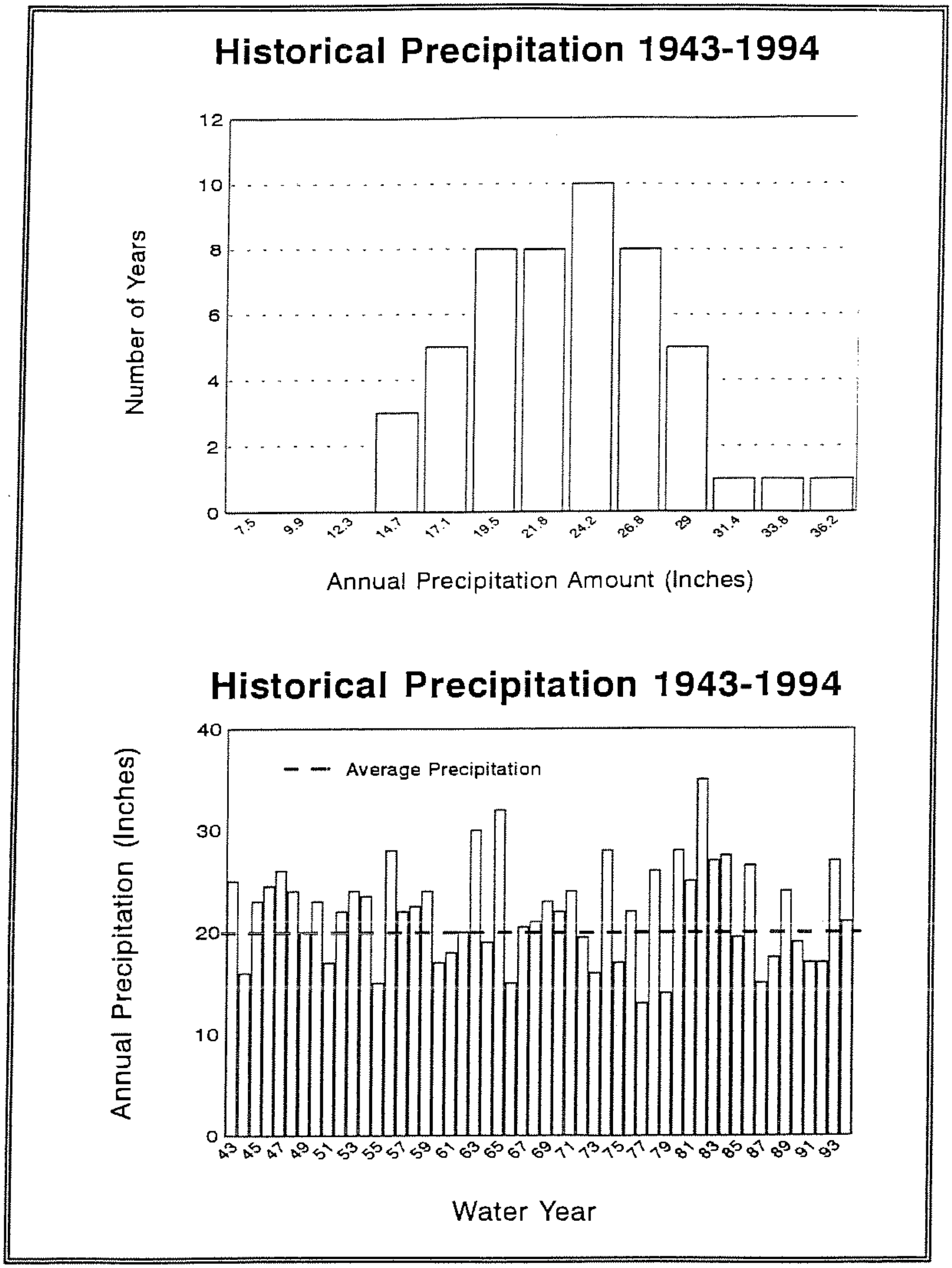
[a]=Source data Zimmer (1983); [b]=Source data Entranco (1991); [c]=Source data Worth (1993, 1994); [d]=Source estimates EPA (1977)

Table 3.2 Total annual inflows and outflows for Cascade Reservoir.

| MORPHOMETRIC MEASURES[d] | | | | |
|---|---|---|---|---|
| Volume (Total Capacity) | 703,200 acre-ft (867.4 x $10^6$ $m^3$) | | | |
| Mean Depth | 26.5 ft (8.1 m) | | | |
| Surface Area | 26,500 acres (107.24 $km^2$) | | | |
| SOURCE | ANNUAL INFLOWS AND OUTFLOWS (acre-ft) | | | |
| | 1981[a] | 1989[b] | 1993[c] | 1994[c] |
| N.F. Payette River | 239,967 | 274,878 | 316,810 | 138,144 |
| Gold Fork River | 94,690 | 148,556 | 173,052 | 66,095 |
| Boulder Creek | 52,614 | 55,498 | 26,119 | 8,806 |
| Lake Fork Creek | 100,770 | 78,318 | 108,074 | 29,678 |
| Misc. Tributaries | | | | |
| West Mountain | 87,312 | 25,283 | 36,684 | 12,570 |
| Other | 164,572 | 2,457 | | |
| Willow Creek | | 4,890 | 7,105 | 2,696 |
| Mud Creek | | 8,272 | 11,495 | 4,738 |
| Total Runoff | 739,925 | 598,152 | 538,738 | 262,727 |
| (BOR Estimate) | | | (752,260) | (298,100) |
| Precipitation | 61,628 | 51,189 | 57,218 | 46,176 |
| (Inches) | (27.9) | (23.18) | (25.91) | (20.91) |
| % Normal (22.14) | 126 | 104 | 117 | 94 |
| Outflows - N. F. Payette River | 846,200 | 531,178 | 662,922 | 407,182 |
| Residence Time - yr (Volume/Outflow) | 0.83 | 1.34 | 1.06 | 1.7 |

[a]=Source data Zimmer (1983); [b]=Source data Entranco (1991); [c]=Source data Worth (1993, 1994); [d]=Source data BOR

Figure 3.1. Annual precipitation records and distribution of precipitation frequency for Cascade Reservoir (Records from BOR)



Nonpoint source runoff accounts for an average of 81% (ranging from a high of 88% in 1993, to a low of 72% in 1994) of the total input of phosphorus. The North Fork Payette River contributes the largest percentage of nutrients due to the corresponding large contribution of water from this source, averaging 46%, 47%, and 53%, respectively for WYs 1989, 1993 and 1994 (Figure 3.2).

Point source contributions of phosphorus from the treatment plant in WY 1975 are based on measured concentrations in the effluent and estimates of discharge volume. Estimates for WY 1981 were based on measured differences in water quality upstream and downstream of the effluent discharge (Zimmer, 1983). The remaining estimates are obtained from NPDES reporting of monthly average concentrations and discharge volume.

Contributions of phosphorus from direct precipitation were based on a constant of 0.175 kg/ha (0.4324 kg/ac) phosphorus of lake surface for WY 1981 (EPA, 1977). Estimates for the remaining water years were obtained by applying a phosphorus content of precipitation (assumed equal to 0.05 mg/l) and multiplying by the volume of direct rainfall/snowfall in the water budget. Actual measurements of phosphorus content in precipitation have not been obtained and could be underestimated in the loading budget.

Estimates of phosphorus contributions from septic tank effluent were evaluated using four different accounting techniques. The method used is presented in Table 3.3.

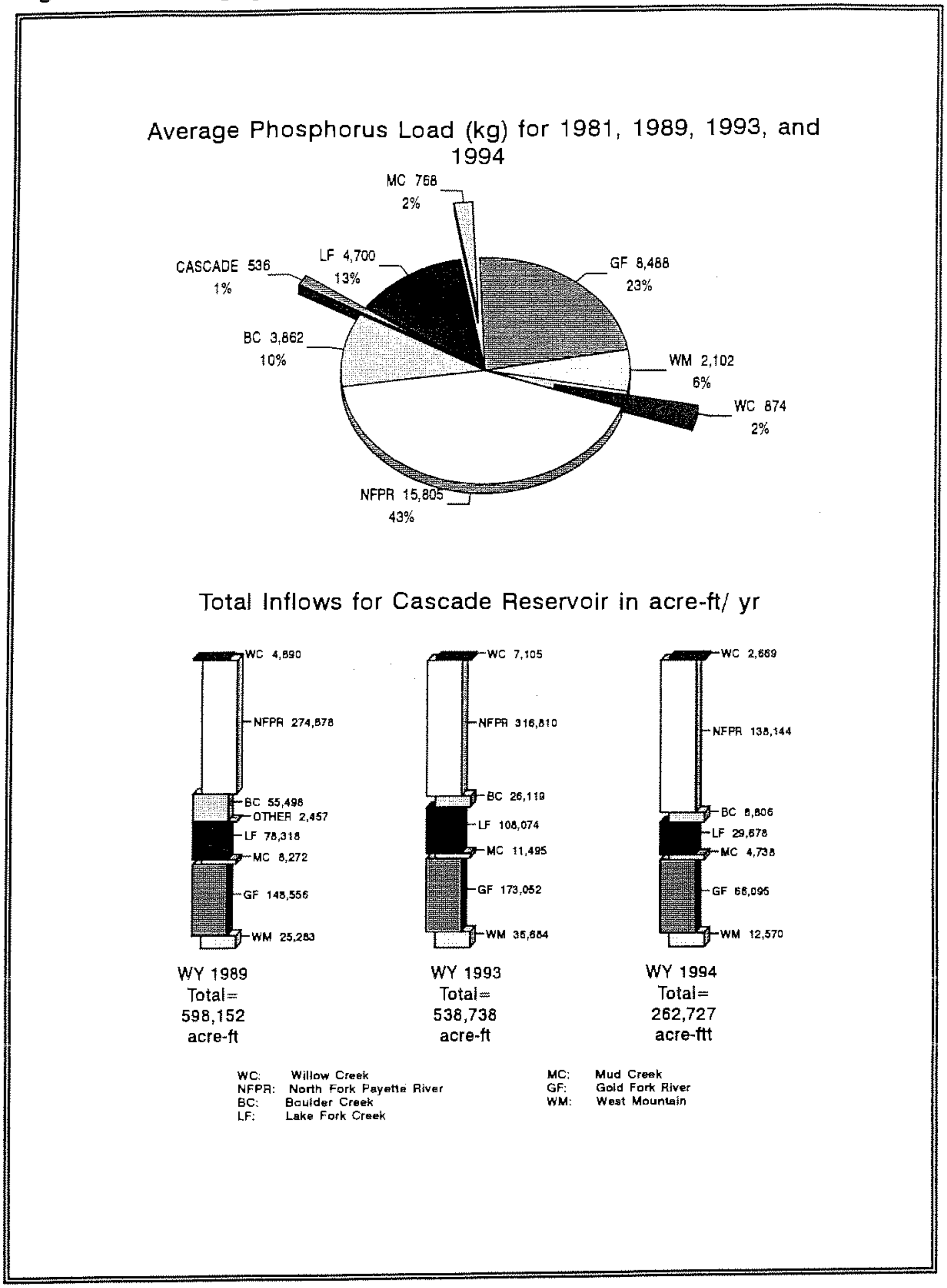
Although binding capacity for soils in the Cascade Watershed is good for surface soils, phosphorus sorption declines rapidly with depth (McGeehan, 1995). Seasonally high ground water tables may increase mobilization of phosphorus and eventually transport all sources of phosphorus from septic tank effluent to the reservoir. Estimates for WY 1993 and 1994, were based on a soil retention factor of 0.1 (poor binding capacity), number dwelling units with septic tanks around the reservoir, use days by season, number persons per household, and a effluent phosphorus loading of 0.9 kg/person/yr phosphorus (moderate rate for no restrictions on phosphate detergent; Uttormark et al.,1974).

Other potentially important contributions of phosphorus are associated with erosion of shorelines within the reservoir. The amount of the annual phosphorus loading attributed to this source is unknown. DEQ initiated analysis of watershed soils for phosphorus content in 1994. Results of this work will provide an estimate of the quantity of phosphorus associated with a variety of soil types that can be extrapolated to estimate contributions from shoreline erosion.

## 3.3 Subwatershed Summaries

Land ownership and land uses in each of the subwatersheds are shown in Figure 3.3 and Table 3.4. Information is based on inventories conducted by the Idaho Soil Conservation Commission (SCC) prior to 1989. The total watershed occupies approximately 357,000 acres. Forest lands comprise more than 71% of the acreage with agriculture accounting for 23%. The information is somewhat dated due to accelerated conversion of agricultural lands and other open spaces to rural ranchettes. The City of Boise, Idaho's largest metropolitan center 70 miles south of Cascade, Idaho, is undergoing rapid growth and in turn stimulating growth of Valley County. Land prices are comparatively lower and recreational opportunities are abundant, making Valley

Figure 3.2. Average phosphorus load and total inflows by subwatershed




County a popular recreation area and an attractive market for second homes. A revised land use delineation currently being prepared using county tax records and converted to GIS for mapping will be presented in Phase II.

## Table 3.3 Septic Tank Loading Calculations

**Calculation of septic tank TP contribution using Export Coefficient and Soil Retention Factors.**

**Method assumes that soils retain SOME of the Phosphorus.**

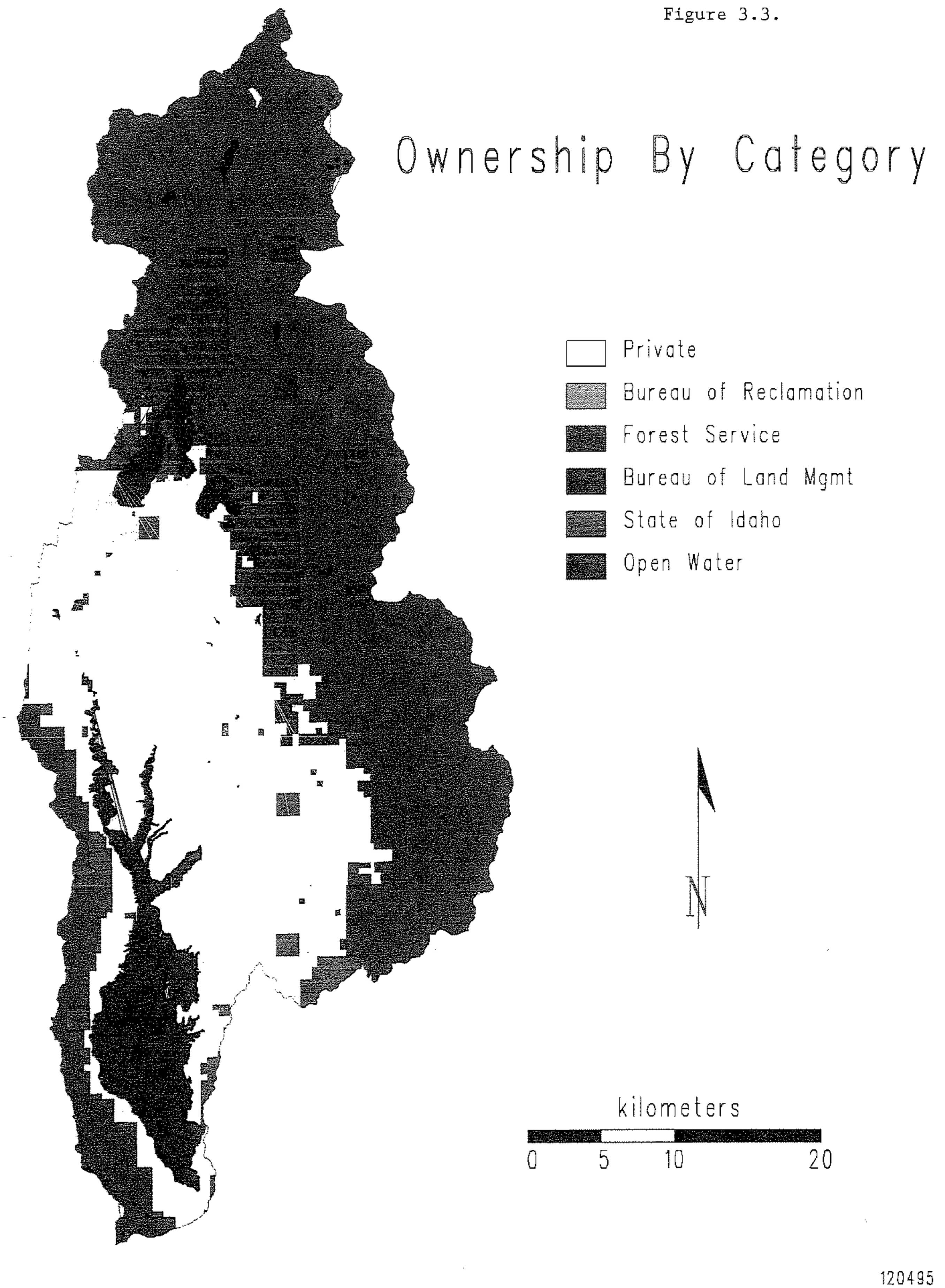
| Area | Name | Soil Type | # Septic Tanks | System Avg. Age Yrs. | Summer Use Days | Person Use | Occupied # Units | Avg. Use Days Seasonal Capita/yr | Winter Use Days | Person Use | Occupied # Units | Permanent Capita/yr | Soil Retention Factor | Estimated Load Based on Total P Output @ Coef. Value 1.8kg/yr High (kg/yr) | 0.9kg/yr Med(kg/yr) | 0.3kg/yr Low(kg/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Tamarack Falls | | 277 | 8 | 150 | 4 | 166 | 273 | 215 | 3 | 83 | 147 | 0.1 | 680 | 340 | 113 |
| 2 | Duck Creek | | 79 | 7 | 150 | 4 | 47 | 78 | 215 | 3 | 24 | 42 | 0.1 | 194 | 97 | 32 |
| 3 | Deer Creek | | 82 | 9 | 150 | 4 | 49 | 81 | 215 | 3 | 25 | 43 | 0.1 | 201 | 101 | 34 |
| 4 | West Mountain | | 364 | 10 | 150 | 4 | 218 | 359 | 215 | 3 | 109 | 193 | 0.1 | 894 | 447 | 149 |
| 5 | Ponderosa | | 105 | 8 | 150 | 4 | 63 | 104 | 215 | 3 | 32 | 56 | 0.1 | 258 | 129 | 43 |
| 6 | Crown Point | | 176 | 8 | 150 | 4 | 106 | 174 | 215 | 3 | 53 | 93 | 0.1 | 432 | 216 | 72 |
| 7 | Day Star | | 75 | 9 | 150 | 4 | 45 | 74 | 215 | 3 | 23 | 40 | 0.1 | 184 | 92 | 31 |
| 8 | Wagon Wheel | | 240 | 9 | 150 | 4 | 144 | 237 | 215 | 3 | 72 | 127 | 0.1 | 590 | 295 | 98 |
| 9 | Morning Dawn | | 163 | 11 | 150 | 4 | 98 | 161 | 215 | 3 | 49 | 86 | 0.1 | 400 | 200 | 67 |
| | | | 1561 | | | | 937 | 1540 | | | 468 | 828 | 0.10 | | | |
| | | | | | | | | | | | | | Total | 3835 | 1917 | 639 |
| | | | | | | | | | | | | | Winter | 1341 | 670 | 223 |
| | | | | | | | | | | | | | Summer | 2494 | 1247 | 416 |
| | | | | | | | | | | | | | #1994 TP | 14.5 | 7.8 | 2.8 |
| | | | | | | | | | | | | | #1989 TP | 9.3 | 4.9 | 1.7 |
| | | | | | | | | | | | | | #1993 TP | 6.0 | 3.1 | 1.1 |

* Soil retention factor estimates the adsorption capacity of soils to trap phosphorus. Ground water tables, age of septic systems and soil type effect the retention capacity. Retention values range from 0 – 1.0; 0 = no retention and 1.0 = 100% retention of P.

** Typical literature values for phosphorus inputs from septic tanks with no phosphate detergent restrictions (Uttormark et. al. 1974).

| kg/yr TP/single dwelling unit/person @ Effluent Concentrations | | | |
|---|---|---|---|
| Effluent concentrations | 20mg/l | 15mg/l | 20mg/l |
| Septic Output coefficients | 1.0441 | 0.7831 | 1.0441 |

Figure 3.3.



Ownership By Category
Private
Bureau of Reclamation
Forest Service
Bureau of Land Mgmt
State of Idaho
Open Water
N
kilometers
0
5
10
20
120495

Table 3.4 Drainage area and land use associated with subwatershed monitoring sites.

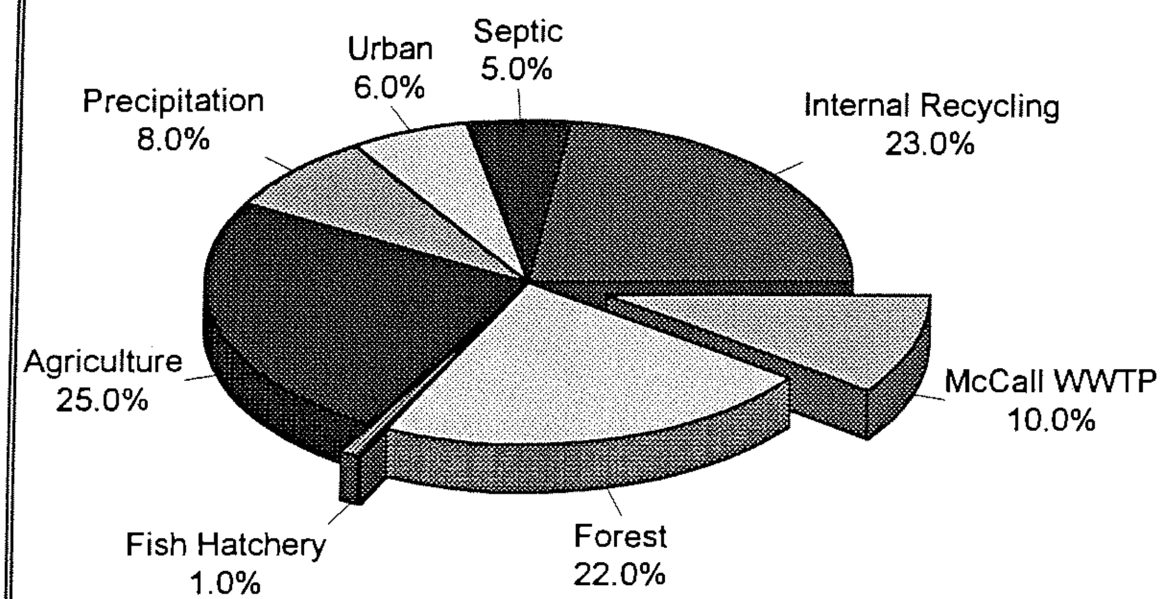
| Subwatershed | Drainage Area (acres) | Irr. Pasture (acres) | Non-Irr. Pasture (acres) | Irr. Crop (acres) | Non-Irr. Crop (acres) | Range Land (acres) | Forest Land (acres) | Rec. Land (acres) | Urban Land (acres) | Water + Wild Life (acres) |
|---|---|---|---|---|---|---|---|---|---|---|
| Boulder Creek | 27,788 | **7,724** | 947 | 267 | 346 | 144 | **17,292** | | 886 | 183 |
| Cascade | 18,390 | **5,690** | 2,060 | 1,226 | | 196 | **6,318** | 129 | 2,173 | 599 |
| Gold Fork River | 97,153 | 717 | 1,607 | 231 | 156 | | **93,874** | | 398 | 171 |
| Lake Fork Creek | 49,878 | 7,689 | 1331 | | | | **39,653** | | 974 | 231 |
| Mud Creek | 14,702 | **11,056** | 35 | 1572 | | | 646 | | 1,301 | 93 |
| NF Payette River | 30,490 | **6,426** | 1,393 | 183 | | **5,641** | 12,756 | | **3,405** | 685 |
| West Mountain | 27,581 | 538 | | | | | 22,909 | 565 | **2,997** | 599 |
| Willow Creek | 8149 | **3,110** | 835 | 581 | 127 | 365 | **2,439** | | 655 | 37 |
| Total | 274,131 | 42,950 | 8,208 | 4,060 | 629 | 6,346 | 195,887 | 740 | 12,789 | 2598 |

**[Bold]** = Indicates dominate land use.

## 3.4 Pollutant Loading Analysis

Combined point and nonpoint source contributions of phosphorus are summarized in Figure 3.4. The loads in Figure 3.4 were determined by averaging 1) the yearly loads for septic, internal recycling, precipitation and fish hatchery, and 2) the years 1981, 1989, 1993 and 1994 for the McCall wastewater treatment plant (WWTP). The loads for forestry, agriculture and urban were proportioned by relative area and applied to the remainder of the total load after subtracting the sources mentioned above.

Figure 3.4. Cascade Reservoir phosphorus loading




Average Measured Load 37,135 kg/yr Phosphorus

| | | | |
|---|---|---|---|
| Agriculture | 9358 kg/yr P | Septic | 1917 kg/yr P |
| Internal Recycling | 8719 kg/yr P | Precipitation | 2853 kg/yr P |
| Forest | 7877 kg/yr P | Urban | 2349 kg/yr P |
| McCall WWTP | 3675 kg/yr P | Fish Hatchery | 387 kg/yr P |

Forest and agricultural activities contribute similar proportions of the total phosphorus load under the range of conditions monitored. Urban and recreational nonpoint sources comprised a relatively small percentage of the total phosphorus load (6% and 8%). Monitoring data indicates that the City of McCall wastewater treatment plant accounts for 10% of the total phosphorus load to the reservoir during drought conditions due to a corresponding reduction in nonpoint source loading. Under average conditions, with a corresponding increase in nonpoint source loading, this source accounts for only 9% of the total load.

Internal recycling is a potentially large and significant contributor of phosphorus. Approximately 8,719 kg phosphorus was estimated as the load from this component using the 1989 version of the Cascade model. Although this same value was used to calculate a budget for subsequent years, it is highly likely that annual contributions vary considerably under differing limnological conditions. Revised models will be used to provide more accurate estimates of load due to internal recycling and to compare estimates of the change in reservoir content of phosphorus before and after fall turnover of the reservoir.

## 4.0 Watershed Management Strategy

The overall goal of the watershed management strategy is to improve water quality in Cascade Reservoir so the reservoir can support beneficial uses. In watersheds where a significant part of the pollutants come from nonpoint sources, it is often difficult to fully determine the contributions from each source and to identify the management actions that will result in specific water quality improvements. In part, the difficulties result from the inability to measure pollutants released from nonpoint sources and from a lack of data on the phosphorus reduction that can be expected from specific BMPs. DEQ proposes to address these problems by seeking water quality improvements using a phased approach.

The phased approach consists of setting a goal and strategy for reducing phosphorus load to the reservoir based on the best information available at this time. The strategy will be implemented and monitoring will be conducted to evaluate progress. If the phosphorus reduction goal is not met, the strategy will be revised. If the phosphorus reduction goal is met and the reservoir still is not able to support beneficial uses, the goal and strategy will be revised based on improved information (Figure 4.1).

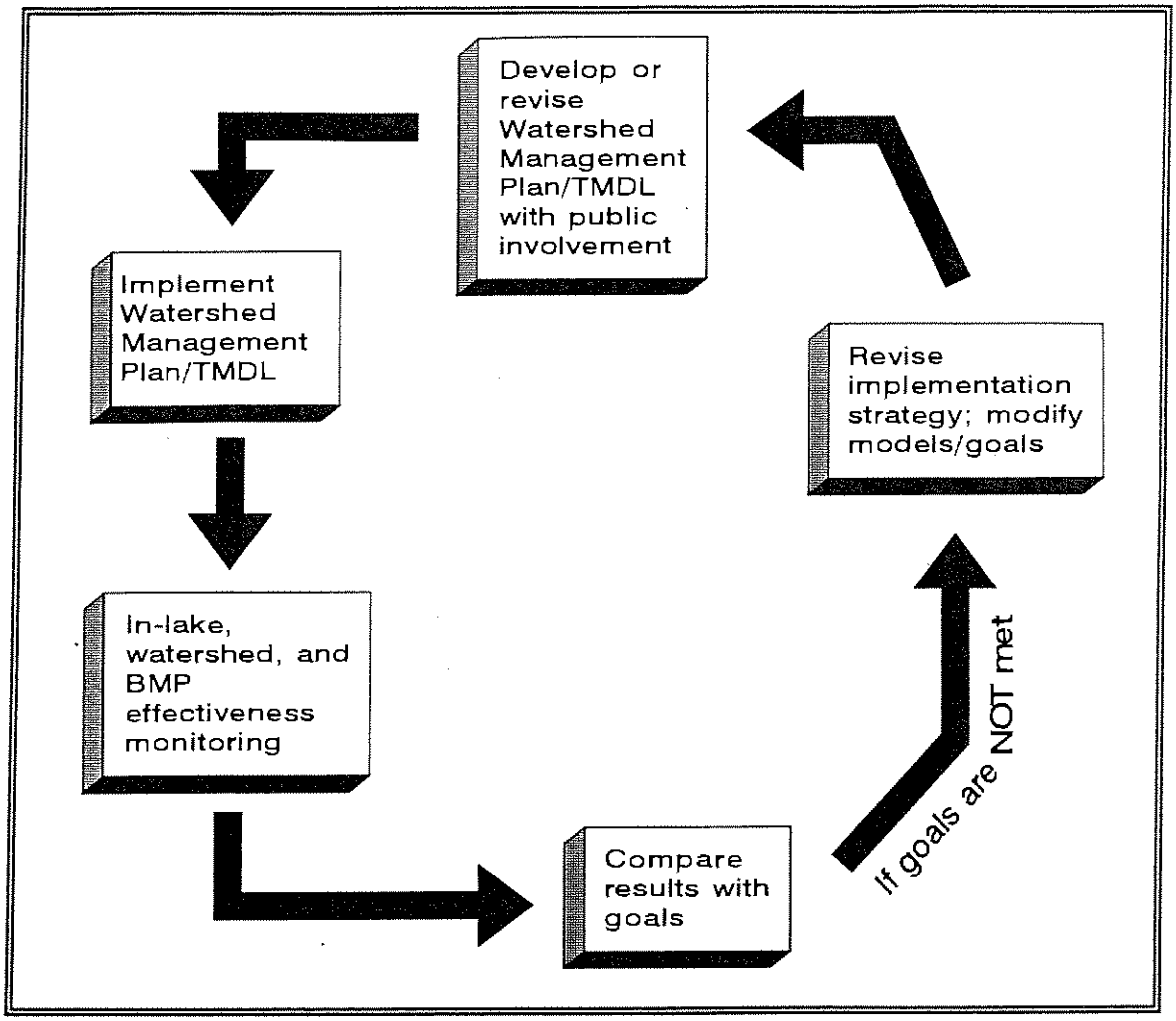
In recent years water quality problems in Cascade Reservoir have resulted in public health concerns. In 1993 the IDHW, Division of Health issued a public health advisory recommending that the public avoid contact with reservoir water. Because of the public health concerns DEQ, in cooperation with the community and other agencies, promptly initiated efforts to improve water quality.

Phase I of the Cascade Reservoir plan formalizes an initial phosphorus reduction goal, outlines an implementation strategy for improving water quality and describes ongoing water quality improvement efforts. DEQ plans to continue data collection and evaluation to further refine the phosphorus reduction goal, while Phase I of the plan is being implemented.

During Phase I implementation, DEQ will:

- work with the community to implement water quality improvement projects to achieve the phosphorus reduction goal;
- monitor implementation of water quality improvement projects;
- continue to collect and evaluate data to improve our ability to predict the water quality effects of management actions;
- continue water quality monitoring to measure the effects of phosphorus reduction efforts; and
- continue to work with the community to develop a more detailed implementation strategy.

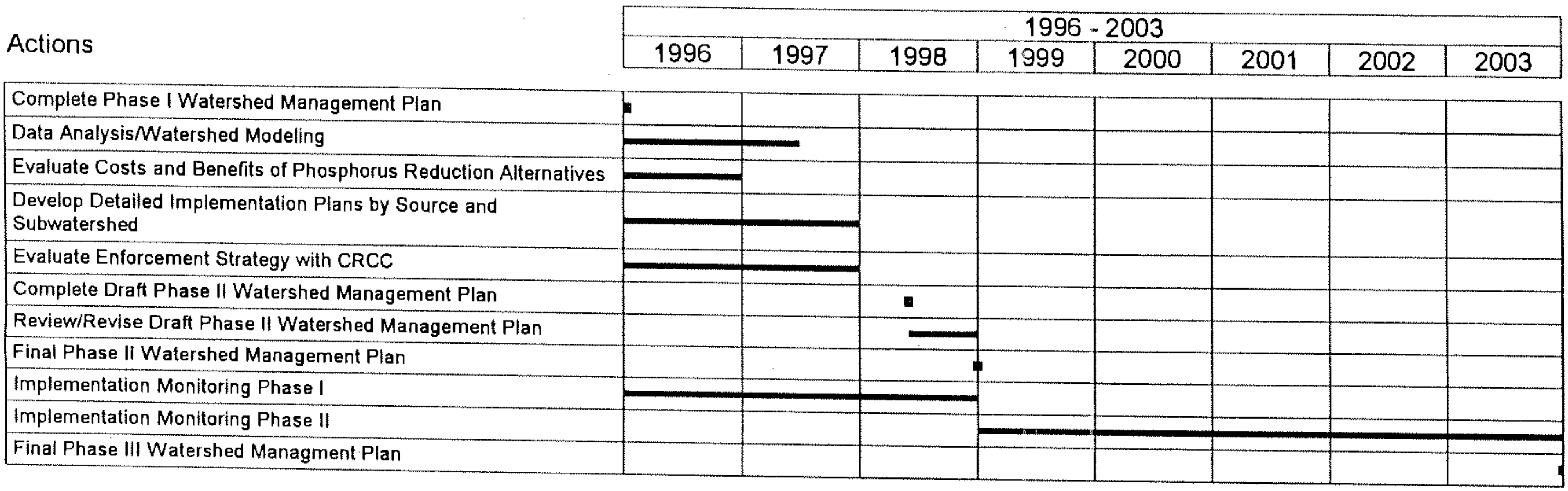
Figure 4.1 A phased approach to implementation of the phosphorus reduction goal.




Phase II of the plan will include further evaluation of phosphorus reduction goals and alternatives and a more detailed implementation plan. The implementation plan will identify specific phosphorus reduction actions needed to allow the Reservoir to support beneficial uses, including an evaluation of costs and benefits for the proposed treatment actions. DEQ plans to complete Phase II of the plan in 1998 and to implement Phase II for five years or until 2003. During Phase II implementation, DEQ will continue monitoring to determine if phosphorus reduction efforts are successful and the reservoir meets water quality standards. If the phosphorus reduction efforts are not successful, DEQ will determine if there is a need to change the load allocation or implementation strategy in Phase III. Figure 4.2 shows a tentative schedule for completion and implementation of Phases I, II and III of the Watershed Management Plan.

The watershed management strategy focuses on the control and reduction of nutrients contributed by the eight major subwatersheds flowing into Cascade Reservoir. Management actions to achieve load reductions will focus on point sources and cost effective voluntary reductions from

Figure 4.2 Tentative schedule for Phases I, II and III of the Watershed Management Plan.



nonpoint sources that can be effectively reduced or eliminated on a long term basis. The Technical Advisory Committee (TAC) and the Cascade Reservoir Coordinating Council (CRCC) are developing criteria for evaluating individual projects.

Within this overall framework, DEQ will place priority on addressing the most significant sources of phosphorus in each subwatershed first. However, a voluntary program depends on willing participation. Sources that are not necessarily the most significant will be treated to reduce phosphorus where demonstration projects may help encourage broader acceptance of BMPs.

## 4.1 Load Allocation

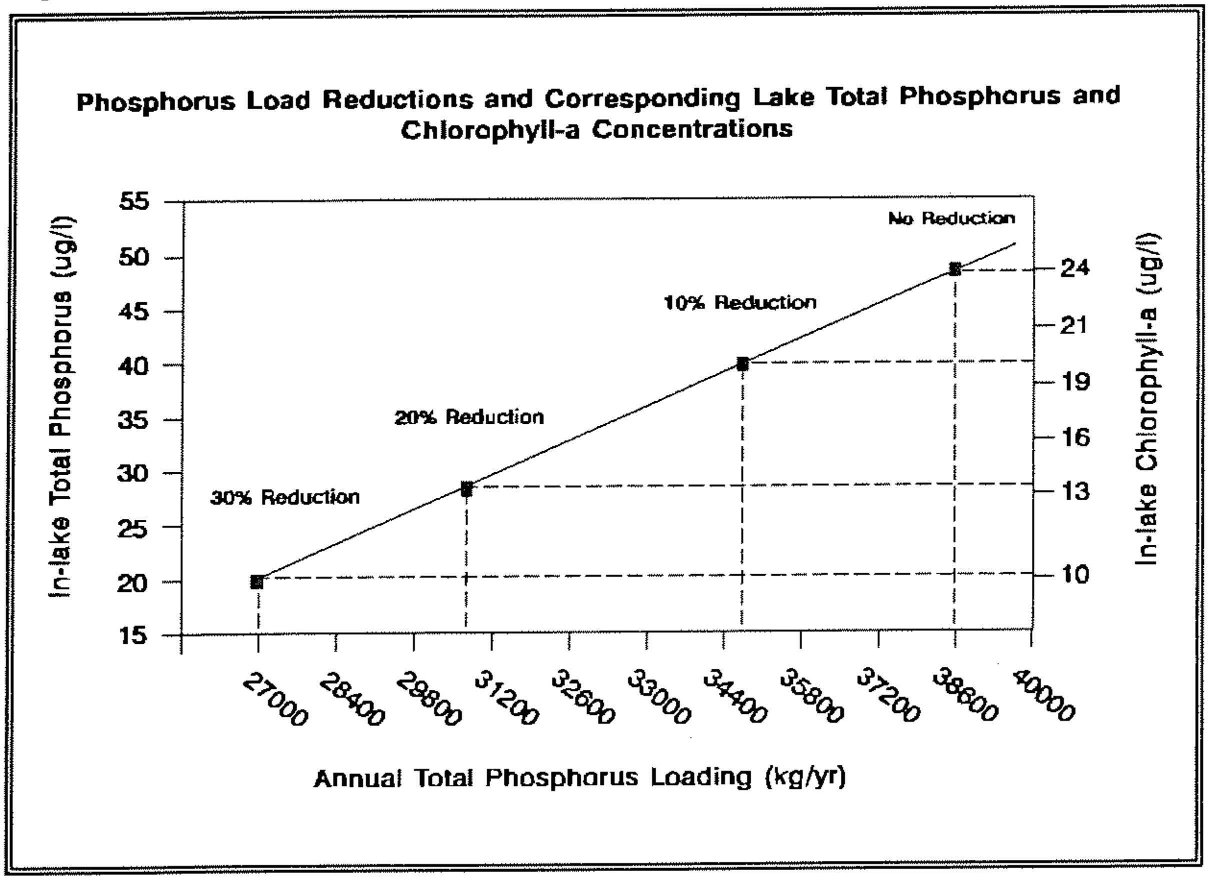
An annual load allocation has been established for Cascade Reservoir to reduce external contributions of total phosphorus (measured in kg/yr) now entering the reservoir from point and nonpoint sources. The method for determining the load allocation is based on scientific data that indicate there is a direct relationship between the amount of total phosphorus entering the reservoir (external loading) and the concentration of total phosphorus measured in the reservoir water column. A computer model (Chapra, 1990) was used to simulate changes in reservoir total phosphorus and chlorophyll a concentrations in response to changes in total phosphorus contributed by the subwatersheds.

Entranco (1991) used the 1989 phosphorus loading data as the most current data available for the model analysis. While measured precipitation amounts were near normal for that water year (October 1988 to September 1989), measured runoff from the subwatersheds may not accurately reflect "normal" conditions due to the effects of prior years of drought. Runoff may have been less than normal because precipitation and snowmelt replenished dry soils rather than draining to streams.

Results of the 1989 model are being utilized because this is the best information currently available. Model simulations were conducted using 1989 data to establish the relationship between total phosphorus loading from the subwatersheds and corresponding reservoir concentrations of total phosphorus and chlorophyll a. The model results are depicted in Figure 4.3 and predict that reservoir total phosphorus and chlorophyll a increase as the amount of total phosphorus entering the reservoir increases. This relationship also indicates that a 30% reduction from the average measured load (for 1981, 1989, 1993 and 1994) would achieve the desired chlorophyll a concentration of 10 $\mu$g/l and provide improvement in water quality. Wetzel (1983) suggests that this concentration is necessary to maintain lakes and reservoirs in a mesotrophic condition. Reservoir phosphorus concentrations would also attain the desired level of 0.025 mg/l (EPA, Quality Criteria for Water 1986). It is estimated that by sustaining a 30% reduction in phosphorus loading over a five year period, desired concentrations for chlorophyll a and phosphorus will be attained in Cascade Reservoir.

Due to limitations in the existing model capabilities, the load allocation will be re-evaluated using an improved reservoir model for Phase II of the Watershed Management Plan. The revised model will include modifications to better simulate internal phosphorus recycling and improve sensitivity to changes in the phosphorus contributed by the subwatersheds.

Figure 4.3 Relationship between reservoir total phosphorus and annual phosphorus loading.




### *4.1.1 Margin of Safety*

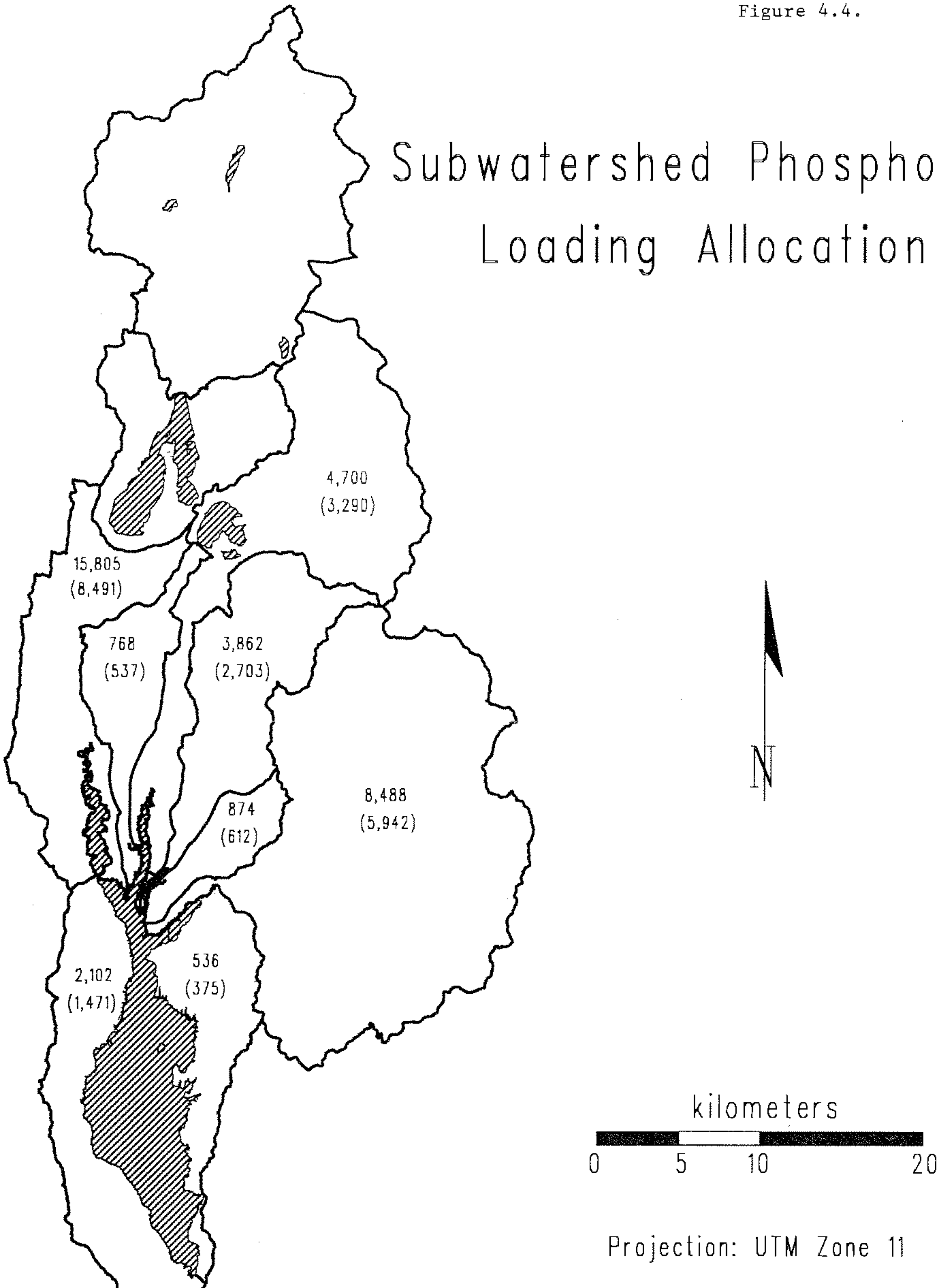
A 30% reduction of the phosphorus load will achieve water quality standards and restore beneficial uses in Cascade Reservoir and its tributaries. In addition, a margin of safety is required under EPA's TMDL guidance. This plan calls for a 7% margin of safety. A 37% reduction can be achieved by complete removal of the City of McCall wastewater treatment plant effluent from the North Fork Payette River and a 30% reduction from the nonpoint sources in each subwatershed.

### *4.1.2 Subwatershed Allocation*

Using the 37% reduction goal, a preliminary load allocation for each subwatershed has been determined. Figure 4.4 shows average phosphorus contribution from each subwatershed and the load allocation after applying a 30% reduction to all subwatersheds except North Fork Payette River. In the North Fork Payette River subwatershed the load allocation reflects full removal of the City of McCall's average phosphorus contribution (3,675 kg/yr) and a 30% reduction for all other sources (3,639 kg/yr). Table 4.1 shows average measured load and phosphorus reduction goals by subwatershed.

Figure 4.4.

# Subwatershed Phosphorus Loading Allocation

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The decision to seek the same percentage reduction from nonpoint sources in each subwatershed was based on comments received during a series of public meetings in 1994 and 1995. With this approach, subwatersheds contributing the largest amount of phosphorus will need to achieve the greatest reductions. For example sources in the Gold Fork subwatershed, with an average load of 8,488 kg/yr, will need to reduce their phosphorus contribution to the reservoir by 2,546 kg/yr. Sources in the Cascade subwatershed, which only contributes an average of 536 kg/yr, will need to reduce their phosphorus load by 161 kg/yr.

Success in reducing the current annual load of total phosphorus will be measured by comparing the individual subwatershed allocations with the measured contributions monitored at or near the mouth of the major tributaries.

Table 4.1 Average measured load and reduction goals by subwatershed.

| Subwatershed | Measured Phosphorus Load[a] (kg/yr) | 37% Phosphorus Reduction Goal[b] (kg/yr) |
|---|---|---|
| North Fork Payette River | | |
| McCall Wastewater Treatment Plan | 3,675 | 3,675 |
| Other Sources | 12,130 | 3,639 |
| Mud Creek | 768 | 230 |
| Lake Fork Creek | 4,700 | 1,410 |
| Boulder Creek | 3,862 | 1,158 |
| Willow Creek | 874 | 262 |
| Gold Fork River | 8,488 | 2,547 |
| Cascade | 536 | 161 |
| West Mountain | 2,102 | 630 |
| Totals | 37,135 | 13,712 =37% of Measured Load |

[a] Four year mean load (1989, 1991, 1993, 1994).

[b] The reductions for each subwatershed assume 30% non-point source phosphorus reductions and complete removal of McCall's effluent from the North Fork Payette River.

## 4.2 Citizen Involvement

The most effective way to achieve reduction goals is for the community to determine the most appropriate phosphorus reduction strategies. A citizen involvement program, consisting of the CRCC, a TAC and subwatershed work groups, was established so the community can provide direction and leadership in developing and implementing this plan (Figure 4.5). The CRCC is composed of seven local citizens appointed by the Southwest Idaho Regional Office of DEQ to represent the following major interest groups in the community. The CRCC includes members representing:

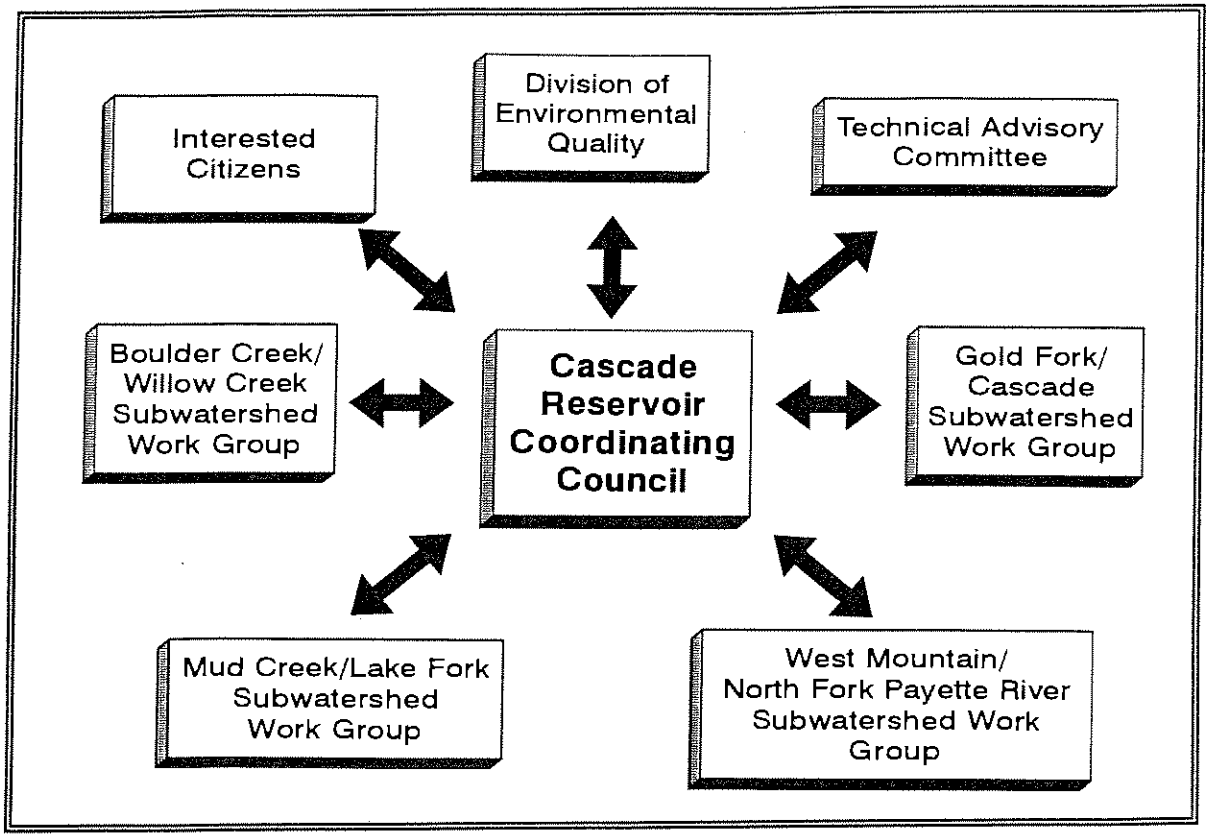
- the Valley County Commission
- the City of Cascade or Donnelly
- sporting or recreational interests
- timber interests
- agricultural interests
- the Cascade Reservoir Association, and
- citizens at large.

CRCC members work directly with their respective interest groups to provide direction to DEQ in developing and implementing a watershed management plan. They also help identify funding needs and sources of support for specific projects that may be implemented. The CRCC assists with management plan implementation by setting priorities for expenditure of restoration funds. The CRCC will periodically review progress toward phosphorus reduction goals.

The TAC, consists of local, state and federal agency, industry and municipal scientific and engineering staff. The TAC is responsible for reviewing proposed projects to ensure projects are consistent with phosphorus reduction goals, are scientifically sound, and that monitoring follows scientifically accepted procedures. Members of the Cascade Reservoir TAC represent:

- Idaho Division of Environmental Quality-SWIRO
- U.S. Forest Service Payette National Forest
- Idaho Soil Conservation Commission
- U.S. Forest Service Boise National Forest
- Valley Soil and Water Conservation District
- Idaho Power Company
- Boise Cascade Corporation
- U.S. Natural Resources Conservation Service
- Idaho Department of Water Resources
- U.S. Fish and Wildlife Service
- Idaho Department of Agriculture
- Idaho Department Fish and Game
- U.S. Environmental Protection Agency
- U.S. Bureau of Reclamation
- Central District Health Department
- Payette Lakes Water and Sewer District
- West Central Highlands Resource Conservation and Development
- Idaho Department of Lands

Figure 4.5 Citizen involvement program for the Cascade Reservoir Restoration Project.




Subwatershed work groups have been formed at the local level to identify and help implement nutrient control measures. These groups represent a variety of interests including landowners (homeowner associations or individuals), city or county governments, federal and state land managers, businesses, irrigation companies and recreational interests. Subwatershed work groups are responsible for identifying potential sources of nutrients and specific projects to reduce nutrients at their source within the subwatersheds.

The eight subwatersheds have been grouped into four subwatershed work groups according to common land use activities, water quality problems and irrigation management practices:

North Fork Payette River/West Mountain
Lake Fork Creek/Mud Creek
Boulder Creek/Willow Creek
Gold Fork River/Cascade (includes Kennally Creek)

Subwatershed work groups have been meeting since early 1993. The Boulder Creek/Willow Creek and Gold Fork River/Cascade work groups have been the most active. They met regularly throughout 1994 and early 1995. They identified and established priorities among more than 40 potential phosphorus reduction projects. Status reports summarizing accomplishments of the Gold Fork River/Cascade and Boulder Creek/Willow Creek subwatershed work groups are included in Appendix J.

## 4.3 Phosphorus Reduction Strategy

DEQ, in cooperation with state and federal agencies and the community, has established an initial phosphorus reduction strategy. Phosphorus reductions that can be achieved by this strategy were estimated by source for each subwatershed. The following sections include descriptions of the institutional framework for water quality management and the approach used to estimate the phosphorus reductions that may be achieved by implementing the strategy.

### *4.3.1 Point Source Reductions*

Control of point sources of pollution must be consistent with TMDL objectives. Consistency is ensured by incorporating specific requirements into NPDES permits issued by the EPA. The two point sources subject to an NPDES permit in Cascade Reservoir watershed are the City of McCall's wastewater treatment plant and IDFG's McCall Fish Hatchery.

The City of McCall is currently developing an alternative method for wastewater disposal using land application of treated effluent (J.U.B Engineers, Inc., 1995). The City plans to upgrade its wastewater treatment facilities in two phases. DEQ has recently recommended modifications to the City of McCall's NPDES permit to achieve water quality standards in Cascade Reservoir. A 100% reduction in the current effluent contribution of phosphorus from the McCall treatment plant is recommended. In addition, the Idaho legislature provided the city with a special appropriation contingent on the city reducing phosphorus in its effluent by 95%. The proposed 100% reduction of phosphorus from the McCall treatment plant is consistent with the management strategy of this phased Watershed Management Plan because it would result in an effective long term elimination of a known significant source of phosphorus.

The McCall Fish Hatchery has implemented changes in facility operation and maintenance to reduce phosphorus inputs to Cascade Reservoir. Current contributions account for less than 1% of the annual total phosphorus load. Staff will attempt to further improve maintenance and operation for additional phosphorus removal. A maintenance and operation plan will be submitted as part of a formal NPDES permit renewal.

***Estimated Phosphorus Reductions***

The City of McCall NPDES permit requires monitoring of phosphorus concentrations in the effluent weekly from mid-September through May and three times per week June through mid-September. Reductions anticipated from removal of McCall's wastewater discharge from the North Fork Payette River were estimated by averaging the phosphorus load in McCall's effluent for 1981, 1989, 1993 and 1994, the same years used to estimate average subwatershed loads. The average load for these four years is 3,675 kg/yr.

IDFG changed its operation of the McCall Fish Hatchery to reduce phosphorus concentrations in the effluent. Monitoring conducted by IDFG indicates that phosphorus load from the hatchery's effluent has been reduced by about 508 kg/yr as a result of the changes.

### *4.3.2 Nonpoint Source Reductions*

The process to control nonpoint source pollution is identified in the Idaho Water Quality Standards and Wastewater Treatment Requirements (Section 350). Nonpoint source activities are required to operate according to state approved BMPs, or in the absence of approved BMPs, activities must be conducted using "knowledgeable and reasonable efforts to minimize water quality impacts" (Subsection 350.02.a). If monitoring indicates a violation of standards despite use of approved BMPs or knowledgeable and reasonable efforts, then BMPs for the nonpoint source activity must be modified by the appropriate agency to ensure protection of beneficial uses (Subsection 350.02.b.ii). This process is known as the "feed back loop" in which BMPs or other efforts are periodically monitored and modified if necessary to ensure protection of beneficial uses.

#### *Agriculture*

For agricultural activities there are no required BMPs. Consequently, agricultural activities must use knowledgeable and reasonable efforts to achieve water quality standards. Generally, voluntary implementation of BMPs would be considered a knowledgeable and reasonable effort. A list of recommended BMP component practices developed by the Natural Resource Conservation Service (NRCS), which when selected for a specific site become a BMP, has been published in the Idaho Agricultural Pollution Abatement Plan (1993). To encourage use of these practices, the state provides cost share incentives through the State Agricultural Water Quality Plan (SAWQP.) Cost share funds are made available to private landowners through local Soil Conservation Districts. Contracts with landowners require that BMPs be implemented for 10 years, but changes in management practices should provide longer term benefits.

The Valley Soil and Water Conservation District (VSWCD) developed and implemented SAWQP projects in three of the critical subwatersheds of Cascade Reservoir: Boulder Creek, Willow Creek, and Mud Creek (VSWCD, 1992; 1995a; 1995b). These subwatersheds comprise roughly 18% of the total watershed draining to Cascade Reservoir. An implementation plan has been developed for each subwatershed outlining the critical acres contributing nutrients and sediment to local streams based on the erosion potential of soils (VSWCD, 1991). Priority is being given to implementation of BMPs that reduce phosphorus, including protection and restoration of riparian areas. Appendix I includes a list of the BMPs adopted by VSWCD for use in SAWQP projects in the Cascade watershed and a summary of the BMPs planned or implemented as of October 1995.

The Boulder Creek SAWQP project was initiated in 1991, and established a goal of reducing phosphorous loading from agricultural sources by 50%. To achieve this goal, it was deemed necessary to treat 85% of the critical acres and 50% of the non-critical acres with BMPs. Implementation of agricultural BMPs is voluntary and requires a 25% cost share match by the local landowner. In the recent past it has taken several years to negotiate, design, approve and fully implement BMPs. Contracting agreements with the landowners stipulate that BMPs remain in place for ten years. DEQ evaluates BMP effectiveness under cooperative agreements with VSWCD.

The Willow Creek and Mud Creek SAWQP projects were initiated in 1995 and were also established with the goal of reducing phosphorus loading from agricultural sources by 50%, by treating 85% of the critical and 50% of the noncritical acres in each SAWQP project area. There are 8,526 critical acres in the Mud Creek subwatershed and 1,411 critical acres in the Willow Creek subwatershed.

Implementation of SAWQP projects within the watershed is the main vehicle for voluntarily achieving phosphorus reductions on agricultural lands. In addition, funds appropriated by the Idaho legislature have been provided to VSWCD for cost share for BMPs on agricultural lands not currently eligible for SAWQP funds. Additional SAWQP projects are needed to address agricultural practices in the Lake Fork Creek, Gold Fork River, North Fork Payette River and Cascade subwatersheds.

*Estimated Phosphorus Reductions*

Phosphorus load reductions attributable to implementation of agricultural BMPs were estimated assuming that BMPs will be implemented on 85% of all critical agricultural acres and 50% of all noncritical agricultural acres in each subwatershed. This assumption is consistent with the goals established for the existing SAWQP projects. Total agricultural acres and critical agricultural acres in each subwatershed were obtained from maps prepared by the NRCS in 1989 (Table 4.2). The phosphorus load, prior to BMP implementation, was estimated by multiplying acres of each agricultural land use (irrigated pasture, non-irrigated pasture, non-irrigated crops, irrigated crops and rangeland) by estimated load per acre. Load per acre for each land use was estimated by Entranco (1991).

The load associated with each land use was then reduced by the following percentages assuming treatment of 85% of critical acres and 50% of noncritical acres in each subwatershed.

| Land use | Phosphorus Load kg/ac/yr | Percentage Phosphorus Reduction |
|---|---|---|
| Irrigated Pasture | 0.2672 | 70 |
| Non-irrigated Pasture | 0.1336 | 30 |
| Irrigated Crops | 0.2834 | 10 |
| Non-irrigated Crops | 0.1012 | 30 |
| Rangeland | 0.1012 | 25 |
| Urban | 0.2832 | 40 |

The percentages are NRCS estimates of the phosphorus reduction that can be achieved with full implementation of BMPs on treated acres. For Phase II, DEQ will work with VSWCD to verify and improve the estimated reductions and to further define a strategy for incorporating agricultural phosphorus reductions in the overall phosphorus reduction strategy for the watershed.

Table 4.2 Total acres and critical acres by land use and subwatershed.

| Subwatershed/Land Use | Critical Acres Agriculture | Total Acres |
|---|---|---|
| North Fork Payette River | | |
| Forest | | 12,756 |
| Irrigated Cropland | 3 | 183 |
| Irrigated Pasture | 3,335 | 6,426 |
| Non-irrigated Pasture | 2 | 1,393 |
| Range | 809 | 5,641 |
| Urban | | 3,405 |
| Water | | 149 |
| Wildlife | | 536 |
| Subtotals: | 4,149 | 30,489 |
| Mud Creek | | |
| Forest | | 646 |
| Irrigated Cropland | 590 | 1,572 |
| Irrigated Pasture | 6,574 | 11,056 |
| Non-irrigated Pasture | | 35 |
| Range | | |
| Urban | | 1,301 |
| Water | | 12 |
| Wildlife | | 81 |
| Subtotals: | 7,164 | 14,703 |
| Lake Fork Creek | | |
| Forest | | 39,653 |
| Irrigated Cropland | | |
| Irrigated Pasture | 4,208 | 7,689 |
| Non-irrigated Cropland | | |
| Non-irrigated Pasture | 281 | 1,331 |
| Range | | |
| Urban | | 974 |
| Water | | 103 |
| Wild Life | | 127 |
| Subtotals: | 4,489 | 49,877 |

| Subwatershed/Land Use | Critical Acres Agriculture | Total Acres |
|---|---|---|
| **Boulder Creek** | | |
| Forest | | 17,292 |
| Irrigated Cropland | 214 | 267 |
| Irrigated Pasture | 6,357 | 7,724 |
| Non-irrigated Cropland | 253 | 346 |
| Non-irrigated Pasture | 424 | 947 |
| Range | 6 | 144 |
| Urban | | 886 |
| Water | | 108 |
| Wildlife | | 75 |
| Subtotals: | 7,254 | 27,789 |
| **Willow Creek** | | |
| Forest | | 2,439 |
| Irrigated Cropland | 112 | 581 |
| Irrigated Pasture | 1,206 | 3,110 |
| Non-irrigated Cropland | 1 | 127 |
| Non-irrigated Pasture | 4 | 835 |
| Range | | 365 |
| Urban | | 655 |
| Water | | 1 |
| Wildlife | | 36 |
| Subtotals: | 1,323 | 8,149 |
| **Gold Fork River** | | |
| Forest | | 93,874 |
| Irrigated Cropland | 118 | 231 |
| Irrigated Pasture | 238 | 717 |
| Non-irrigated Cropland | 142 | 156 |
| Non-irrigated Pasture | 306 | 1,607 |
| Urban | | 398 |
| Water | | 53 |
| Wildlife | | 119 |
| Subtotals: | 804 | 97,155 |

| Subwatershed/Land Use | Critical Acres Agriculture | Total Acres |
|---|---|---|
| Cascade | | |
| Forest | | 6,318 |
| Irrigated Cropland | 596 | 1,226 |
| Irrigated Pasture | 2,786 | 5,690 |
| Non-irrigated Pasture | 78 | 2,060 |
| Range | 196 | 196 |
| Recreation | | 129 |
| Urban | | 2,173 |
| Water | | 68 |
| Wildlife | | 531 |
| Subtotals: | 3,656 | 18,391 |
| West Mountain | | |
| Forest | | 22,909 |
| Irrigated Pasture | 41 | 538 |
| Recreation | | 565 |
| Urban | | 2,997 |
| Water | | 37 |
| Wildlife | | 535 |
| Subtotals: | 41 | 27,581 |

***Forest Practices***

The Idaho Forest Practices Act was passed in 1974 (revised 1992; Title 38, Chapter 13, Idaho Code). Rules that implement the Act establish required minimum BMPs for forest practices to protect state water quality. In addition to logging, forest practices include road construction, slash management and other activities associated with logging. The rules, which govern activities on Forest Service, private and state lands, primarily address surface erosion and stream channel protection. Reductions in the export of nutrients are not directly addressed. Moreover, forestry BMPs do not address the export of nutrients and sediment caused by land disturbing activities that occurred prior to 1974.

The Forest Service does not currently recognize the TMDL process as being appropriate for addressing nonpoint sources of sediment, as it relates to phosphorus. However, BNF and PNF have agreed to reduce the phosphorus load to the extent possible. A joint phosphorus reduction plan (Appendix E) has been developed, which describes how they will attempt to achieve reductions during Phase I of the Watershed Management Plan (BNF and PNF 1996). Appendix E also includes a summary of a watershed analysis currently being conducted by BCC in the Gold Fork River subwatershed. DEQ will continue to work with the National Forests and BCC to develop more detailed implementation plans for Phase II of the Watershed Management Plan.

In addition to identifying specific sediment control actions in the plan, the Forests have identified several questions that they believe need to be answered to effectively achieve the 30% reduction goal:

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 the amount of phosphorus generated or transported to streams?
4. How much phosphorus is present in a given amount of sediment?
5. What are background phosphorus levels from forest lands?

BNF and PNF have also identified the need for a method to determine sediment and phosphorus yield from specific problem areas and development of a list of forestry BMPs and treatments with an estimate of their effectiveness in reducing phosphorus loading.

*Estimated Phosphorus Reductions*

The load attributable to forest land was estimated based on measured load at the BNF boundary in 1992, 1993 and 1994. The data is on file at the Cascade Ranger District office in Cascade. The average of the highest and lowest annual loads measured in the Gold Fork River was divided by the total number of acres draining into the River to estimate the phosphorus load per acre from forested lands. All of the area draining to the Gold Fork River at the forest boundary is forested. The estimated load of 0.062 kg/acre/yr was multiplied by the number of forested acres in each subwatershed to estimate load from forest lands.

Once the phosphorus load was estimated, a 30% reduction was applied to arrive at the reduction goal for forest lands. As more information and analysis becomes available the 30% reduction goal will be modified in Phase II to reflect actual watershed conditions and achievable reductions. Reductions to date were estimated by BNF and PNF (1996).

***Septic Tanks***

Two areas adjacent to the reservoir have been identified as potential nutrient sources due to inadequate treatment of septic tank effluent: 1) subdivisions aggregated at the north end of the reservoir in the vicinity of the Boulder Creek, Gold Fork River and Lake Fork Creeks, and 2) subdivisions located along the southwest shore of the reservoir. Both locations have high ground water tables, evidence of ground water contamination, a high density of septic tanks and poor soil types.

North Lake Recreational Sewer and Water District (NLSWD) was established in 1995 around the north end of the reservoir to implement a central collection and treatment system. Construction is expected to be completed by 1997. Upon completion, all existing and future dwellings will be required to connect to the central collection system and remove existing septic systems from use. Central District Health Department (CDHD) has established a policy that requires any permits issued for new or replacement systems within the District be effective only until the sewer is operational.

In November 1995, residents of an area along the southwest shore of the reservoir voted to form South Lake Recreational Sewer and Water District (SLSWD). The board of the new sewer district will formulate a plan for a collection and treatment system and will then seek funding for construction. In the interim, CDHD has established a policy precluding the issuance of any new septic permits in the West Mountain area and requiring that replacement systems be pressurized or use holding tanks. Any systems with interim permits will be required to hook up to the sewer system as soon as it is available.

*Estimated Phosphorus Reductions*

Phosphorus load entering the reservoir from septic tanks (1,917 kg/yr) was assumed to come entirely from septic tanks around the reservoir as described in Section 3.3 and shown in Table 3.3. The load reduction attributable to sewer hookups in NLSWD and SLSWD was estimated by assuming that all existing residences around the lake (estimated at 1,392) have septic tanks, that each tank discharges the same amount of phosphorus, and that the discharge from all residences within the current boundaries of NLSWD and SLSWD will be eliminated when hookups are complete. An estimated 1,125 existing residences are within the boundaries of the Districts. Reductions achieved to date are those attributed to NLSWD, which is under construction.

In addition to reducing existing phosphorus load, the sewer districts will prevent future load associated with development of many lots around the reservoir. In NLSWD, about 40% of existing lots have septic tanks and about 60% remain to be developed in the future.

*Stormwater Management*

At present, there are no ordinances governing the treatment of nonpoint sources of urban runoff in Valley County. The CDHD has recently directed staff to provide comments on stormwater treatment for newly platted developments in Valley County. Valley County has begun to include stormwater management in its review of proposed developments. A review of stormwater BMPs will be conducted in conjunction with county officials, DEQ and CDHD to develop BMP guidelines, and possibly ordinances, specific to Valley County conditions. The review will include an inventory of existing sources of stormwater, and consideration of potential new sources associated with new developments, to identify appropriate treatment or prevention alternatives. Examples of possible treatment alternatives include use of grassy swales, detention ponds and catchment basins. Results will be included in Phase II of the Watershed Management Plan.

*Estimated Phosphorus Reductions*

Potential phosphorus reductions that could be achieved by implementation of stormwater management BMPs were estimated based on information from EPA (1993). Total phosphorus load from urban lands was first reduced by the estimated benefits resulting from construction of NLSWD and SLSWD. The benefits attributable to stormwater management measures was estimated as 40% of the remaining load.

***Other Phosphorus Reduction Measures***

In 1995 the BOR constructed three water quality improvement projects on lands adjacent to the reservoir. The projects consist of constructed wetlands and impoundments to increase phosphorus uptake by plants and decrease the amount of sediment transported to the reservoir. BOR plans to construct additional improvement projects in 1996.

DEQ is currently evaluating the feasibility of constructing large scale detention structures on the North Fork Payette River, Gold Fork River and Lake Fork Creek. A structure at any of these sites presents an opportunity to reduce sediment entering the reservoir and to increase plant uptake of phosphorus by enhancing existing wetlands. An engineering feasibility study for these sites is scheduled to be completed in 1996. If large scale detention structures prove infeasible for either technical or financial reasons, DEQ will evaluate other treatment alternatives to achieve the phosphorus reductions attributed to these ponds.

*Estimated Phosphorus Reductions*

Phosphorus reductions from the BOR projects were estimated by the BOR (Jeff McLaughlin, written communication 1995). BOR estimated the load associated with each project from estimated phosphorus concentrations and flows, and estimated phosphorus reduction at 50% of the load during the summer months and 30% during the winter months. The three projects constructed in 1995 will reduce phosphorus entering the reservoir by an estimated 20 kg/yr.

The potential phosphorus reductions attributable to large scale detention structures were estimated for Gold Fork River and North Fork Payette River. These two sites were chosen because they had the highest potential for wetlands development, both had good structural engineering sites available and neither subwatershed had achieved a 30% reduction with implementation of other land use BMPs. A detention pond was assumed to remove 20% of the phosphorus from water passing through the system. Therefore, the phosphorus load reduction was calculated as 20% of the load, after subtracting phosphorus reductions attributable to other projects in the subwatershed.

### *4.3.3 Summary of Estimated Phosphorus Reductions*

Table 4.3 summarizes phosphorus reductions that have been achieved to date, and future reductions needed to achieve the 37% reduction goal. Table 4.4 shows who is responsible for implementing major water quality improvement projects and expected completion dates.

Table 4.3 Phosphorus reductions to date and necessary future reductions needed to achieve 37% reduction goal.

| Land Use Type | Phosphorus Reductions to Date (kg/yr) | Future Phosphorus Reductions Needed to Achieve 37% Goal (kg/yr) | Total Required Phosphorus Reductions to Achieve 37% Goal (kg/yr) | % Goal Achieved to Date |
|---|---|---|---|---|
| North Fork Payette River | | | 3,639.00 | 16.20% |
| Nonpoint Source | | 3,049.50 | | |
| Forest | 33.30 | | | |
| Agriculture | | | | |
| SAWQP | 0.00 | | | |
| Other | 0.00 | | | |
| Septic | 48.20 | | | |
| McCall Fish Hatchery | 508.00 | | | |
| McCall wastewater treatment plan | 0.00 | 3,675.00 | | |
| Subtotals: | 589.50 | 6,724.50 | | |
| Mud Creek | | | 230.40 | 101.22% |
| Nonpoint Source | | 0.00 | | |
| Forest | 0.00 | | | |
| Agriculture | | | | |
| SAWQP | 141.00 | | | |
| Other | 0.00 | | | |
| Septic | 92.20 | | | |
| Subtotals: | 233.20 | 0.00 | | |

| Land Use Type | Phosphorus Reductions to Date (kg/yr) | Future Phosphorus Reductions Needed to Achieve 37% Goal (kg/yr) | Total Required Phosphorus Reductions to Achieve 37% Goal (kg/yr) | % Goal Achieved to Date |
|---|---|---|---|---|
| Lake Fork Creek | | | 1,410.00 | 15.38% |
| Nonpoint Source | | 1,193.20 | | |
| Forest | 0.00 | | | |
| Agriculture | | | | |
| SAWQP | 0.00 | | | |
| Other | 0.00 | | | |
| IDFG Detention Pond | 30.00 | | | |
| Septic | 186.80 | | | |
| Subtotals: | 216.80 | 1,193.20 | | |
| Boulder Creek | | | 1,158.60 | 16.95% |
| Nonpoint Source | | 962.20 | | |
| Forest | 0.00 | | | |
| Agriculture | | | | |
| SAWQP | 80.00 | | | |
| Other | 17.00 | | | |
| IDFG Detention Pond | 64.00 | | | |
| Septic | 35.40 | | | |
| Subtotals: | 196.40 | 962.20 | | |
| Willow Creek | | | 262.20 | 209.84% |
| Nonpoint Source | | 0.00 | | |
| Forest | 0.00 | | | |
| Agriculture | | | | |
| SAWQP | 0.00 | | | |
| Other | 196.00 | | | |
| Septic | 354.20 | | | |
| Subtotals: | 550.20 | 0.00 | | |

| Land Use Type | Phosphorus Reductions to Date (kg/yr) | Future Phosphorus Reductions Needed to Achieve 37% Goal (kg/yr) | Total Required Phosphorus Reductions to Achieve 37% Goal (kg/yr) | % Goal Achieved to Date |
|---|---|---|---|---|
| Gold Fork River | | | 2,546.40 | 28.45% |
| Nonpoint Source | | 1,821.92 | | |
| Forest | 2.08 | | | |
| Agriculture | | | | |
| SAWQP | 0.00 | | | |
| Other | 640.00 | | | |
| Septic | 82.40 | | | |
| Subtotals: | 724.48 | 1,821.92 | | |
| Cascade | | | 160.80 | 112.38% |
| Nonpoint Source | | 0.00 | | |
| Forest | 2.00 | | | |
| Agriculture | | | | |
| SAWQP | 0.00 | | | |
| Other | 29.00 | | | |
| Septic | 97.70 | | | |
| BOR Detention Ponds | 52.00 | | | |
| Subtotals: | 180.70 | 0.00 | | |
| West Mountain | | | 630.60 | 15.54% |
| Nonpoint Source | | 532.80 | | |
| Forest | 60.00 | | | |
| Agriculture | | | | |
| SAWQP | 0.00 | | | |
| Other | 0.00 | | | |
| Septic | 0.00 | | | |
| BOR Detention Ponds | 38.00 | | | |
| Subtotals: | 98.00 | 532.60 | 10,038.00 | |
| TOTALS: | 2789.28 | 10,923.72 | 13,713.00 | 20.34% |

Table 4.4 Major water quality improvement projects, responsible agency and expected completion date.

| Project Name | Responsible Agency | Expected Completion |
|---|---|---|
| North Lake Sewer & Water District | NLSWD | 1997 |
| South Lake Sewer & Water District | SLSWD | to be determined |
| City of McCall Wastewater Treatment Plant | McCall | 1998 |
| Boulder Creek SAWQP | VSWCD | 1991 to 1996 to initiate 21 contracts |
| Mud Creek SAWQP | VSWCD | 1995 to 2000 to initiate 32 contracts |
| Willow Creek SAWQP | VSWCD | 1995 to 2000 to initiate 26 contracts |
| Non-SAWQP Agricultural BMP's | VSWCD | 1995 to 1996 for contracts |
| Bureau of Reclamation Detention Ponds | BOR | 1998 (3 completed in 1995) |
| Idaho Dept. of Fish and Game Detention Ponds | IDFG | 1996 (2 completed in 1995) |
| Additional SAWQPs | VSWCD | 2000 to 2005 |
| Stormwater Management | Cities and County | 1996 to 2001 |

Estimated phosphorus reductions attributable to the proposed management strategy are preliminary and represent the best estimates available at this time. Both the estimated phosphorus reductions and the preferred reduction measures will be adjusted in Phase II as better information is obtained. In particular, results from ongoing studies should significantly improve estimates of achievable phosphorus reductions on forest lands.

## 4.4 Future Nonpoint Source Phosphorus Reduction Measures

Phase II of the Plan will include an evaluation of other possible phosphorus reduction measures that could be implemented to achieve the reduction goal, including improvements to irrigation water delivery systems and management of reservoir operations to reduce internal recycling.

### *4.4.1 Irrigation Water Management*

Irrigation practices are another potential agricultural source of sediment and phosphorus in the Cascade Reservoir watershed. DEQ, in cooperation with the Idaho Department of Water Resources, has initiated an evaluation of the irrigation practices and water conveyance and drainage system in the watershed. This effort will result in recommendations for changes to structures and practices and possible treatment alternatives that will help improve both water management and water quality. Recommendations will be available in 1996. IDWR has some cost share funds available to assist water delivery systems with structural improvements. Potential benefits from improvements to irrigation systems include reduced sediment from erosion and increased instream flows due to improved water management. In addition to providing water quality benefits, increases in instream flows could improve water temperature and DO for fish during the hot summer months by allowing more cool water to reach the reservoir and could provide refuge for fish in the tributaries.

### *4.4.2 Reservoir Operations*

DEQ will work with BOR to evaluate reservoir operations to identify opportunities to improve water quality. Internal recycling of phosphorus from reservoir sediment is a significant source of phosphorus in the reservoir water column. Fluctuation of the water level in the reservoir is likely to increase internal recycling.

In February 1995, BOR issued a Finding of No Significant Impact and Final Environmental Assessment that administratively established a minimum conservation pool of 300,000 acre-feet for the Reservoir. That amount was recommended by IDFG to improve fish survival during the winter. The minimum conservation pool also provides water quality benefits. DEQ will continue to work closely with BOR to ensure maintenance of the conservation pool. In addition, DEQ and IDFG are evaluating the adequacy of the pool for protecting water quality and improving fish habitat during the summer.

## 4.5 Compliance Strategy

DEQ will rely upon existing authorities and voluntary implementation of additional phosphorus reduction measures to achieve the goals and objectives of this plan. Attainment of water quality standards for Cascade Reservoir will require a significant long term coordinated effort from all pollutant sources throughout the watershed.

For point source discharges of pollutants subject to NPDES permits, DEQ will ensure achievement of water quality goals established in this plan through water quality certifications provided in Section 401 of the CWA.

For nonpoint sources, the feed back loop will be used to achieve water quality goals, as described in Section 4.3.2. DEQ, in cooperation with other agencies, will conduct monitoring to evaluate the effectiveness of site specific BMPs and other restoration projects in reducing phosphorous loading. If BMPs prove ineffective they will be modified to ensure effectiveness of existing and future projects. Any modifications to required BMPs for forest practices will be subject to state rule-making requirements.

If BMPs for nonpoint sources are not implemented adequately using a voluntary approach, DEQ will use existing regulatory authorities to seek water quality improvements. Adequate implementation requires that enough reduction measures be installed (for example, BMPs installed on 85% of critical agricultural acres and 50% of noncritical acres) and that they be properly maintained. Phase II of the plan will include criteria for determining adequate implementation.

Under existing authorities, DEQ may investigate potential violations of the Idaho Water Quality Standards and Wastewater Treatment Requirements and if a violation has occurred, may pursue either administrative or civil enforcement actions. In addition, DEQ will work closely with the CRCC, applicable resource agencies and affected parties to review the existing authorities and determine if there is a need for additional regulatory requirements for nonpoint source activities to achieve the goals of the plan. A "Bad Actor" law, is one of the alternatives that will be reviewed.

DEQ's regulatory and enforcement authorities are generally set forth in the Idaho Environmental Health and Protection Act of 1972, as amended (Idaho Code Sections 39-101 *et. seq.*). Section 4.3 generally describes the existing regulatory requirements for point and nonpoint sources.

## 4.6 Innovative Approaches and Pollutant Trading

This phase of the plan seeks a 30% reduction of phosphorus load from nonpoint sources in each subwatershed and elimination of McCall's wastewater treatment plant effluent from the North Fork Payette River. It may be more cost effective to eliminate or reduce certain significant pollutant sources, rather than reduce phosphorus from all sources equally. It is also possible that certain projects may present exceptional opportunities for achieving significant reductions, thus allowing other nonpoint sources to seek less than a 30% reduction. If a particular source is unable to achieve its phosphorus reduction goal, other sources may need to make larger reductions to make up the difference. This is known as pollutant trading. The CRCC and the subwatershed work groups will be instrumental in identifying high priority and cost-effective load reduction projects that can be used for pollutant trading. Opportunities for pollutant trading may be identified from the evaluation of costs and benefits of various treatment measures that will be prepared for Phase II of the plan.

## 4.7 Phase II of the Cascade Reservoir Watershed Management Plan

The phased approach to development and implementation of the Cascade Reservoir Watershed Management Plan provides the opportunity for further analysis of the available data to improve understanding of the factors that affect water quality. Phase II of the plan will fill some of the current data and analysis gaps, which will allow development of a more accurate load allocation, better estimation of the benefits associated with management alternatives and development of a more effective implementation plan. Specifically, Phase II will include the following work:

- additional data collection and analysis, including reservoir modeling, to better characterize the assimilative capacity of the reservoir and understand the dynamics of internal recycling of phosphorus;
- further evaluation of use attainability;
- further evaluation and revision of the load allocation;
- estimation of the costs and benefits of potential phosphorus reductions measures; and
- evaluation and revision of the overall implementation strategy and implementation plan.

Any changes to the plan will be prepared in cooperation with affected parties including opportunities for peer review. Monitoring of both implementation of phosphorus reduction measures and of resulting water quality changes will continue throughout development and implementation of Phase II.

### *4.7.1 Data Collection and Analysis*

Tables 4.5 and 4.6 summarize the monitoring and data analysis gaps that DEQ has identified during preparation of Phase I of the plan. These gaps will be addressed in Phase II to the extent that funding is available.

Table 4.5 Monitoring needed to better characterize reservoir conditions.

| Type | Description |
|---|---|
| Winter DO | Determine winter levels of DO in the reservoir. |
| Vertical Nutrient Stratification | Determine how phosphorus and nitrogen concentrations change with depth in the reservoir. |

Table 4.6 Additional data analysis needed to better characterize the watershed.

| Analysis | Description |
|---|---|
| Watershed Soil Phosphorus | Determine phosphorus distribution in watershed soils. |
| Background Phosphorus | Determine background phosphorus in soils and other natural sources. |
| Internal Recycling | Improve understanding of how internal recycling affects the reservoir. |
| Sedimentation Rates | Investigate the rate at which the reservoir fills with sediment. |
| Phosphorus in Reservoir Sediments | Determine quantity and type of phosphorus stored in reservoir sediments. |
| Sediment Sources and Transport | Determine sources of sediment and evaluate travel time to the reservoir for Gold Fork subwatershed. |
| Phytoplankton Composition | Determine differences in phytoplankton species over time and their relationship to trophic states. |
| Beneficial Use Status of Tributary Streams | Complete analysis of beneficial use reconnaissance data to determine use status of streams. |
| Reservoir Hydrology | Determine influence of hydrology on phosphorus loading rate. |
| Re-evaluation of Load and In-lake Chlorophyll a and Total Phosphorus | Model will be run based on more than one year of data. |
| Beneficial Use Attainability | To determine if reservoir is capable of supporting beneficial uses. |
| Adequacy of Minimum Conservation Pool | The minimum conservation pool was established based on a 1984 IDFG recommendation for winter fish survival. IDFG and DEQ will jointly re-evaluate the minimum conservation pool for summer fish survival and improved water quality. |

### *4.7.2 Implementation Issues*

Completion of ongoing projects and further assessment of restoration alternatives in Phase II will provide information needed to improve the implementation plan. Phase II will better address the following questions:

- What are the relative costs and phosphorus reduction benefits of various restoration measures?
- What phosphorus reductions can be realistically achieved on forest lands?
- Are there any measures that can be used to reduce internal recycling of phosphorus?
- Is construction of one or more large scale detention structures feasible and cost effective?
- What specific measures can be taken to reduce phosphorus load from urban runoff/stormwater?
- Should each subwatershed be held to a 30% reduction in load from nonpoint sources, or is there a more cost effective approach?
- Is the current minimum conservation pool adequate to help protect water quality and fish?

### *4.7.3 Other Issues*

There are several outstanding issues that must be addressed to ensure the success of restoration efforts. DEQ will work with the community and affected agencies to resolve these issues during development and implementation of Phase II. The issues include:

- Current state law provides irrigation water users with a broad exemption from compliance with state environmental requirements. Improvements to irrigation practices and structures will be sought on a voluntary basis, but there are few incentives for participation.
- Current water law appears to provide disincentives to improving irrigation efficiency. Improved irrigation efficiency could provide for increased instream flows, which benefit both water quality and fish. There are currently no minimum instream flows in any tributaries in the Cascade Reservoir watershed.
- Phosphorus reduction benefits for the proposed management actions are estimates. Additional actions may be needed if they prove to be less beneficial than expected.
- The community is concerned about the social and economic costs of proposed phosphorus reduction actions, particularly how the local economy and way of life will be affected.

The community will object to restoring the reservoir if it requires significant changes in land use in the watershed. They are particularly concerned about costs to individual, private landowners.

# 5.0 Cascade Reservoir Restoration Implementation Actions and Monitoring Plan

## 5.1 Implementation Actions

Efforts to restore beneficial uses and meet water quality standards in Cascade Reservoir are based on a cooperative watershed approach. This means that all the stakeholders within the watershed boundaries work cooperatively with state and federal agencies, on a voluntary basis, to reduce phosphorus loads entering Cascade Reservoir, thus improving conditions for restoring uses and meeting water quality standards.

In response to community interest, the Idaho legislature has appropriated funds for nutrient control measures in the Cascade Reservoir watershed. The legislature appropriated $2,350,000 in State Fiscal Year (SFY) 95 and $900,000 in SFY 96 for the restoration effort. In each of those years, $200,000 was designated for monitoring and support of a satellite office in Cascade and the balance was designated for planning and implementation projects.

DEQ has been and will continue working with the CRCC, TAC, subwatershed work groups and other state, federal and local agencies to identify nutrient control projects for implementation using SFY 95 and SFY 96 funds. In addition, local government and the citizens have initiated a variety of nutrient control projects such as upgrading sewage treatment facilities and establishing new sewer districts. This section summarizes the projects that are currently being planned or implemented.

Identifying nutrient reduction projects has been the principal responsibility of the subwatershed work groups. The Boulder Creek/Willow Creek and Gold Fork River/Cascade work groups have each identified possible projects that could be implemented to reduce phosphorus in those watersheds. When projects are identified they are referred to the appropriate agencies for possible funding. Individual projects involve the following practices:

- Streambank erosion control/restoration
- Canal/ditch delivery upgrades
- Irrigation management upgrade (from gravity to sprinkler)
- Irrigation pumpback system
- Wetland construction
- Reservoir shoreline erosion control
- Sediment pond settling and removal
- Stormwater management
- Surface erosion control

Implementation of these practices is expected to reduce phosphorus entering the reservoir by reducing phosphorus entering drainage systems, reducing soil erosion, and filtering and settling irrigation water. Monitoring will document the effectiveness of these practices to reduce phosphorus loading. It should be noted that implementation depends on cooperation of the affected landowner and availability of funding. Some of the activities are more cost effective than others and DEQ anticipates implementation of the more cost effective projects first, although again, this depends on landowner participation.

Below are phosphorus reduction activities by subwatershed that are currently being planned or implemented. Included are tentative implementation dates where available, funding sources and responsible implementing agency. Figure 5.1 shows the schedule for implementation projects completed to date or planned for 1996 and 1997.

### *5.1.1 Gold Fork River/Cascade Subwatersheds*

- Cascade Reservoir Pumpout Station (Planned): The VCWC has proposed installing a mobile boat pumpout station on Cascade Reservoir to provide dumping facilities for boats on the reservoir. The pumpout facility would reduce nutrient loading to the reservoir by providing a disposal facility for boats that currently dump wastewater directly into the reservoir. DEQ has committed $7,500 and Valley County has committed $2,500 for this project. VCWC has received approval for $30,000 in federal funding for the project under the Clean Vessel Act. The pumpout station will be operating in the reservoir in 1996.

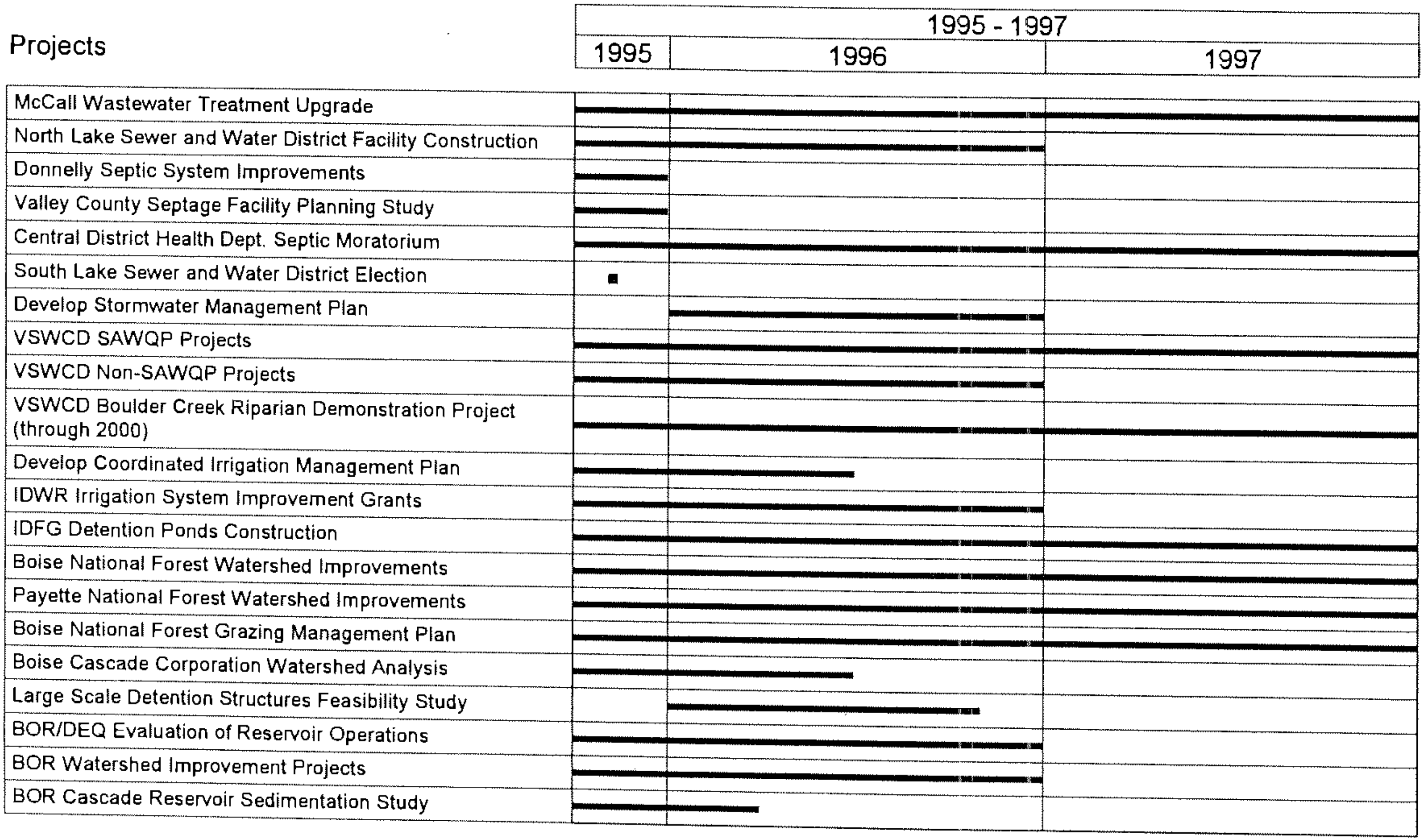
- Boise National Forest Road and Watershed Rehabilitation (On-going): The BNF has completed a road and watershed inventory in the upper portions of Gold Fork River, associated with the Spruce Creek timber sale. As part of this assessment, the Forest identified several rehabilitation projects within the sale area. The timber sale prescribes BMPs far above those currently specified by the Idaho Forest Practices Act, including riparian set-backs, road surfacing, elimination of creek crossings and special harvest prescriptions, aimed at reducing surface erosion and protecting stream channels. Funds generated by the sale of timber are financing these measures and they are being implemented concurrent with the timber sale contract.

- Boise National Forest Tire Pressure (Complete): The BNF is conducting a pilot study of the effects of low tire pressure on logging trucks and equipment in an attempt to reduce road surface erosion. Results will be available from Boise National Forest in 1996.

- Boise Cascade Corporation Road Inventory (On-going): BCC is conducting a road inventory on their lands in the Gold Fork River drainage. Results should be available in 1996.

- Boise Cascade Watershed Analysis (On-going): BCC, in cooperation with DEQ, BNF and PNF, IDFG and other interested parties, has initiated a large scale watershed analysis for the entire Gold Fork River basin. The analysis will evaluate the amount of sediment contributions from 1) roads, 2) bank erosion, including grazing effects, 3) surface erosion and 4) mass wasting. Background rates of sediment input and rates associated with land

Figure 5.1 Schedule for selected water quality improvement projects.



management activities will be estimated. Phosphorus concentrations of soils will be evaluated to help interpret results. The analysis will also address hydrology, bedload transport, riparian condition, stream shading and fish habitat. The project will develop approaches to controlling major phosphorus loads and a monitoring plan to determine the effectiveness of actions. BCC has committed $125,000 for this effort. Additional funds will be committed to implementing the selected approach. The analysis is expected to be complete in early 1996.

### *5.1.2 Boulder Creek/Willow Creek Subwatersheds*

- Boulder Creek SAWQP (On-going): VSWCD has SAWQP projects in Boulder and Willow Creeks. These projects seek to improve water quality by implementing BMPs and changing agricultural practices on 6,826 critical acres. Since 1991, VSWCD has approved nine contracts for BMP implementation on 885 critical acres in the Boulder Creek project area. Appendix F includes a summary of the BMPs planned or implemented to date in the Boulder Creek subwatershed. SAWQP projects are appropriated by the legislature from the Water Pollution Control Account. A total of $734,453 was awarded to the District for Boulder Creek projects.

- Willow Creek SAWQP (On-going): The Willow Creek SAWQP project began in the spring of 1995. No contracts with landowners for implementation of BMPs have been approved yet in the Willow Creek project area. Two applications are pending. The project seeks implementation of BMPs on 1,411 critical acres. A total of $295,150 was awarded to the District for Willow Creek projects.

- North Lake Recreational Sewer and Water District (On-going): Home owners on the western edge of the Boulder Creek/Willow Creek subwatershed have voted to form the North Lake Recreational Sewer and Water District and have approved a $4.5 million bond for construction of facilities. Three stream crossings were constructed in 1995. Winter storage facilities and a segment of the pressure sewer line will be constructed in the fall of 1995. Phase II, design and construction of the remaining collection and transmission systems, will begin in 1996.

- Boulder Creek Riparian Demonstration Project (On-going): A riparian demonstration project is currently under way in the Boulder Creek subwatershed. This project seeks to demonstrate beneficial water quality impacts and reductions in phosphorus loading from implementation of improved grazing management practices in the riparian zone of influence, such as rotation grazing. Funds for this project are from a federal grant program established under Section 319 of the CWA. VSWCD is administrating $39,453 for this project. The demonstration project will be completed in 2000.

- Donnelly Wastewater Treatment System Improvements (On-going): The City of Donnelly is upgrading their wastewater treatment system. Improvements include construction of a winter storage lagoon, upgrades to existing lagoons, addition of aeration and disinfection of waste and an increase in the area used for land application of wastewater. The project will be completed in 1996.

- Detention Ponds (Complete): An agricultural water detention pond was built on Ivan Phelps property under IDFG's Habitat Improvement Program. The pond will treat runoff from about 600 acres to reduce phosphorus and will also create wildlife habitat. The project was built at a cost of $21,000 and was completed in December 1994.

- Idaho Department of Lands Road Improvements (Planned): The Idaho Department of Lands plans to surface the road to Boulder Reservoir. This will reduce the erosion from the road and reduce the phosphorus associated with the sediment from erosion. This project will be completed in 1996.

### *5.1.3 Lake Fork Creek/Mud Creek Subwatersheds*

- Mud Creek SAWQP (On-going): The Mud Creek project began in the spring of 1995. VSWCD is the responsible agency. This project seeks to improve water quality by implementing BMPs and changing agricultural practices on 8,224 critical acres. Seven contracts with landowners for implementation of BMPs on 1,366 critical acres have been approved. Appendix F includes a summary of the BMPs planned or implemented to date in the Mud Creek subwatershed. A total of $1,521,720 is available for pollution abatement projects through this program.

- J-Ditch Lateral (Proposed): VSWCD is working with irrigators served by J-Lateral Ditch to reach agreement on a plan to replace the open ditch with a pipe and convert flood-irrigated lands to sprinklers. The District conducted an engineering study of the project in fall 1995. Sources of funds for this project are still being investigated. If agreements can be reached with all effected landowners and funding can be identified, the J-Ditch conversion could begin in 1996. This project could treat up to 3,784 critical acres.

### *5.1.4 North Fork Payette River/West Mountain Subwatersheds*

- City of McCall Wastewater Treatment System (Planned): A two phase plan has been approved by the City of McCall for upgrade of the City's wastewater treatment system to remove their discharge from the North Fork Payette River (J-U-B Engineers, Inc., 1995) Phase I involves upgrade of existing and construction of new sand filters, construction of a pipeline and land application of wastewater during the cropping season. Phase II involves construction of a lagoon to store winter discharge. Funding for Phase I is anticipated to include $1,020,000 appropriated by the Idaho legislature, a local contribution of about $3,140,000 supported by a low interest loan from the state and $1,500,000 in supplemental grant funds from the state. The City of McCall is currently working with the BOR to obtain about $5,600,000 in grant funds for Phase II. The balance would be obtained from local sources. Phase I construction began late in 1995 and is slated for completion in late 1996. Phase II is scheduled for completion in 1998.

- Septic Tank Moratorium (On-going): CDHD implemented a moratorium on new septic tanks in portions of Valley County based on public health concerns and impacts to Cascade Reservoir. In November 1995, residents around the south and west sides of the reservoir voted two to one in favor of establishing South Lake Recreational Sewer and Water District.

- Boise National Forest Grazing Management (Complete): The BNF has changed the grazing management of their west side allotments based on water quality monitoring results and to comply with Idaho water quality standards. This involved eliminating flood irrigation, reducing allotment capacity by 62% and fencing of reservoir shoreline. Allotment capacity is measured by the number of cattle and the length of time they spend on the allotment. The Forest Service is continuing to monitor water quality from the allotments. This management strategy was implemented partially in 1994 and fully in 1995.

- Big Payette Lake Water Quality Study (On-going): A water quality study of Big Payette Lake has been initiated by the Big Payette Lake Water Quality Council to preserve the high quality water that currently exits. This study has been funded jointly by private donations, federal Clean Lakes funds (CWA, Section 314), and state funds appropriated by the Idaho Legislature for implementation of the watershed management program. Managing Big Payette Lake to insure continued high quality water may help to reduce phosphorus entering Cascade Reservoir from the North Fork Payette River.

### *5.1.5 General Phosphorus Reduction Activities*

- Sediment Controls on Forest Lands (Ongoing): BNF and PNF have jointly developed an interim plan that identifies sediment reduction actions completed to date and planned for forest lands. The interim plan is included in Appendix E. Results of the cooperative watershed study in the Gold Fork River subwatershed should provide answers to questions relating to sediment, phosphorus and forestry practices. With this information the Forest Service will develop a more detailed control plan in 1996 (see 5.1.1).

- Evaluation of Reservoir Operations (On-going): DEQ and BOR are jointly evaluating reservoir operations to determine if there may be opportunities to minimize internal recycling of phosphorus or otherwise improve water quality through structural or operational measures. The agencies are evaluating options using the BETTER reservoir model. The evaluation and recommendations will be completed in 1996.

- Large Scale Detention Structures (Proposed): DEQ has contracted with an engineering firm to evaluate the feasibility of constructing large scale detention structures in the watershed. Potential sites include Gold Fork River, Lake Fork Creek and North Fork Payette River. If a feasible site is identified, the contractor will estimate potential costs and benefits and may provide a preliminary design. DEQ plans to spend an undetermined amount, not to exceed $200,000, for this effort. Implementation depends on findings of the feasibility study and acquisition of funds.

- Idaho Department of Fish and Game Detention Ponds (On-going): Funding is available for cost sharing construction of agricultural water detention ponds through IDFG's Habitat Improvement Program. Detention ponds will treat runoff to reduce phosphorus and will also create wildlife habitat. IDFG is administering a total of $100,000 cost share funds for detention ponds, in cooperation with DEQ. The first pond was constructed in the Boulder Creek/Willow Creek subwatershed (See discussion in Boulder Creek/Willow Creek subwatershed).

- Agriculture BMP Cost Share Projects (On-going): VSWCD has agreed to provide planning, design and implementation assistance for projects identified by subwatershed work groups that are not eligible for funding under SAWQP. These cost share funds are being administered by VSWCD, in cooperation with DEQ. The 1994 Idaho Legislature appropriated $250,000 for this effort. The District has already received application for projects that exceed the available funds.

- Water Delivery System Improvements (On-going): IDWR has established a cost-share program for construction of improvements to water delivery systems. Construction projects proposed by Mahala Ditch Company, Gold Fork River Irrigation Company/Center Irrigation District , Boulder Creek Irrigation Company and Roseberry Irrigation District have been approved. Additional project proposals will be accepted for construction in 1996. A total of $231,000 is available for this effort. IDWR is administering this project in cooperation with DEQ.

- Bureau of Reclamation Improvement Projects (On-going): The Gold Fork River/Cascade subwatershed work group has identified twelve possible water quality improvement projects on BOR lands adjacent to the reservoir. The BOR is constructing six water quality improvement projects on BOR lands, as described below. DEQ will provide up to $92,000 in cost share funds for construction of projects, of which about $58,000 will be used for these projects. BOR is providing design services and about $102,000 for construction costs. Additional projects will be designed for 1996 and will be constructed subject to availability of BOR funds.

    - Hot Springs (Hembry Creek) is a constructed wetland consisting of three small ponds with a total surface area of about five acres.

    - Duck Creek North is a constructed wetland consisting of a pond with a total surface area of about four acres.

    - Duck Creek Osprey Point is a constructed wetland consisting of a pond with a total surface area of about 5 acres.

    - Willow Creek improvements include two instream impoundments, passable to spawning rainbow trout; two upstream sediment ponds; and streambank stabilization.

- Mallard Bay is an existing shallow bay of the reservoir, heavily vegetated primarily with cattails, that dries up each year. An impoundment will be constructed to maintain the water at a constant level.

- Old State Highway improvements consist of an impoundment to create a permanent wetland with a surface area of about 6 acres, slope stabilization, several smaller sediment ponds and diversion of stream flow over former pasture to provide overland treatment.

- Valley County Septic Tank Waste Disposal (On-going): Valley County is conducting a study to evaluate the feasibility of a county-wide treatment and disposal facility for septic tank waste. Currently a large part of the County's septage is treated at the City of McCall's wastewater treatment plant. DEQ provided funds for this study from the wastewater grant program. Implementation depends on the findings of the study and availability of funding.

- Stormwater BMP's (Planned): An engineering firm under contract with DEQ will be developing stormwater BMPs specific to Valley County. The BMPs will assist the County in developing stormwater management ordinances. This project will be supported with funds from the SFY 95 appropriation for nutrient control measures. The cost and schedule are under development.

- Cascade Reservoir Sedimentation Study (On-going): DEQ and BOR are jointly funding a survey of the reservoir to update reservoir storage capacity data and to determine sedimentation rates. This information will be used to evaluate the adequacy of the current minimum conservation pool and for a water quality model that is being developed by BOR and DEQ to identify and evaluate reservoir operation alternatives for improving water quality. The agencies are each providing $62,500 for the reservoir survey. The survey will be complete in 1996.

- Irrigation Management Plan (On-going): DEQ entered into a contract with a consultant for development of a coordinated irrigation management plan for the irrigated acreage in the watershed. Work on this contract should be completed by July of 1996. The plan will recommend improvements to irrigation water delivery systems that will reduce phosphorus and sediment loading to the reservoir. DEQ provided $169,000 for this effort.

- Public Outreach (On-going): DEQ and VSWCD each conduct public outreach activities to keep the community informed of progress on the Cascade Reservoir restoration project. VSWCD publishes a newsletter to update property owners about the availability of agricultural cost share funds through the SAWQP projects. DEQ, in cooperation with the CRCC, conducts periodic public meetings to keep the public informed about the project and provide opportunities for public comments.

- Home*A*Syst Program (Planned): DEQ, in cooperation with the Idaho Association of Soil Conservation Districts and VSWCD, will be providing individual property owners with work sheets and fact sheets to help them determine and address potential sources of pollution on their property under the Home*A*Syst program. Funding from EPA under Section 319 of the CWA has been made available to develop and distribute a booklet on the program. Fact/work sheets are being developed on 13 potential sources of contamination, including grazing on ranchettes. The information will be available for distribution in 1996.

- Phosphorus Sorption Study (On-going): The University of Idaho, Soil Science Division, is conducting a study to evaluate the phosphorus sorption capacity of soils in the watershed. Results will be used for planning land application of wastewater and other similar projects that depend on soil treatment of water. DEQ provided $38,289 for this effort. The project will be complete in 1996.

Tables 5.1 and 5.2 show the restoration projects funded by the Idaho Legislature's SFY 95 and SFY 96 appropriations. Figure 5.2 shows how the SFY 95 appropriation was spent, including both restoration projects, monitoring and support for the Cascade Satellite Office. For SFY 96, the Idaho legislature appropriated $700,000 for nutrient control measures, of which $120,545 has been designated for approved projects. The TAC and CRCC continue to review proposed projects for possible funding using the remaining $579,455 of uncommitted SFY 96 funds. Figure 5.3 shows the state funds that have been made available for cost share for water quality improvement projects from the beginning of the Boulder Creek SAWQP projects through SFY 95. Federal cost share funds have been contributed by the U.S. Fish and Wildlife Service, BOR, and the Consolidated Farm Service Agency.

Table 5.1 Use of Cascade Reservoir Restoration Project SFY 95 state funds.

| Project | Funding | Status |
|---|---|---|
| Upgrade City of McCall Treatment Facilities | $1,020,000 | Phase I scheduled for construction in 1996 |
| Water Delivery System Construction Grants | $231,000 | Four projects approved for funding; additional projects will be considered through 1996 |
| Nutrient Control Measures | | |
| a. Irrigation management plan | $169,000 | Scheduled for completion 7/96 |
| b. Detention ponds | $100,000 | IDFG lead; two ponds constructed in 1995 |
| c. Non-SAWQP nutrient reduction projects | $250,000 | VSWCD lead; applications exceed available cost share funds |
| d. Large scale detention systems; stormwater BMPs | $250,000 | Scope of work and schedule under development |
| Sediment Plan | | |
| a. Model sediment dynamics | $37,000 | Scheduled for completion in 1996 |
| b. Reservoir sedimentation survey | $62,500 | BOR lead; scheduled for completion in 1996 |

Table 5.2 Use of Cascade Reservoir Restoration Project SFY 96 state funds.

| Project | Funding | Status |
|---|---|---|
| BOR Nutrient Control Projects | $92,000 | Cost share for design and construction of projects; 1995/96 |
| Reservoir Boat Pumpout Facility | $7,500 | Valley County Waterways Commission lead; install in 1996 |
| South Lake Recreational Sewer and Water District | $4,500 | CDHD lead; assistance with organizational costs |
| Fish Saving Proposal | $6,545 | Cascade High School lead; demonstration project to enhance fish survival |
| Radionuclides Study | $10,000 | Cost share for analysis to identify sources of sediment by land use in Gold Fork subwatershed |
| Uncommitted Funds | $579,455 | CRCC and TAC reviewing project proposals |

# Cascade Reservoir Restoration Project

Use of SFY95 Funds
Total = $2,350,000

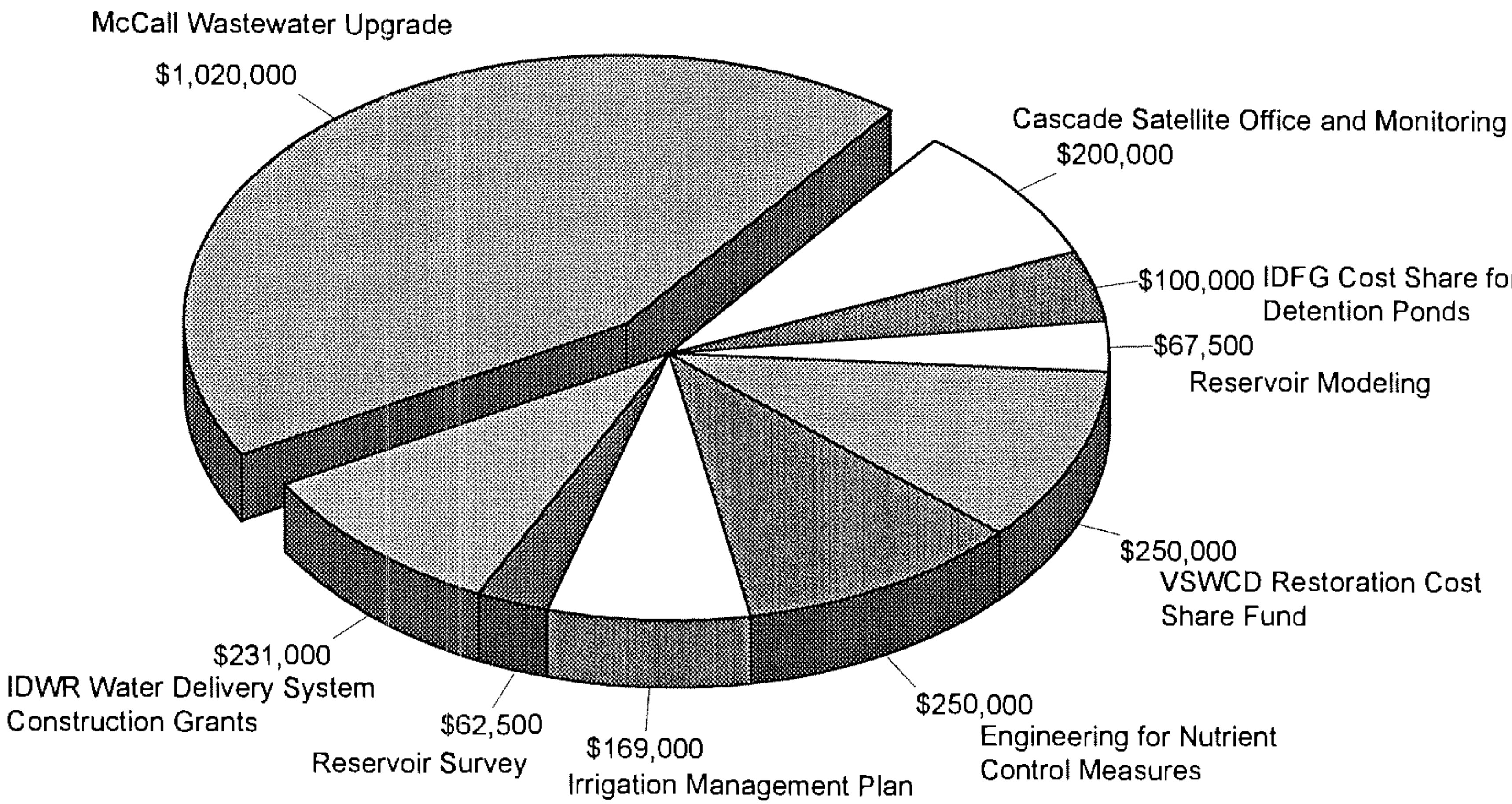



Figure 5.2.

# Cascade Watershed

State Water Quality Improvement Cost Share Funds
Total = $3,132,323

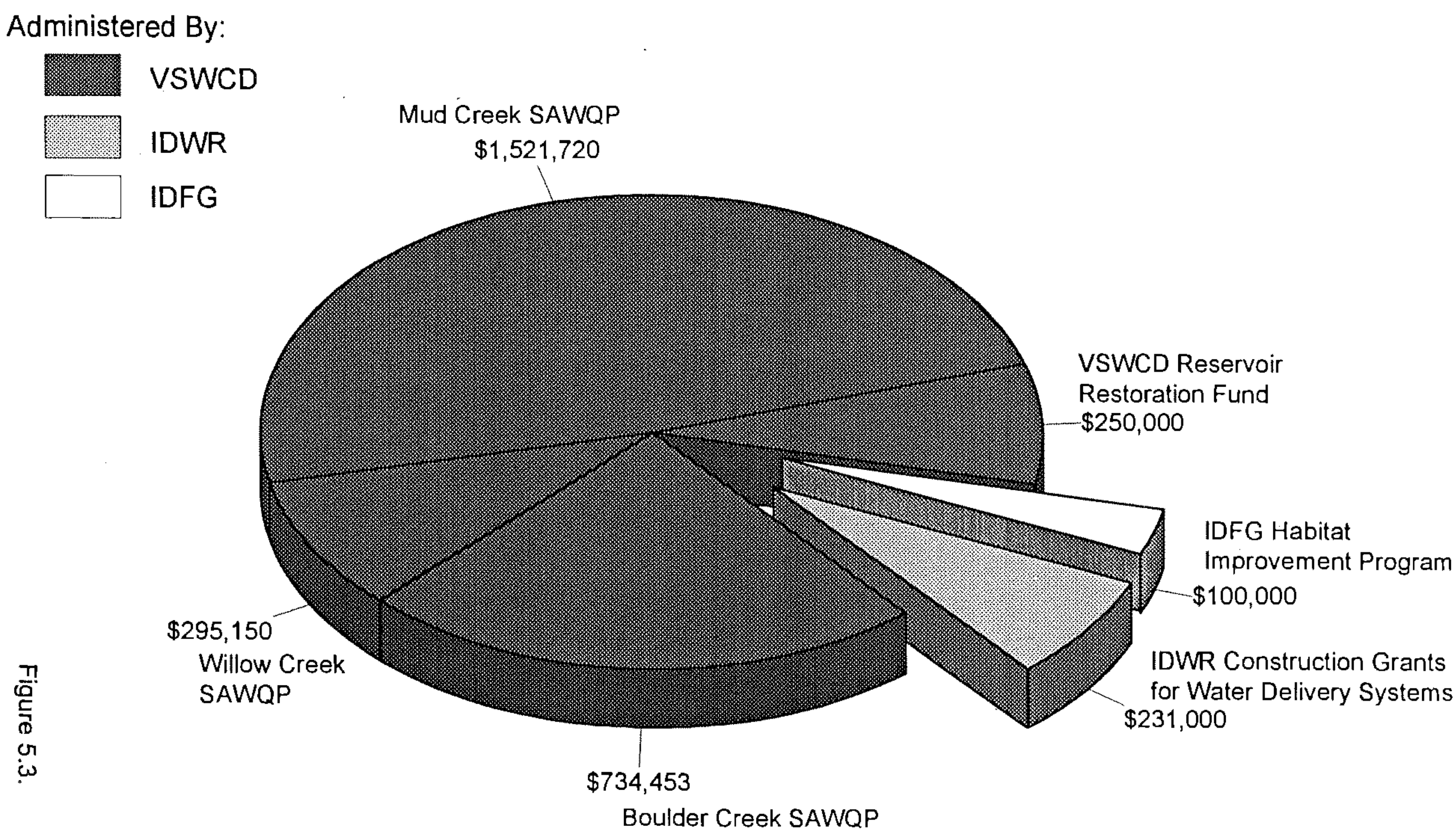



Figure 5.3.

## 5.2 Monitoring

DEQ has been involved in an extensive cooperative monitoring program with the BNF, PNF, VSWCD, and BOR since 1993 to generate a more accurate picture of the phosphorus dynamics in Cascade Reservoir and the surrounding watershed. This is reflected in the analysis that is currently underway (Section 4.7.1, Table 4.5, Table 4.6) on the data collected to date. DEQ will continue to monitor various aspects of Cascade Reservoir and its watershed.

There are three essential components to the Cascade monitoring framework:

1. Implementation Monitoring: to determine if water quality improvement projects were implemented as indicated and were installed correctly;

2. BMP Effectiveness Monitoring: to determine if BMP's are as effective in reducing phosphorus or sediment as estimated and if they are working as intended; and

3. In-reservoir Phosphorus Reduction Monitoring: to determine if phosphorus and chlorophyll a concentrations in the reservoir meet the goals set forth in this plan.

Table 4.4 displays the schedule for implementation of phosphorus reduction measures and Table 5.3 shows who will be responsible for monitoring implementation and BMP effectiveness. Generally, the agency responsible for implementing a project or BMP is also responsible for implementation and effectiveness monitoring. In a few instances DEQ will be assisting other agencies in completing the effectiveness monitoring. DEQ will continue to be responsible for in-reservoir water quality monitoring. Appendix D is DEQ's monitoring plan for in-reservoir, tributary, and effectiveness monitoring. It describes sampling methods, locations, frequency, quality control provisions and reporting. Completion of all of the monitoring depends on availability of future funds, irrespective of agency. DEQ will continue to coordinate overall monitoring throughout the watershed, directly through contract grants and indirectly through the TAC. This will also be the vehicle by which DEQ will track implementation monitoring, through contract quarterly reports and semi-annual agency reports.

Table 5.3 Agency responsibilities for BMP implementation and effectiveness monitoring.

| Project Name | BMP Implementation and Effectiveness monitoring responsibility |
|---|---|
| North Lake Sewer & Water District (NLSWD) | Implementation by NLSWD |
| South Lake Sewer & Water District (SLSWD) | Implementation by SLSWD |
| City Of McCall Wastewater Treatment Plant | Implementation by EPA, effectiveness by City of McCall |
| Boulder Creek SAWQP | Implementation by VSWCD, effectiveness in cooperation with DEQ |
| Mud Creek SAWQP | Implementation by VSWCD, effectiveness in cooperation with DEQ |
| Willow Creek SAWQP | Implementation by VSWCD, effectiveness in cooperation with DEQ |
| Non-SAWQP Program BMP | Implementation by VSWCD, effectiveness will be done through other SAWQP projects |
| Bureau of Reclamation Detention Pond | Implementation by BOR, effectiveness in cooperation with DEQ |
| Idaho Dept. of Fish & Game Detention Ponds | Implementation by IDFG, effectiveness by DEQ |

VSWCD has initiated three different SAWQP projects in the Cascade watershed, in the Boulder Creek, Willow Creek and Mud Creek subwatersheds. A Plan of Operations for each SAWQP project (VSWCD, 1992; 1995a; 1995b) details how and when BMP implementation and effectiveness monitoring will occur. VSWCD will conduct 100% implementation monitoring, to insure all BMP's contracted are installed or implemented. This will occur annually to check contract compliance, confirm that BMPs have been installed or performed according to standards and specifications and assess the need for BMP modifications. BMP effectiveness monitoring will target at least one structural and one management or vegetation practice per SAWQP project each year.

Both the PNF and BNF include monitoring sections as part of their project plans, Environmental Assessments or Environmental Impact Statements. These project specific monitoring plans describe how implementation and BMP effectiveness monitoring will occur. Generally, a fully integrated plan is utilized, one that measures project impact on water chemistry, physical habitat and biology. The Spruce Creek Timber Sale Environmental Impact Statement contains a Watershed Monitoring section under Monitoring. A copy of this is included in Appendix E. Other watershed monitoring plans will be developed by BCC and both National Forests, as new sources are identified through their watershed analysis and as restoration measures are implemented.

## 6.0 Acronyms/Abbreviations

| Acronyms | Full Name |
|---|---|
| BCC | Boise Cascade Corporation |
| BMP | Best Management Practices |
| BNF | Boise National Forest |
| BOD | Biochemical Oxygen Demand |
| BOR | U.S. Bureau of Reclamation |
| CDHD | Central District Health Department |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| CRCC | Cascade Reservoir Coordinating Council |
| DEQ | Idaho Division of Environmental Quality |
| DISS.-$PO_4$ | Dissolved Ortho Phosphorus |
| DO | Dissolved Oxygen |
| EPA | U.S. Environmental Protection Agency |
| IDAPA | Idaho Administrative Procedures Act |
| IDFG | Idaho Department of Fish & Game |
| IDHW | Idaho Department of Health & Welfare |
| LA | Load Allocation |
| IDWR | Idaho Department of Water Resources |
| NLSWD | North Lake Recreational Sewer and Water District |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | National Research Conservation Service |
| P | Phosphorus |
| PNF | Payette National Forest |
| QA/QC | Quality Assurance/Quality Control |
| SAWQP | State Agricultural Water Quality Program |
| SLSWD | South Lake Recreational Sewer and Water District |
| TAC | Technical Advisory Committee |
| TKN | Total Kjeldahl Nitrogen |
| TMDL | Total Maximum Daily Load |
| TN | Total Nitrogen |
| TP | Total Phosphorus |
| USDA | U.S. Department of Agriculture |
| USFS | U.S. Forest Service |
| UTM | Universal Transverse Mercator |
| VCWC | Valley County Waterways Commission |
| VSWCD | Valley Soil & Water Conservation District |
| WLA | Waste Load Allocation |
| WWTP | Wastewater Treatment Plant |
| WY | Water Year |

| Abbreviations | Unit |
|---|---|
| yr | year |
| ft | foot |
| acre | acre |
| mg | milligram |
| m | meter |
| ug | microgram |
| °C | degrees Celsius |
| mgd | million gallons per day |
| kg | kilogram |
| acre-ft | acre-foot |
| km | kilometer |
| mi | mile |
| cfs | cubic feet per second |
| l | liter |
| ha | hectare |
| T | ton |
| ml | milliliter |

# 7.0 Units Conversion Table

| LENGTH | mm. | cm. | in. | ft. | yd. | m. | km. | mi. |
|---|---|---|---|---|---|---|---|---|
| millimeters | 1.0 | 10.0 | 25.4 | 304.8 | 914.40 | 1,000.0 | 1,000,000 | 1,609,347 |
| centimeters | 0.1 | 1.0 | 2.54 | 30.48 | 91.44 | 100.0 | 100,000 | 160,935 |
| inches | 3.94e-02 | 0.3937 | 1.00 | 12.0 | 36.00 | 39.4 | 39,370 | 63,360 |
| feet | 3.28e-03 | 0.0328 | 0.0833 | 1.0 | 3.00 | 3.2808 | 3,280.8 | 5,280 |
| yards | 1.09e-03 | 0.01093 | 0.0278 | 0.33333 | 1.00 | 1.0936 | 1,093.6 | 1,760 |
| meters | 1.00e-03 | 0.01 | 0.0254 | 0.3048 | 0.9144 | 1.0 | 1,000 | 1,609.3 |
| kilometers | 1.00e-05 | 1.00e-04 | 2.54e-05 | 3.05e-04 | 9.150e-04 | 0.001 | 1.0 | 1.6093 |
| miles | 6.21e-07 | 6.21e-06 | 1.06e-05 | 1.89e-04 | 5.68e-04 | 6.21e-04 | 0.61237 | 1.0 |
| AREA | cm2 | in2 | ft2 | m2 | acres | km2 | mi2 | |
| sq. centimeter | 1 | 6.452 | 929 | 1.0e+05 | 40,465,284 | 1.0e+11 | 2.59e+10 | |
| square inches | 0.155 | 1 | 144 | 1,550 | 6,272,640 | 1.55e+09 | 4.014e+09 | |
| square feet | 1.08e-03 | 0.00694 | 1 | 10.76 | 43,560 | 10,763,900 | 27,878,400 | |
| square meters | 1.0e-03 | 6.45e-04 | 0.0929 | 1 | 4,047 | 1.0e+07 | 2,589,998 | |
| acres | 2.47e-08 | 1.59e-07 | 2.3e-05 | 2.47e-04 | 1 | 247.1 | 640 | |
| sq. kilometer | 1.0e-09 | 6.45e-10 | 9.29e-08 | 1.0e-05 | 4.047e-03 | 1 | 2.59 | |
| square miles | 3.86e-11 | 2.49e-10 | 3.59e-08 | 3.86e-07 | 1.563e-03 | 0.3861 | 1 | |
| VOLUME | cm3 | in3 | l | us. gal. | ft3 | m3 | acre-ft | |
| cubic cent. | 1 | 16.39 | 1,000 | 3,785.4 | 28,317.00 | 1.0e+07 | 1.23e+09 | |
| cubic inches | 0.06102 | 1 | 61.0234 | 231 | 1,728.00 | 61,023.00 | 75,271,680 | |
| liters | 0.001 | 0.01639 | 1 | 3.7854 | 28.317 | 1,000.00 | 1,233,490 | |
| U.S. gallons | 2.64e-04 | 0.00433 | 0.26417 | 1 | 7.4805 | 264.17 | 325,851.00 | |
| cubic feet | 3.53e-05 | 5.7e-04 | 0.03531 | 0.13368 | 1 | 35.3145 | 43,560.00 | |
| cubic meters | 1.0e-05 | 1.64e-05 | 0.001 | 0.00388 | 0.02832 | 1 | 1,233.49 | |
| acre feet | 8.11e-10 | 1.3e-8 | 8.1e-07 | 3.07e-06 | 2.296e-05 | 8.107e-04 | 1 | |
| VOLUME/TIME | usgal/day | usgal/min | l/sec | acre-ft/day | ft3/sec | m3/sec | | |
| U.S. gallons/day | 1 | 1,440.00 | 22,824 | 325,850 | 646,317 | 22,824,288 | | |
| U.S. gallons/minute | 6.94e-04 | 1 | 15.85 | 226.28 | 448.83 | 15,850 | | |
| liters/second | 4.38e-05 | 0.063 | 1 | 14.28 | 28.32 | 1,000 | | |
| acre feet/day | 3.07e-06 | 0.004 | 0.07 | 1 | 1.98 | 70.05 | | |
| cubic feet/sec. | 1.55e-06 | 0.002 | 0.04 | 0.50 | 1 | 35.31 | | |
| cubic m/sec. | 4.31e-08 | 6.31e-05 | 0.001 | 0.01 | 0.03 | 1 | | |

Source data Steven's (1978)

(Please note scientific notation example: 1000 = 1.0e+3)

## 8.0 Glossary

**Aeration** - a process by which a water body secures oxygen directly from the atmosphere, the gas then entering into the biochemical oxidation reactions in the water.

**Aerobic** - life or processes that require the presence of molecular oxygen.

**Adsorption** - the adhesion of one substance to the surface of another.

**Alluvium** - the deposition of sediment by a river at any point along its course.

**Ambient** - surrounding, external, or unconfined conditions.

**Anaerobic** - processes that occur in the absence of molecular oxygen

**Anoxia** - the condition of oxygen deficiency.

**Anthropogenic** - caused or produced through the agency of man.

**Assimilative Capacity** - the rate at which an aquatic system must consume and remove impurities from water to maintain water quality.

**Beneficial Uses** - any of the various uses of water, including, but not limited to domestic water supplies, industrial and agricultural water supplies, cold water biota, recreation, wildlife habitat, and aesthetics.

**Biomass** - the weight of biological matter, often measured in terms of grams per square meter of surface area.

**Chlorophyll a** - a photosynthetic pigment reflecting green light and imparting the typical green color to plants; chlorophyll a is found in all autotrophic plants.

**Coliform bacteria** - a group of bacteria predominantly inhabiting the intestines of man and animals but also found in soil. Coliform bacteria and commonly used as indicators of the possible presence of pathogenic organisms.

**Colluvium** - material transported to a site by gravity.

**Critical Acres** - in a State Agricultural Water Quality Project area, those areas where BMPs should be implemented to improve water quality.

**Effluent** - treated or untreated wastewater that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

**Eutrophic** - a body of water of high photosynthetic activity and low transparency.

**Fauna** - the entire animal life of a given region, habitat or geological stratum.

**Fecal Streptococci** - a species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.

**Flora** - the plant life of a given region, habitat, or geological stratum.

**Hydrology** - the science dealing with the properties, distribution, and circulation of water.

**Hypolimnion** - the cold bottom water zone below the thermocline in a lake.

**Igneous** - formed by solidification of molten magma.

**Influent** - a tributary stream to a wastewater treatment plant.

**Infusion** - the continuous slow introduction of one content into another.

**Intergravel D.O.** - dissolved oxygen found in the substrate (usually gravel) of a stream, which is needed to support fish and macroinvertebrates during early life stages.

**Limnology** - scientific study of fresh water, especially the history, geology, biology, physics and chemistry of lakes.

**Mesotrophic** - a trophic state in which a lake or reservoir tends to be moderately productive, but nuisance algae blooms do not occur because the nutrient supply is limited.

**Nonpoint Source** - a geographical area on which pollutants are deposited, dissolved or suspended in water applied to or incident on that area, the resultant mixture being discharged into waters of the state.

**Noxious** - physically or chemically harmful or destructive

**Orthophosphate** - a form of soluble inorganic phosphorus which is directly utilizable for algal growth.

**Pelagic** - The open areas of lake or reservoir.

**Photic Zone** - the surface zone of the sea or a lake having sufficient light penetration for photosynthesis.

**Phytoplankton** - microscopic algae and microbes that float freely in open water of lakes and oceans.

**Point Source Pollution** - the type of water quality degradation resulting from the discharges into receiving waters from sewers and other identifiable "points".

**Residuum** - the by product of a geological process.

**Riparian** - living or located on the bank of a natural watercourse.

**Secchi Disc** - a black and white disc, 20 cm in diameter, used to measure the transparency of water.

**Selective Withdrawal** - the ability to draft water from a reservoir from differing dam elevations

**SNOTEL** - Snow survey telemetry which uses the principle of radio transmission by meteor burst. Radio signals are aimed skyward where trails od meteorites reflect or re-radiate the signals back to earth.

**Stagnation** - the absence of mixing in a waterbody

**Stratification** - organization of a lake into horizontal layers due to differences in temperature.

**Synclinal** - a folded rock structure in which the sides dip toward a common line or plane.

**Thermocline** - a horizontal temperature discontinuity layer in a lake in which the temperature falls by at least 1°C per meter of depth.

**Total Suspended Solids (TSS)** - the material retained on a 45 micron filter after filtration.

**Trophic State** - level of growth or productivity of a lake as measured by phosphorus content, chlorophyll a concentrations, amount of aquatic vegetation, algal abundance and water clarity.

**Trophic State Index** - A system used by many states for classification of the degree of eutrophication exhibited by a lake or reservoir. The index combines measures of phosphorus, chlorophyll a levels and water clarity (transparency) to provide a frame of reference for comparing measurements over time.

**Turbidity** - a measure of the extent to which light passing through water is reduced due to suspended materials.

**Watershed** - a region bounded peripherally by the surrounding topography which ultimately drains to a common lake or stream.

**Water Quality Modeling** - the input of variable sets of water quality data to predict the response of a lake or stream.

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# 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 a. 1982, Reininger a. 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*

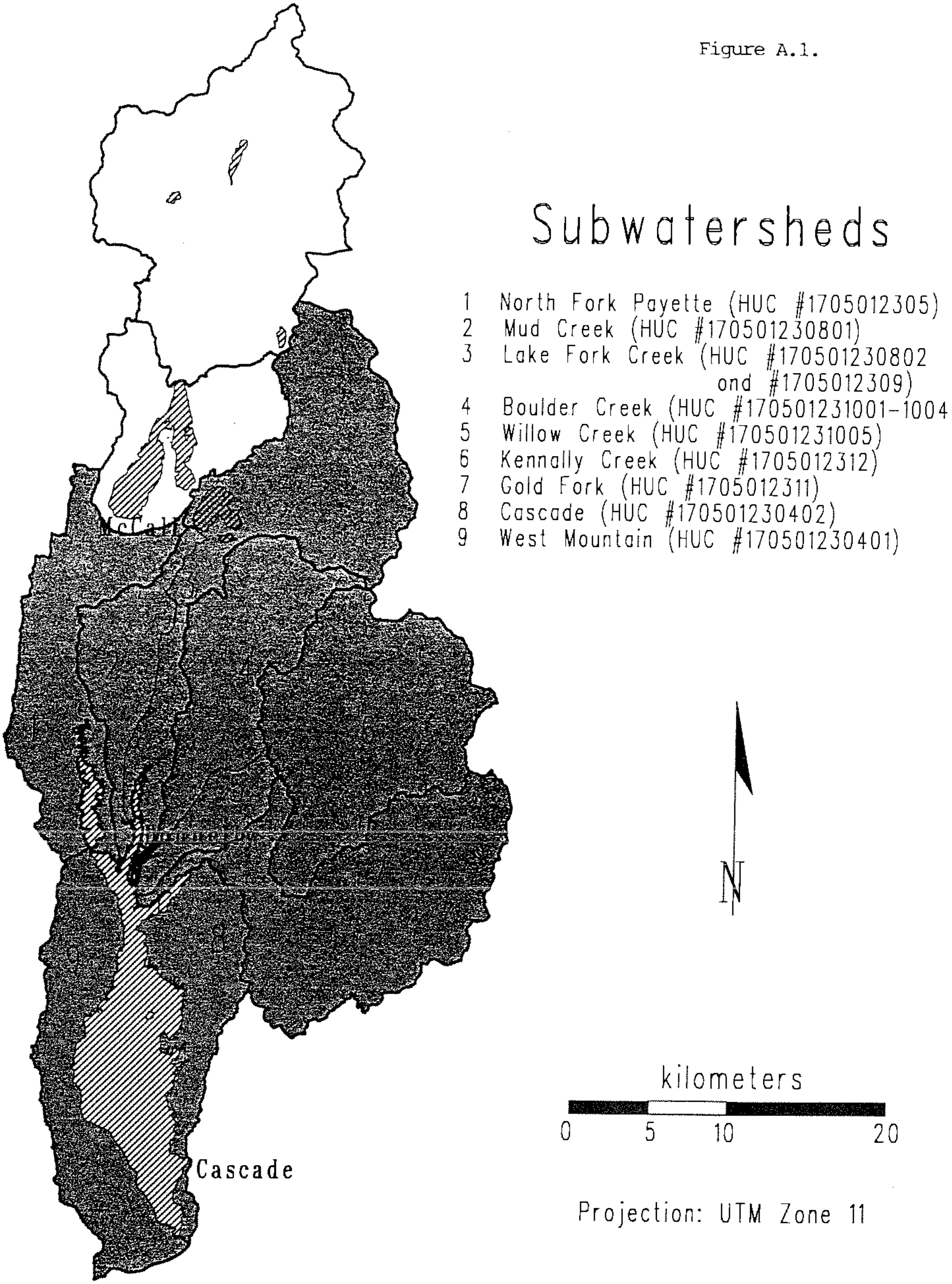
Studies of Cascade Reservoir have identified sediment bound phosphorus as an important source of this limiting nutrient (EPA, 1977; Zimmer, 1983; Entranco, 1991; Chapra, 1990). Efforts to measure and quantify phosphorus sources and distribution of sediments have been conducted (Worth, 1993) to enhance 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
Cascade

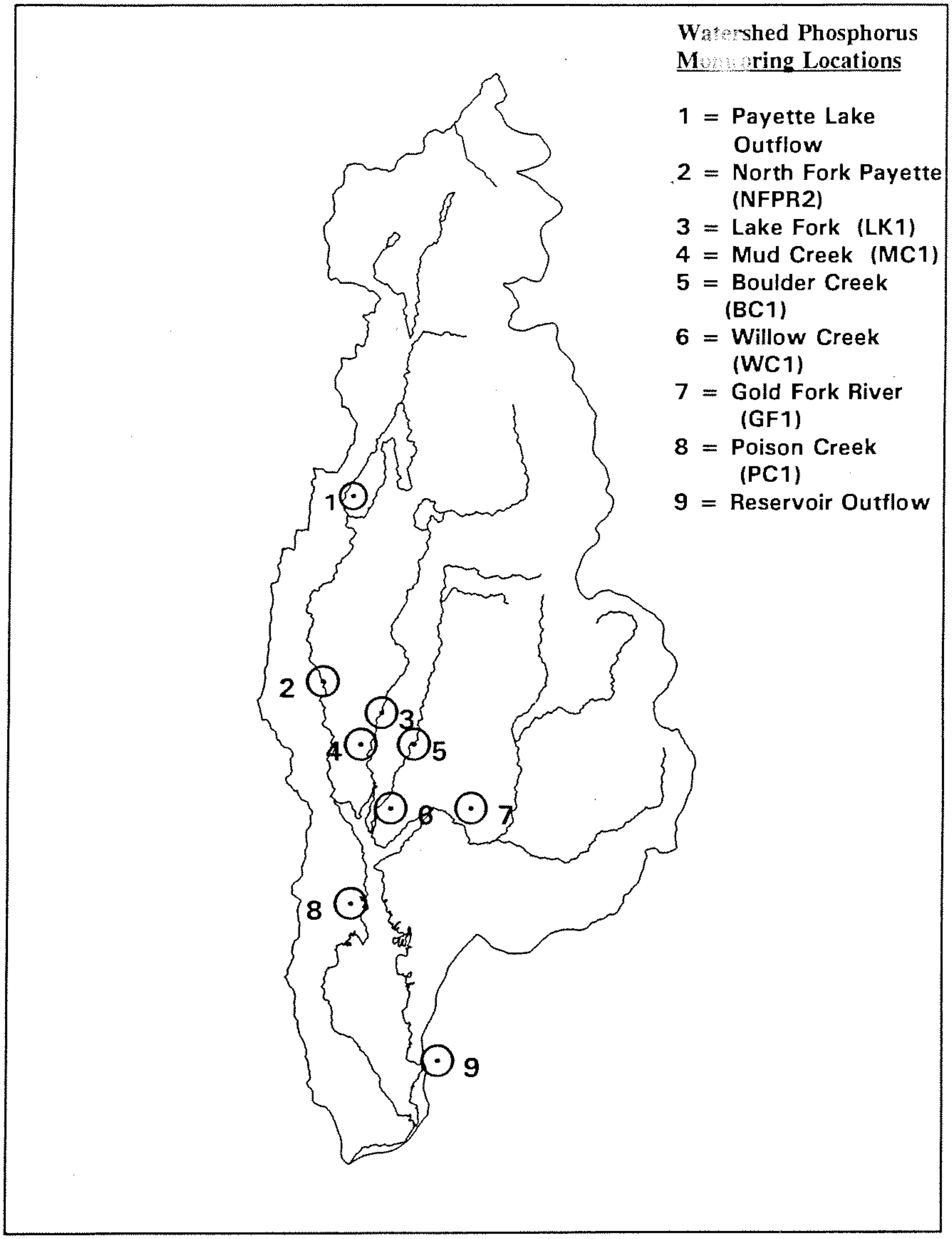



Figure A.2. Watershed Phosphorus Monitoring Locations

### *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).

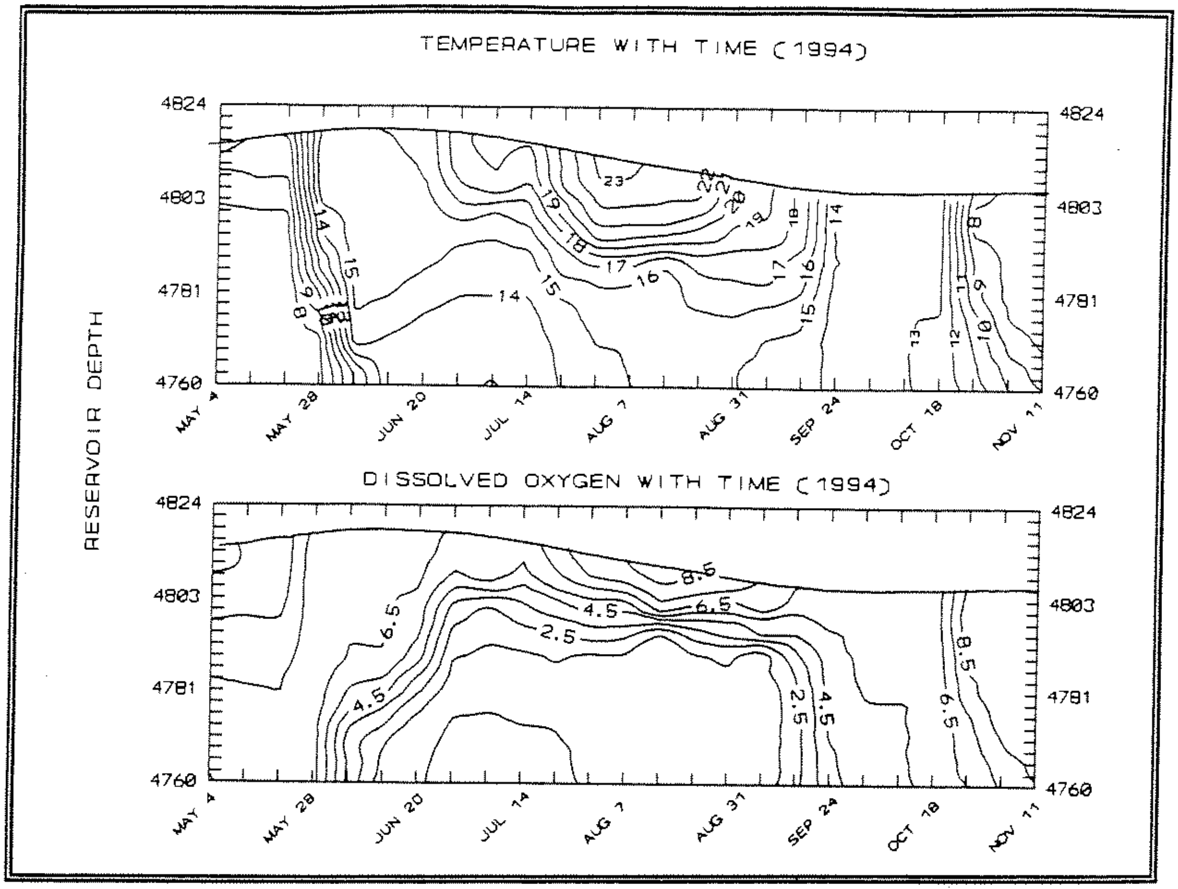
A more detailed survey by Horner (1980) showed low DO concentrations (≤ 3.0 mg/l) present in July and persisting through late August. Reininger et al. (1983) reported similar findings of lowest DO levels (<1.0 mg/l) during summer stratification (July to September) and during winter stagnation (February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



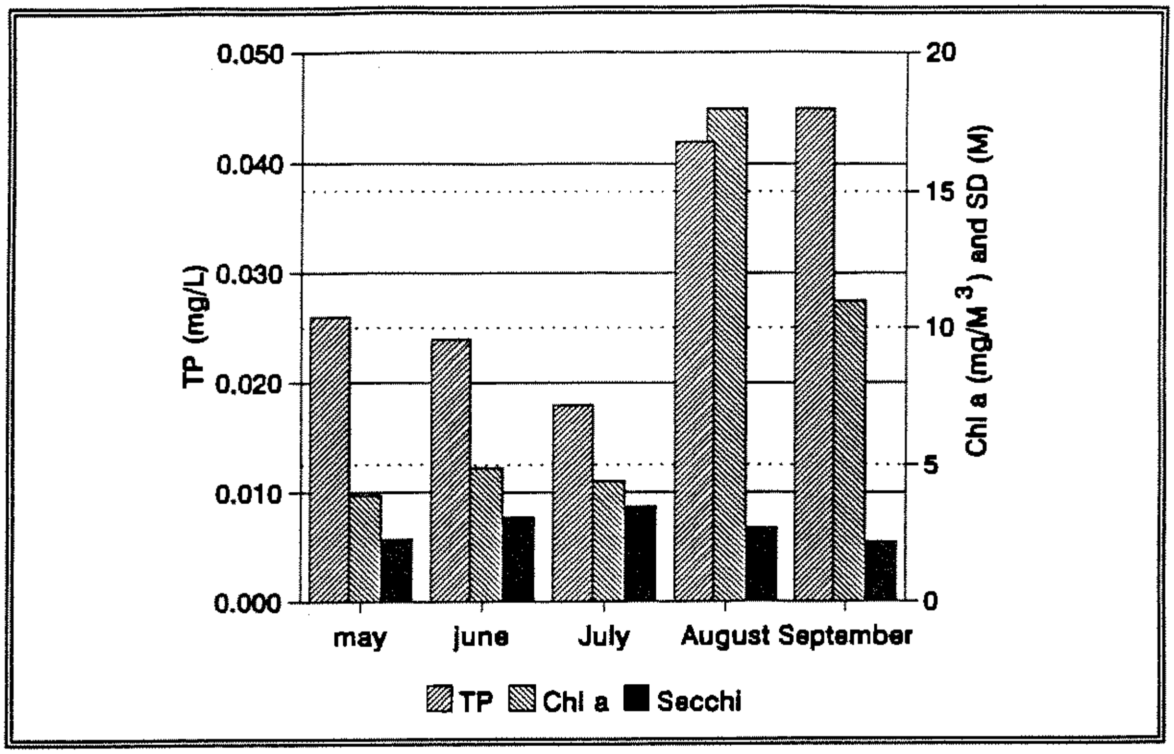

Results of the National Eutrophication study in 1974 (Table B.1), show average reservoir concentrations of chlorophyll a ranged from 7.0 to 10.1 ug/L with highest concentrations present in September (14.3 ug/L). Average reservoir concentrations in total phosphorus ranged from 0.019 to 0.031 mg/L and 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) | | | | | | | | | | | |
| | | | | | | | Diss | | | Inches | |
| Date | Depth | Station | Chl a | $NO_3+NO_2$ | $NH_4$ | TKN | $O-P0_4$ | Tot.N | TP | 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

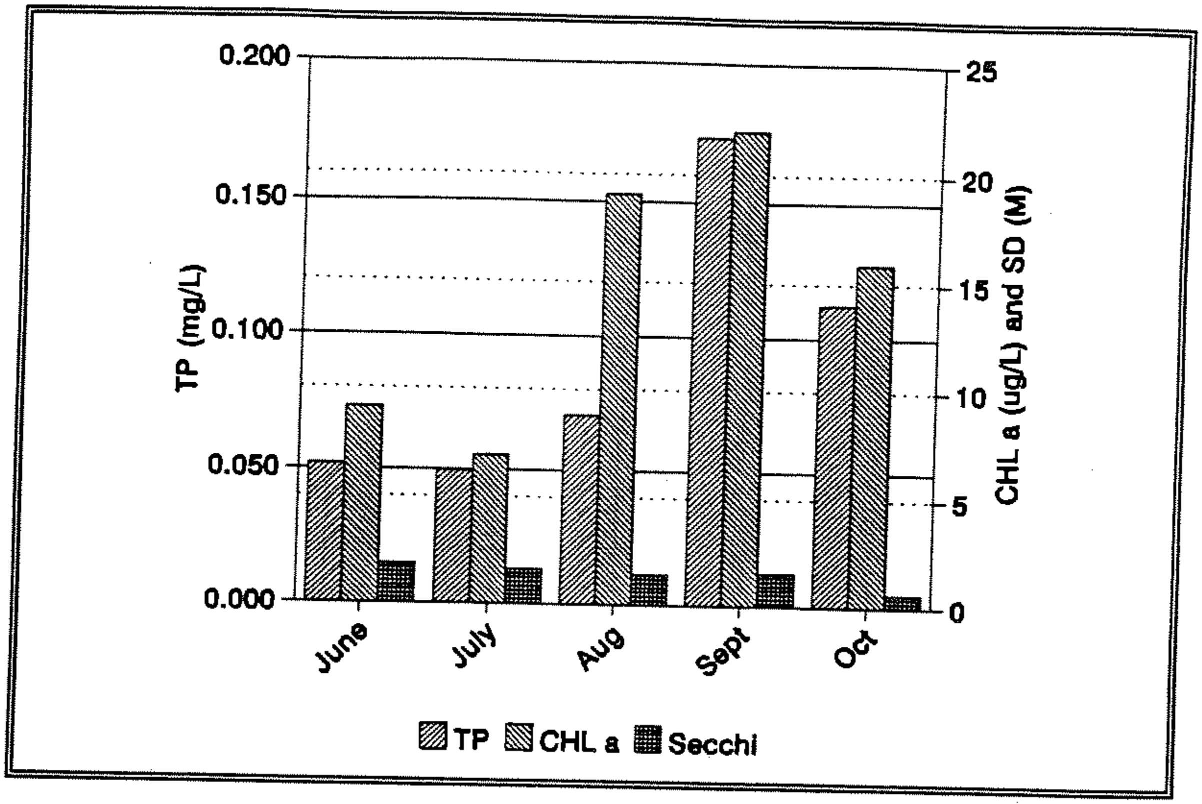



This same seasonal pattern of increases in chlorophyll a concentrations and predominately higher total phosphorus concentrations on the reservoir bottom was observed in subsequent studies conducted from 1988 to 1991 using citizen volunteer monitoring (Klahr, 1989; Entranco, 1991; Ingham, 1992) and during 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.

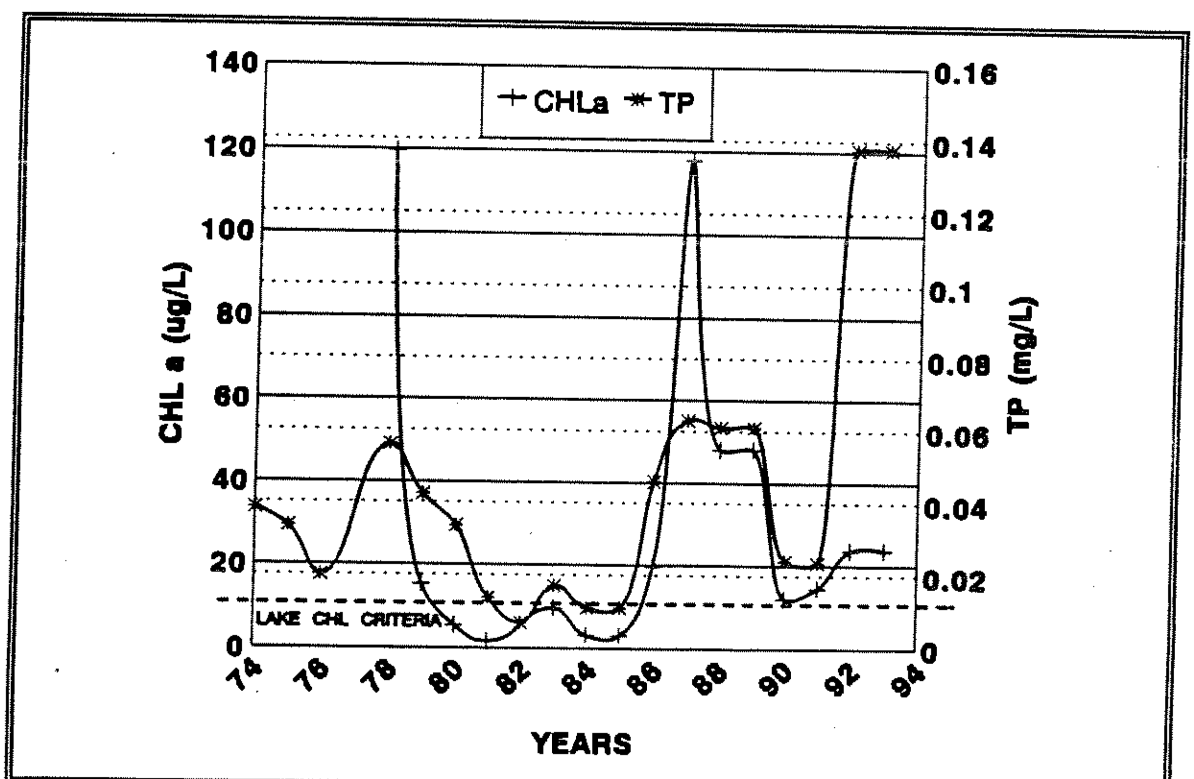
Summer chlorophyll a and total phosphorus concentrations vary from year to year because of phosphorus loading from runoff and internal recycling. Long term monitoring (contiguous records > 10 years) has been conducted near the reservoir dam outflow (referred to as log boom site or dam site; site CWQ002, 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.



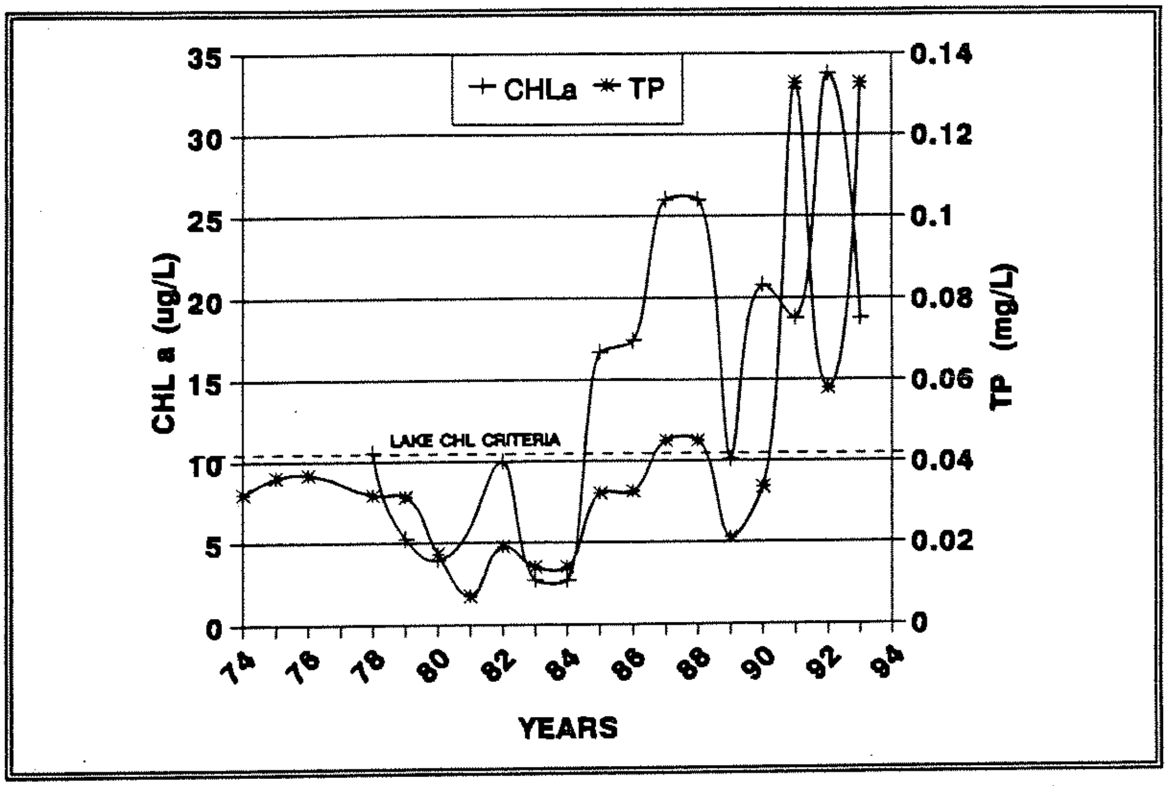

concentrations was observed at this site in 1992 and 1993 (Figure B.4). Although average summer chlorophyll a concentrations were lower compared to previous years, chlorophyll a concentrations were well above the 10 ug/l target established as the restoration goal.

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

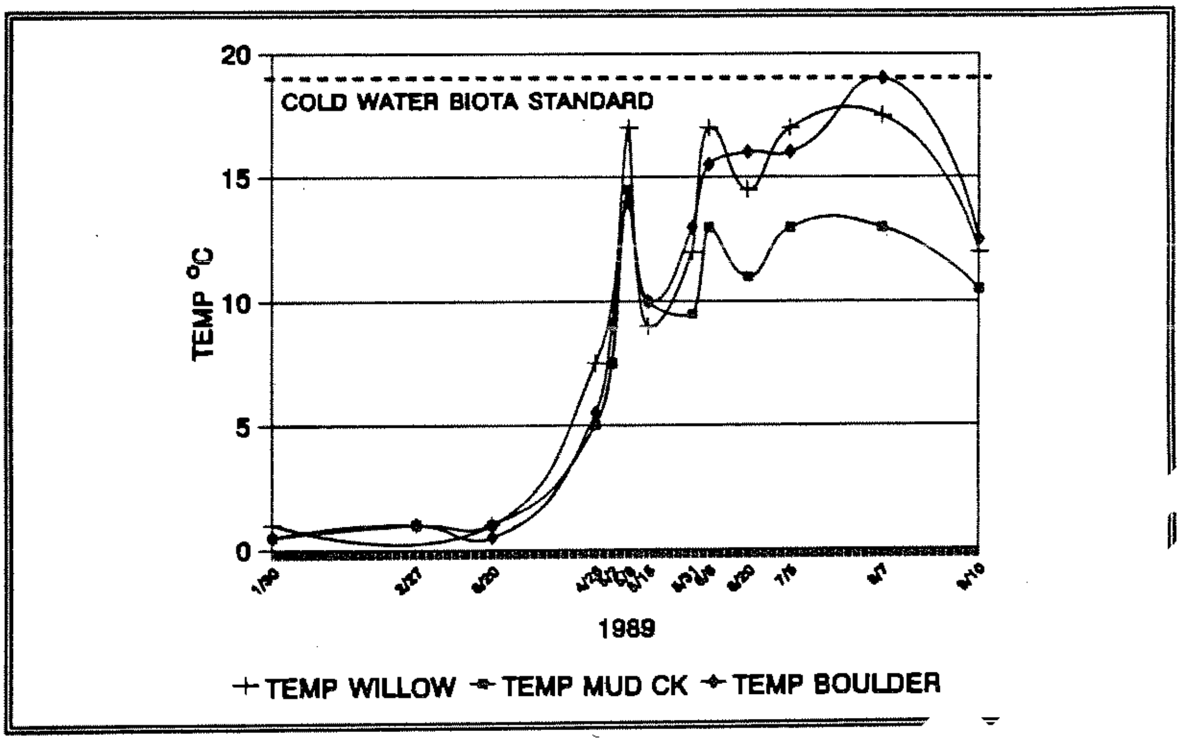


Figure B.7. Seasonal distribution of DO for Willow, Mud, and Boulder Creeks

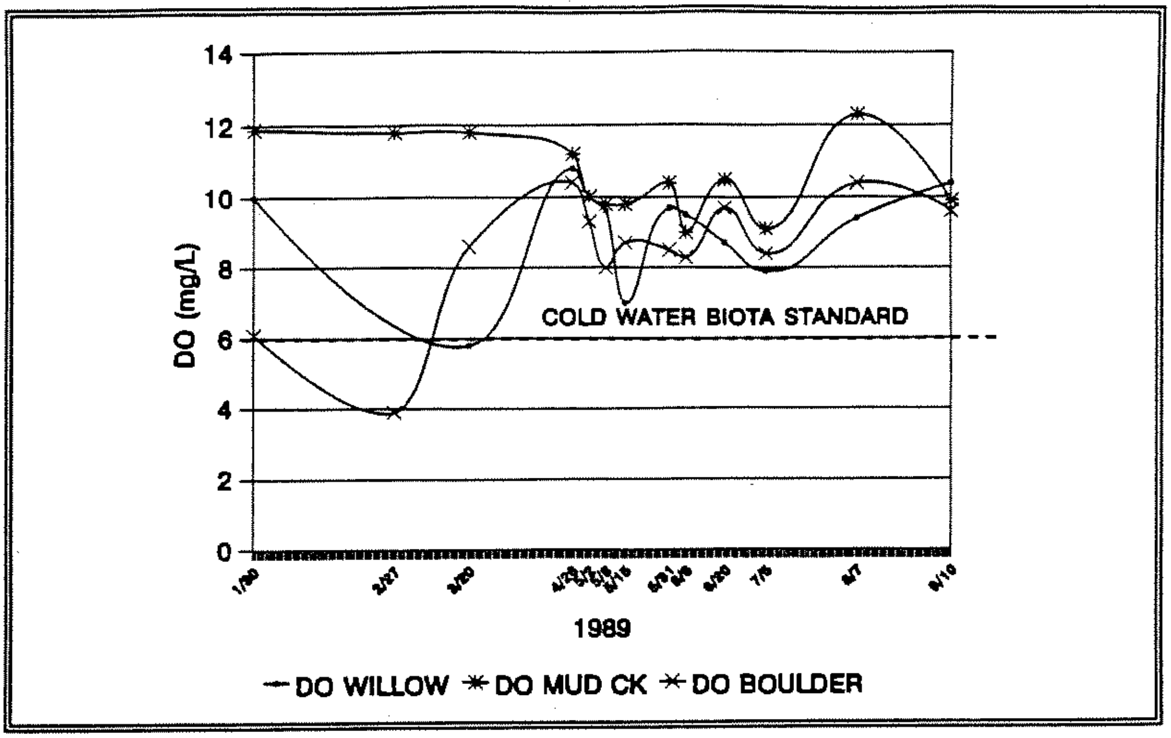



Figure B.8. Seasonal distribution of temperature in the North Fork, Lake Fork, and Gold Fork of the Payette River.

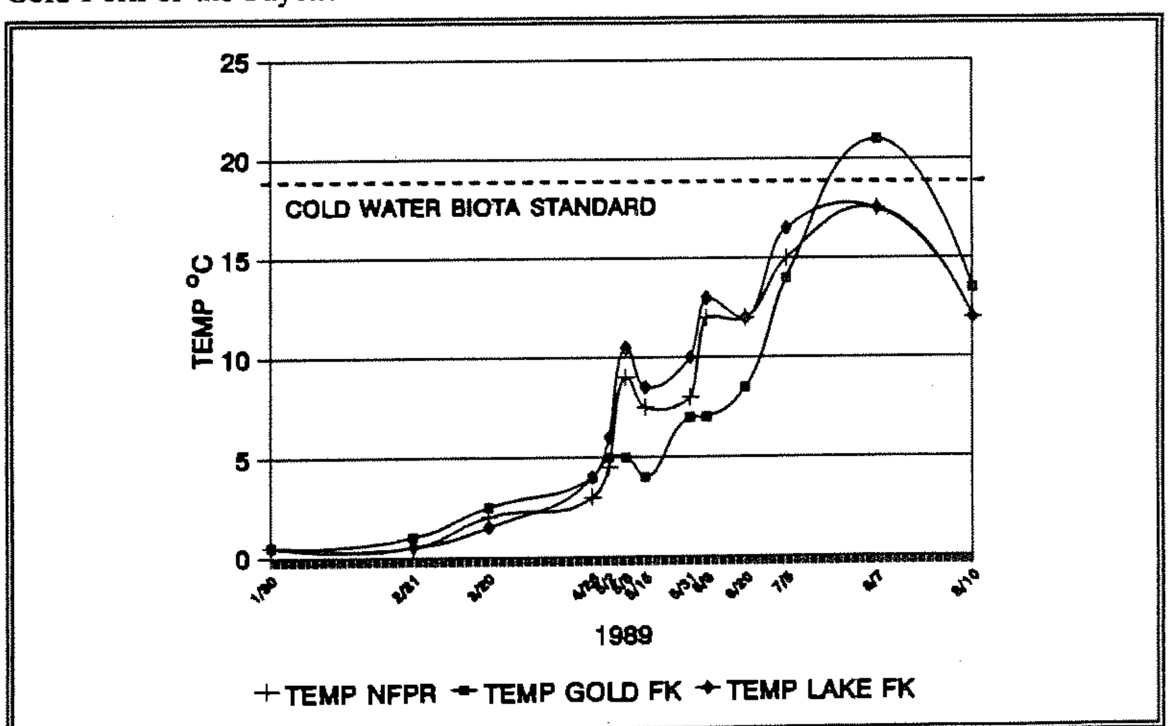


Figure B.9. Seasonal distribution of DO in the North Fork, Lake Fork, and Gold Fork of the Payette River.

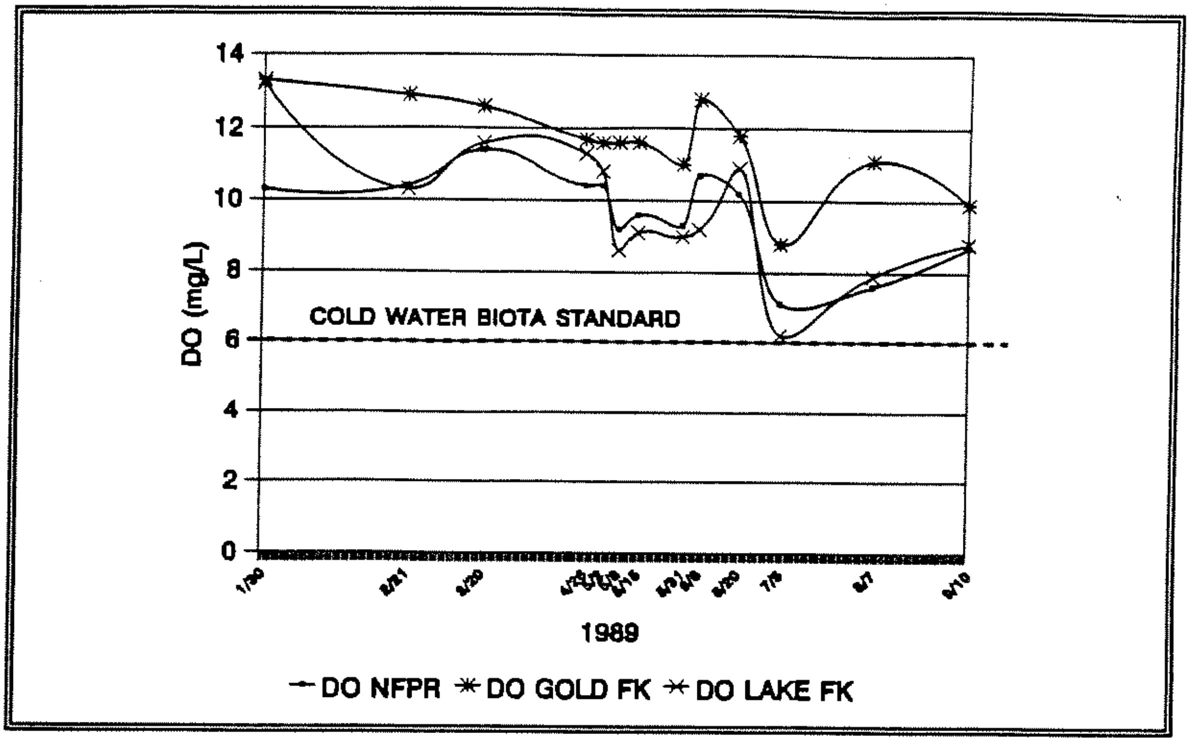



Figure B.10. 1993-1994 Seasonal distribution of temperature in Willow, Mud, and Boulder Creeks.

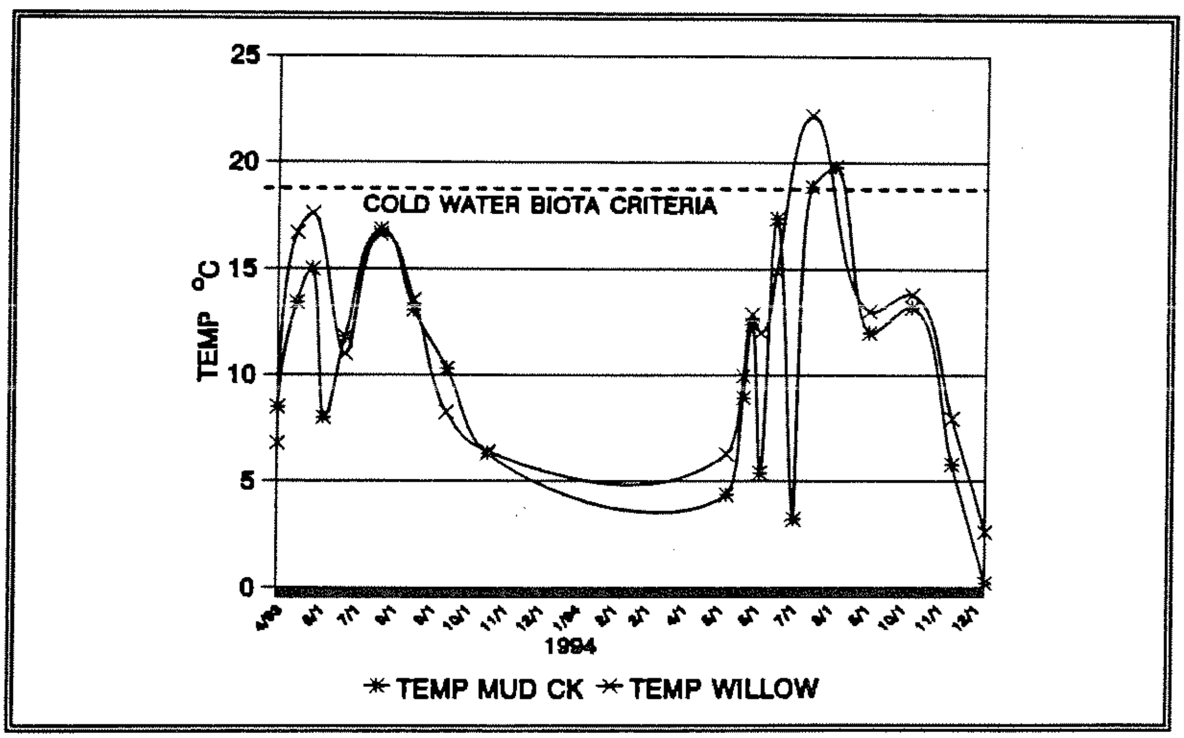


Figure B.11. 1993-1994 Seasonal distribution of DO in Willow, Mud, and Boulder Creeks.

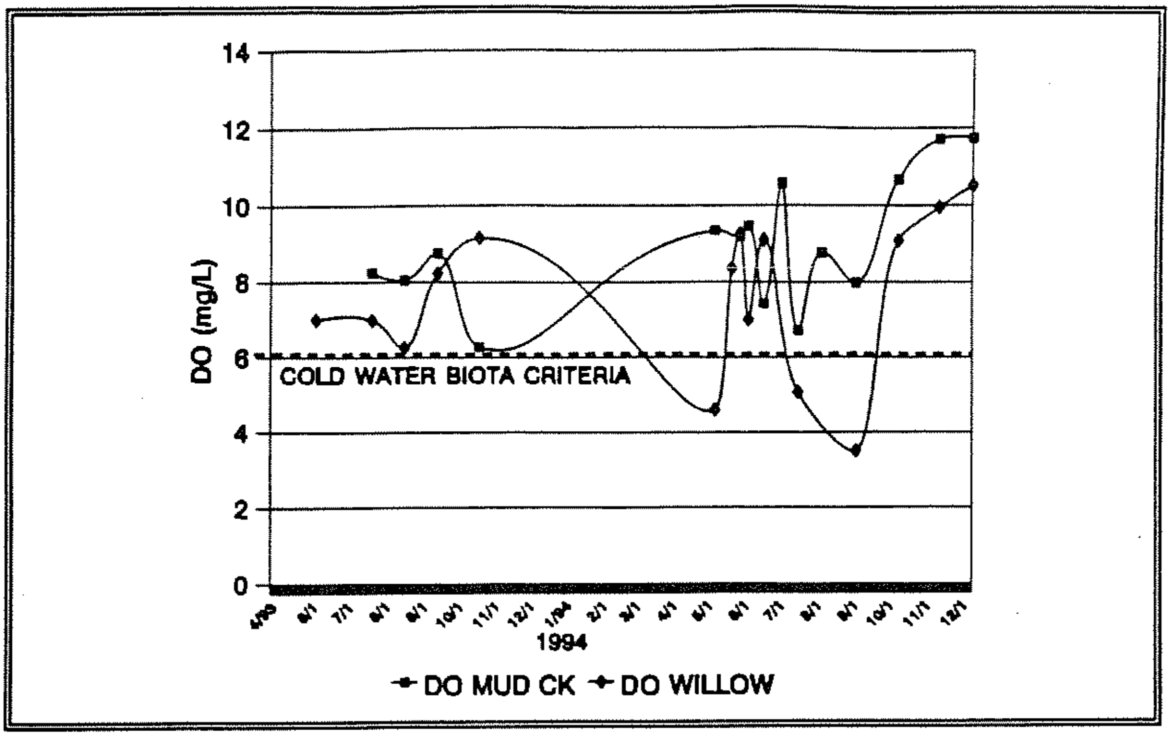



Figure B.12. 1993-1994 Seasonal distribution of temperature in the North, Lake, and Gold Forks of the Payette River.

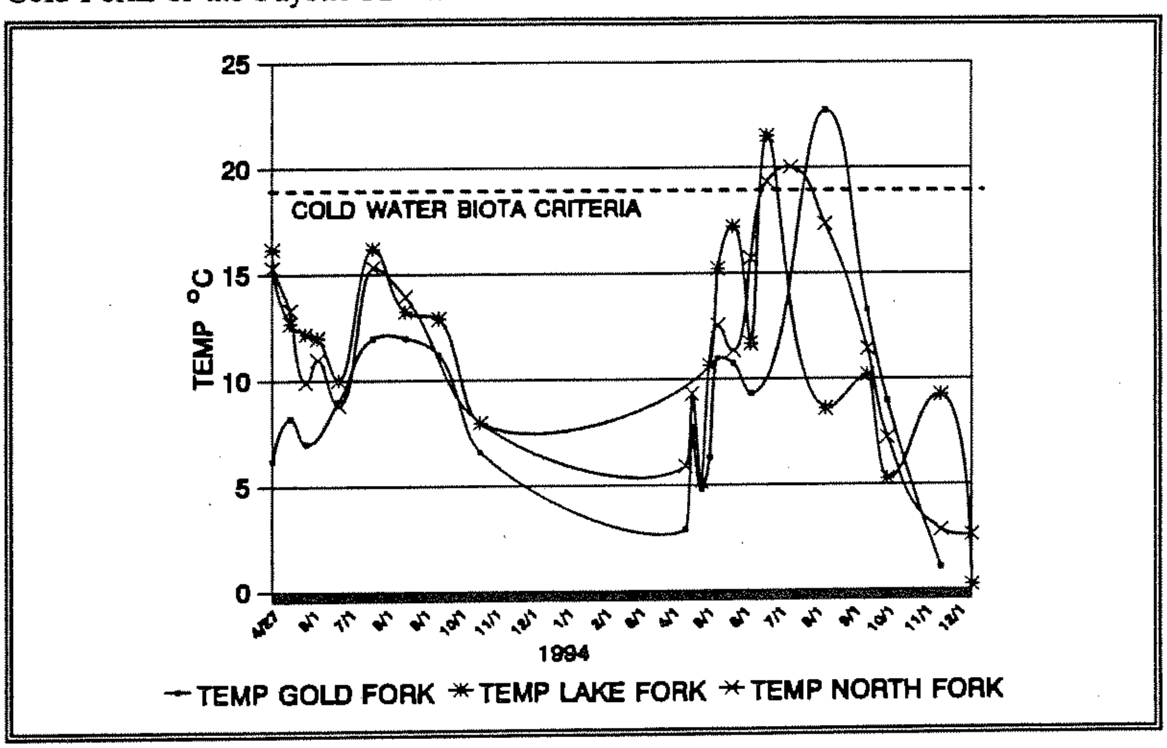
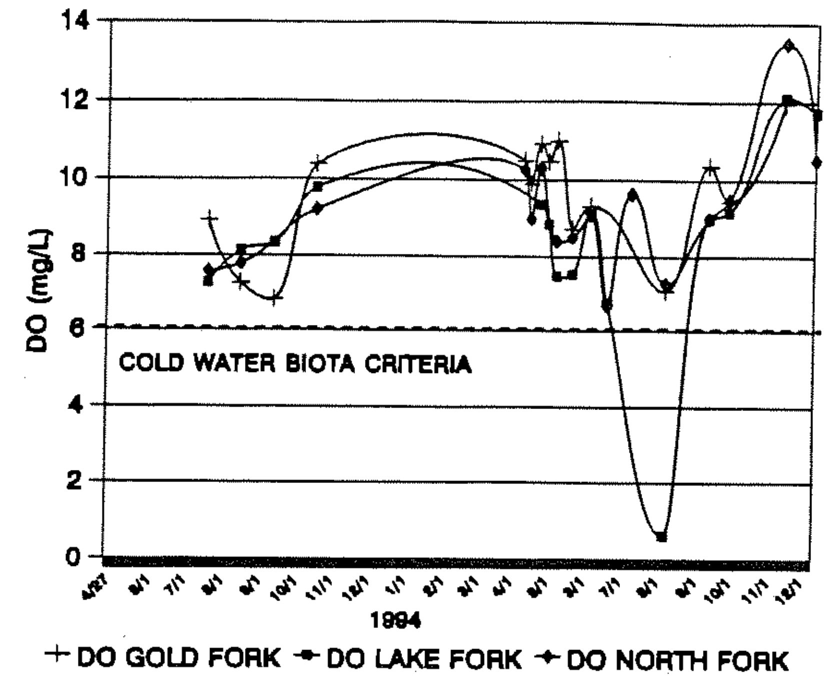


Figure B.13. 1993-1994 Seasonal distribution of dissolved oxygen in the North, Lake, and Gold Forks of the Payette River.




### *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<br><br>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<br><br>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<br><br>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<br><br>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[A] | 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.

[A] 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.

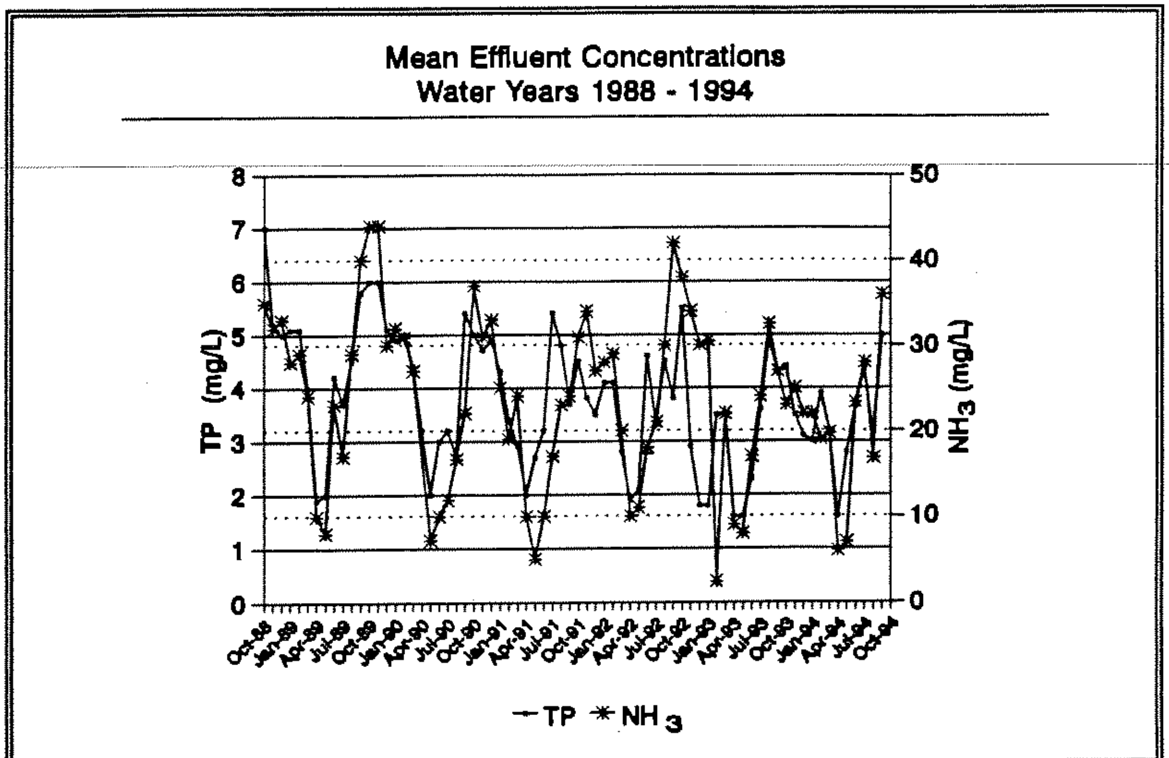
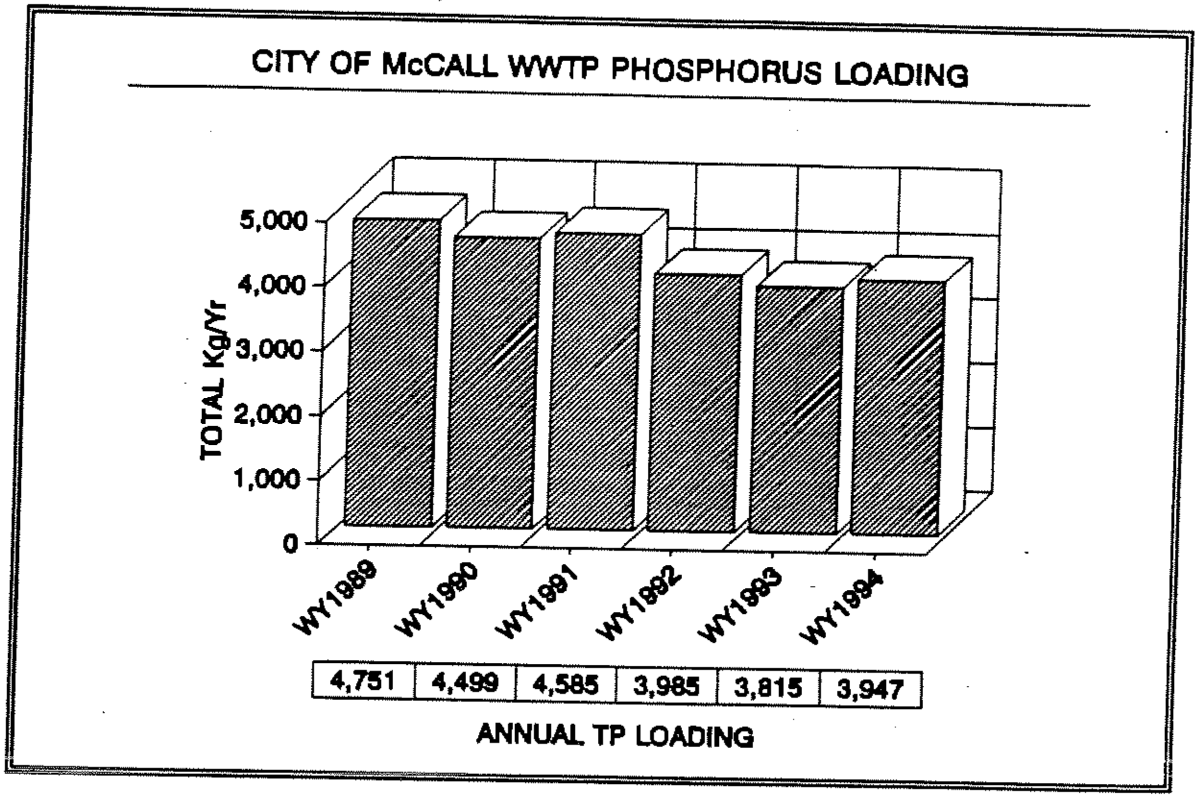



Table B.5. Average ambient and (range) of nutrient concentrations and other water quality parameters from the North Fork Payette River upstream of the City of McCall WWTP.

| 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 ($\geq 0.05$ 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

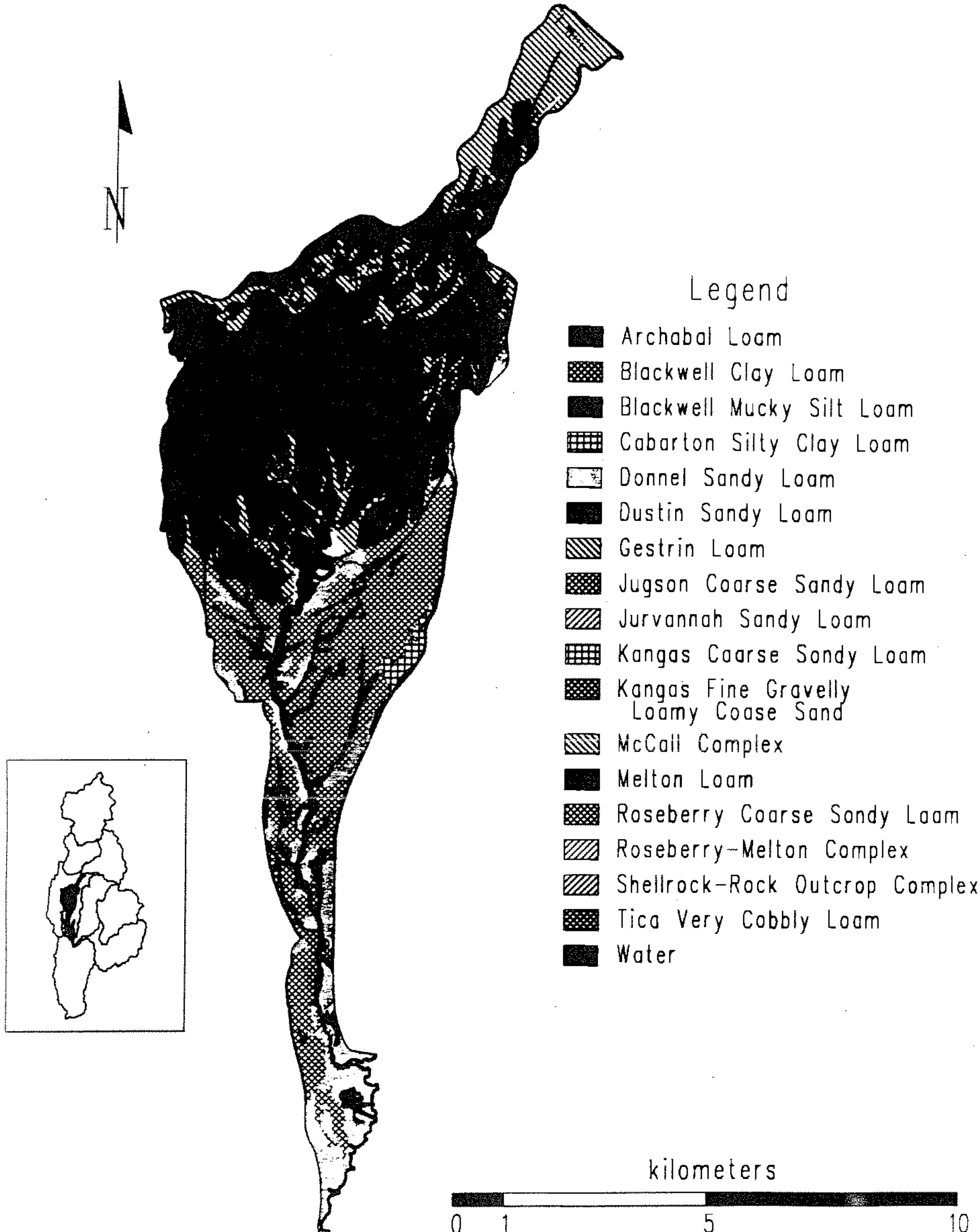
Annual summary of Cascade Reservoir water quality for the period of record 1974 - 1994, excluding 1977 (no data).

| | 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 | 0.008 | 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 | | | 0.587 | | 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 | | | 0.048 | 0.013 | 22.2 |
| Min | | [illegible] | 7.2 | | | | 0.370 | | | [illegible] | | [illegible] |
| **1990** | | | | | | | | | | | | |
| Mean | 2.0 | 2.3 | | 0.000 | | | 0.447 | | 0.000 | 0.027 | 0.001 | 14.7 |
| Max | 3.0 | 2.9 | | | | | 0.640 | | | 0.035 | | 22.1 |
| Min | 1.0 | 1.3 | | | | | 0.320 | | | 0.021 | | [illegible] |
| **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 | | 0.061 | | | 0.790 | | 0.009 | 0.062 | 0.022 | 41.2 |
| Max | 8.0 | 1.8 | | 0.290 | | | 1.140 | | 0.030 | 0.091 | 0.048 | 57.9 |
| Min | 3.0 | 0.9 | | | | | 0.490 | | | 0.044 | 0.010 | 14.0 |
| **1993** | | | | | | | | | | | | |
| Mean | 3.2 | 1.9 | | 0.023 | | | 0.591 | | 0.076 | 0.152 | 0.019 | 18.7 |
| Max | 13.0 | 3.0 | | 0.255 | | | 2.590 | | 1.300 | 0.530 | 0.200 | 125.5 |
| Min | 1.0 | 0.7 | | | | | | | | 0.026 | 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 NH3N | 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 | 0.035 | | 0.319 | | 0.042 | 0.009 | 12.0 |
| Max | 5.0 | 3.7 | 7.5 | 0.150 | | 0.060 | | 0.750 | | 0.091 | 0.025 | 35.9 |
| Min | | 0.9 | 6.5 | | | 0.010 | | 0.170 | | 0.009 | 0.001 | 0.7 |
| **1980** | | | | | | | | | | | | |
| Mean | 1.5 | 2.7 | 7.3 | [illegible] | 0.000 | 0.042 | | 0.325 | | 0.035 | 0.010 | 6.2 |
| Max | 2.0 | 3.8 | 7.7 | 0.060 | | 0.040 | | 0.540 | | 0.065 | 0.023 | 11.9 |
| Min | 1.0 | 1.7 | 7.1 | | | 0.030 | | 0.140 | | [illegible] | [illegible] | 1.5 |
| **1981** | | | | | | | | | | | | |
| Mean | | 3.0 | | | | | 0.224 | | 0.008 | 0.027 | 0.022 | 3.2 |
| Max | | 4.7 | | | | | 0.290 | | 0.220 | 0.062 | 0.004 | 13.2 |
| Min | | | | | | | 0.180 | | | 0.005 | | 1.0 |
| **1982** | | | | | | | | | | | | |
| Mean | | 3.3 | | 0.013 | | | | 0.210 | 0.025 | 0.004 | [illegible] | 5.3 |
| Max | | 5.3 | | 0.020 | | | | 0.231 | 0.100 | 0.013 | [illegible] | 1.5 |
| Min | | 2.3 | | 0.010 | | | | 0.100 | | 0.007 | [illegible] | 1.3 |
| **1983** | | | | | | | | | | | | |
| Mean | | 2.8 | 6.9 | 0.005 | | | 0.305 | | 0.003 | 0.022 | 0.001 | 4.3 |
| Max | | 4.3 | 7.0 | 0.023 | | | 0.330 | | 0.010 | 0.029 | 0.002 | 10.3 |
| 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

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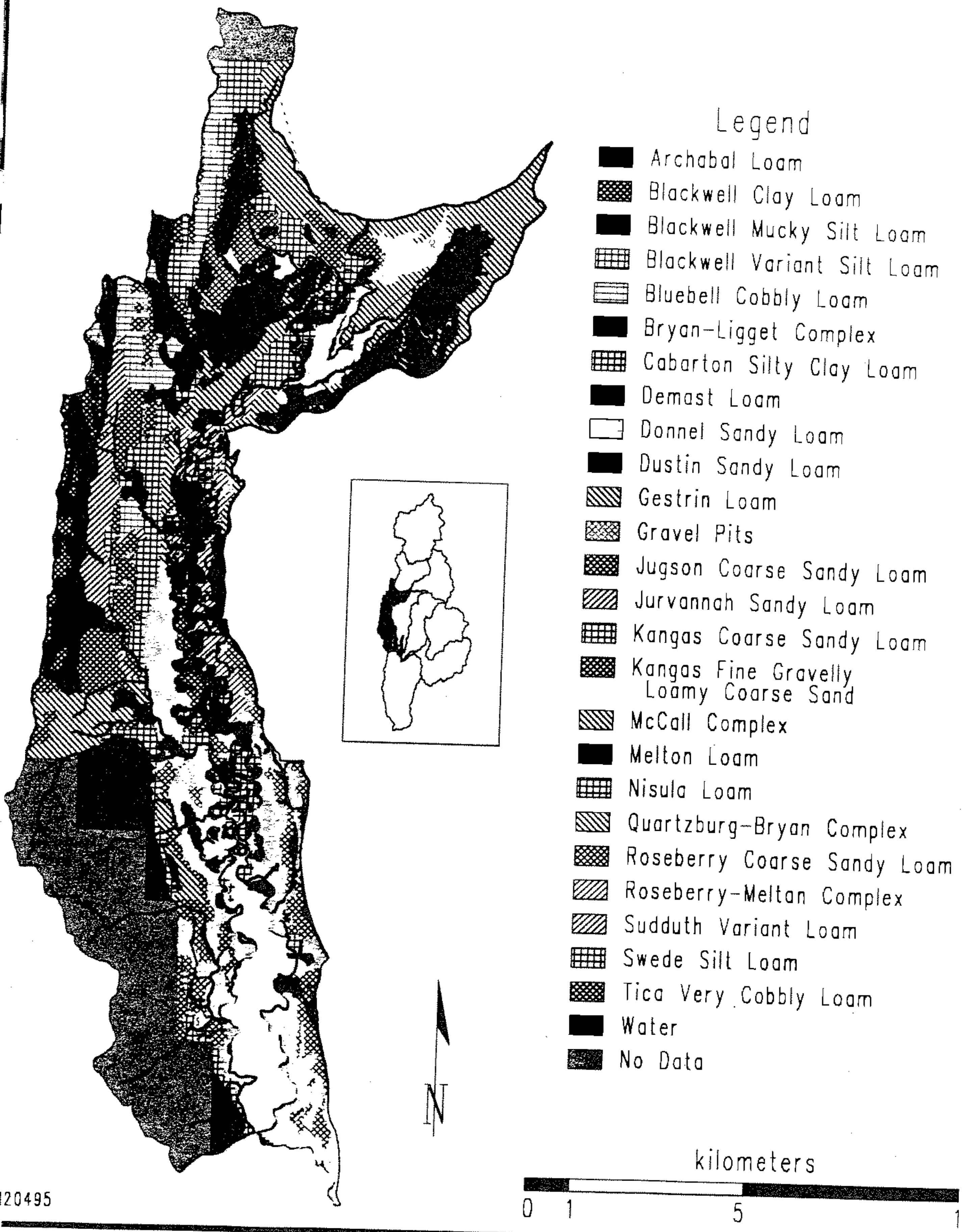
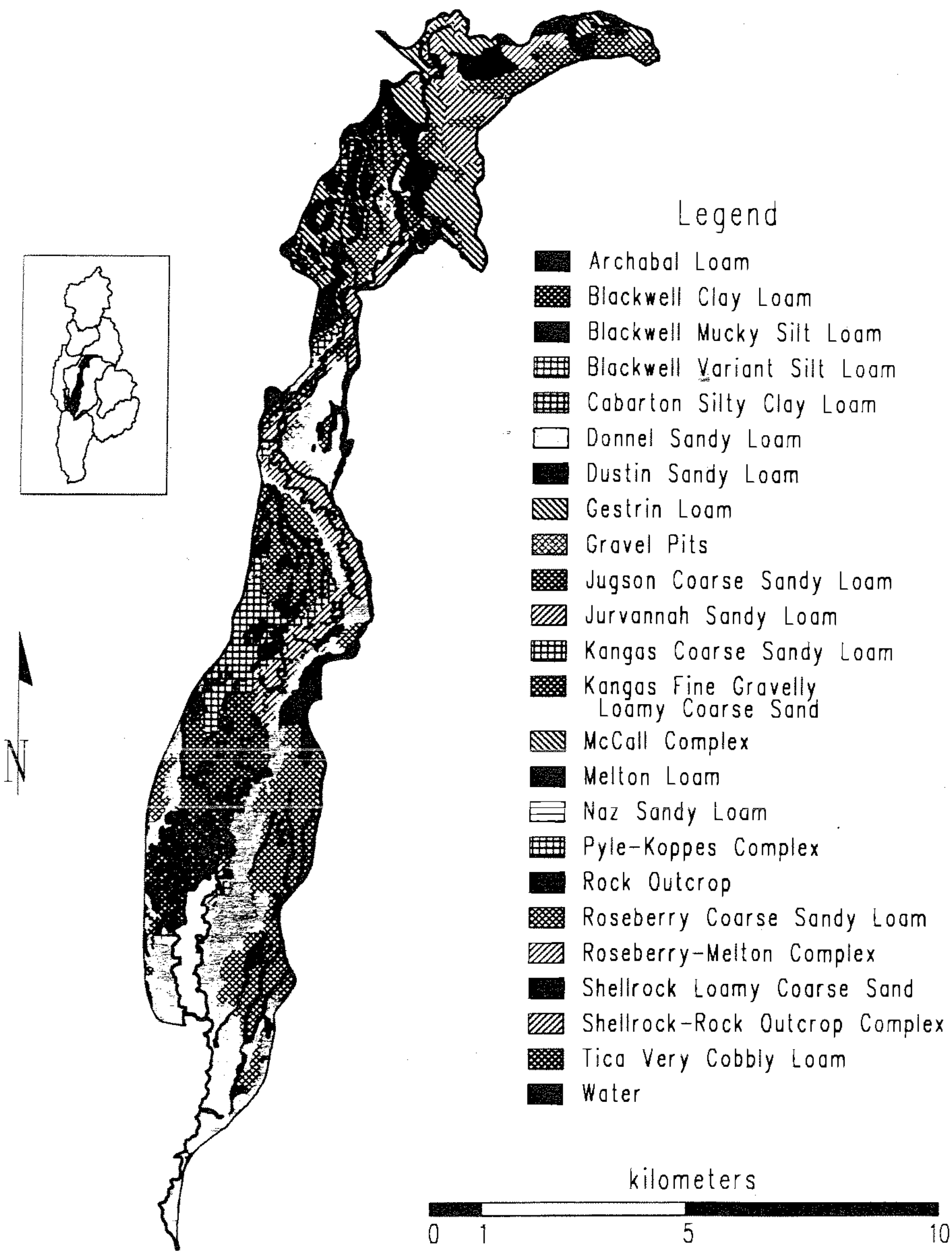
# NORTH FORK PAYETTE WATERSHED
## Soils and Hydrography



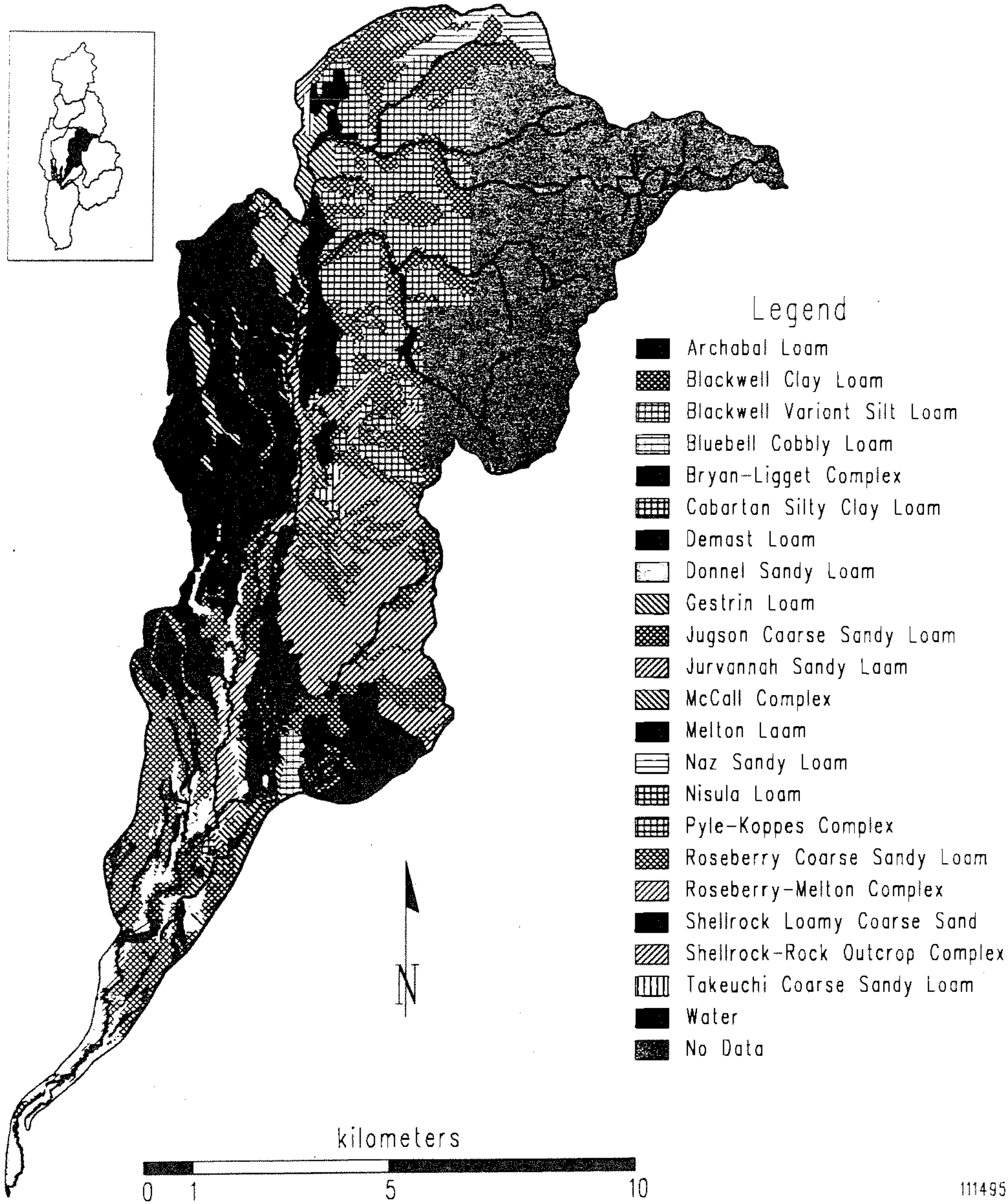

120495

# LAKE FORK CREEK WATERSHED
## Soils and Hydrography



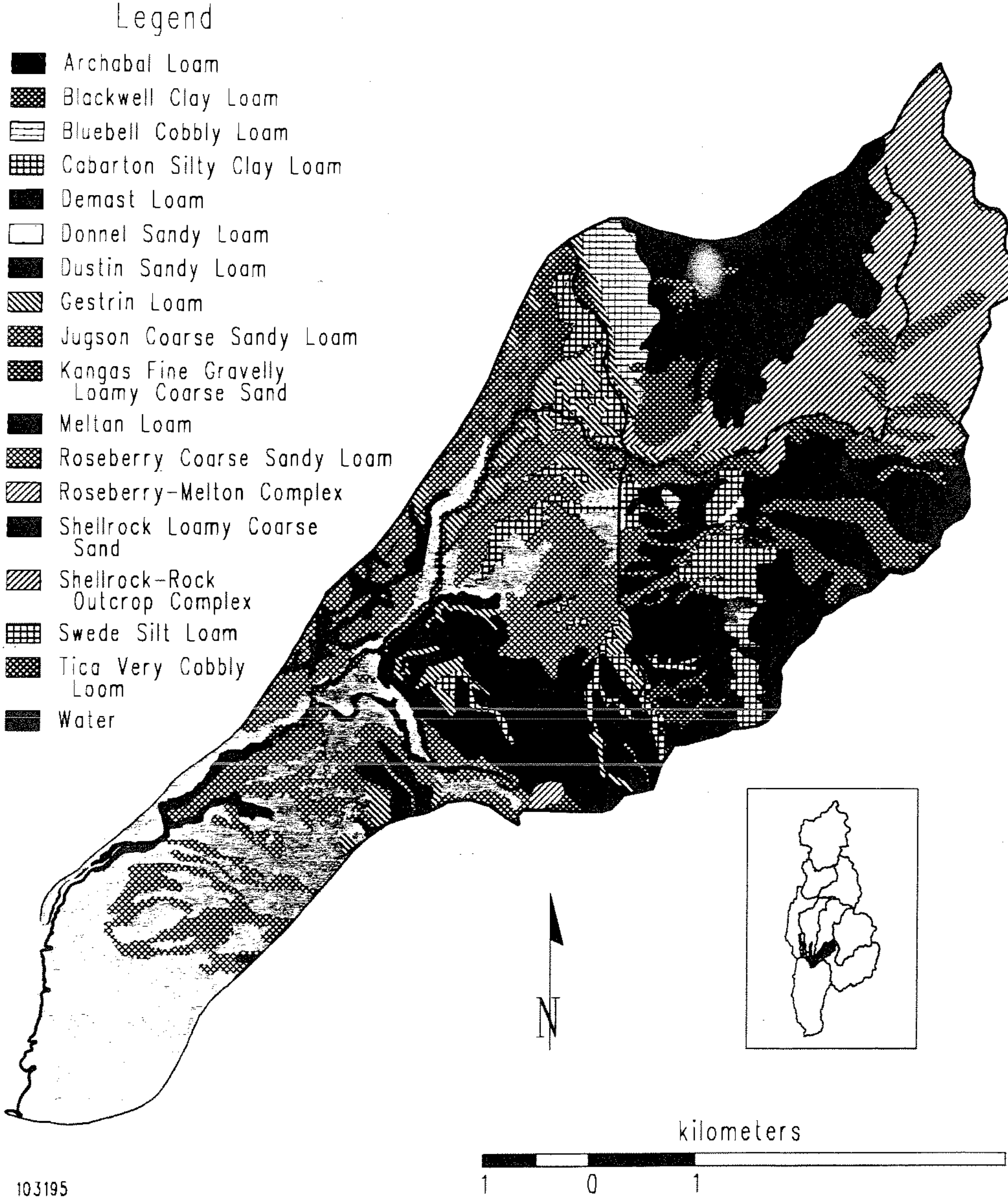

103195

# BOULDER CREEK WATERSHED
## Soils and Hydrography



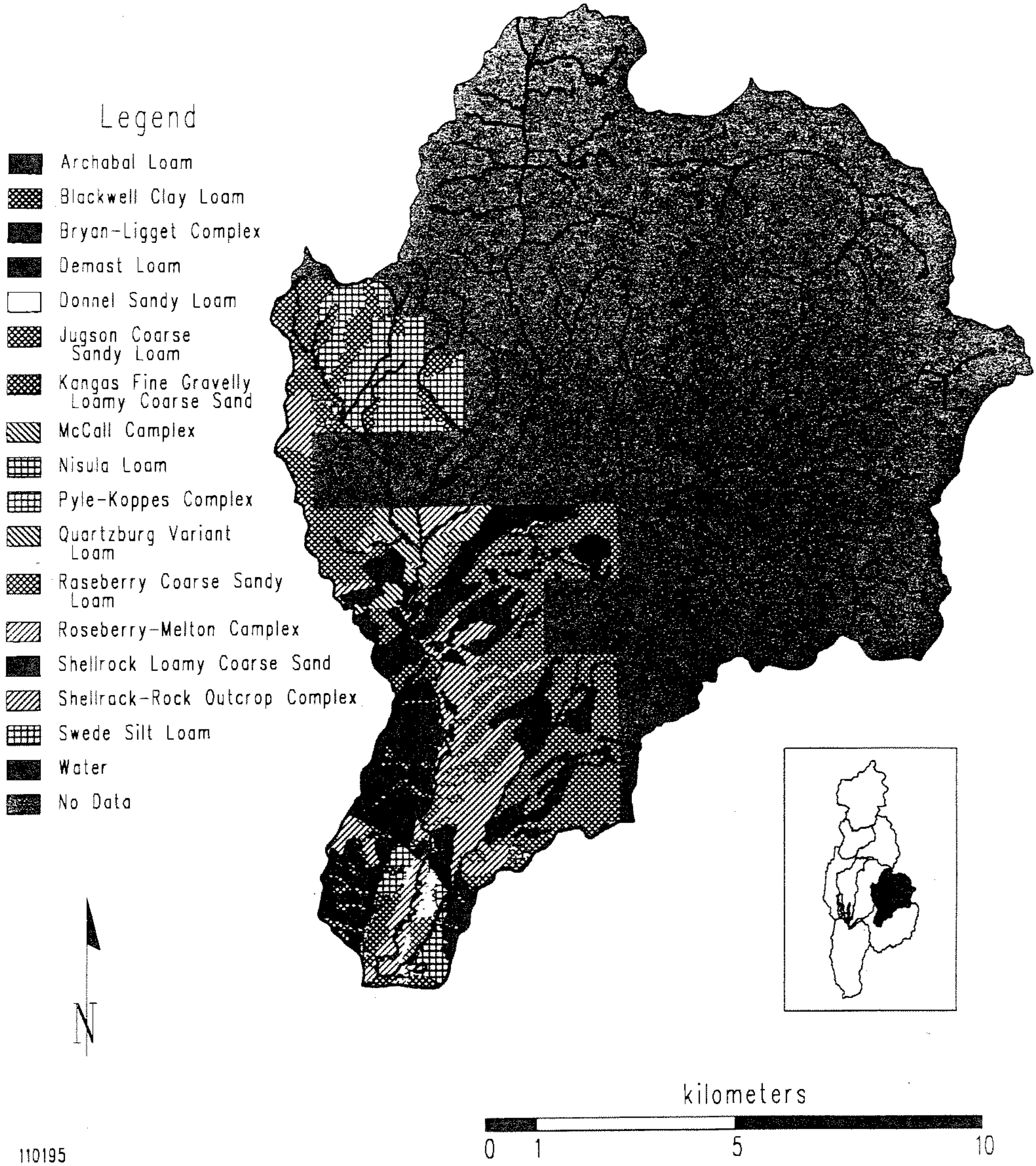

111495

# WILLOW CREEK WATERSHED
## Soils and Hydrography



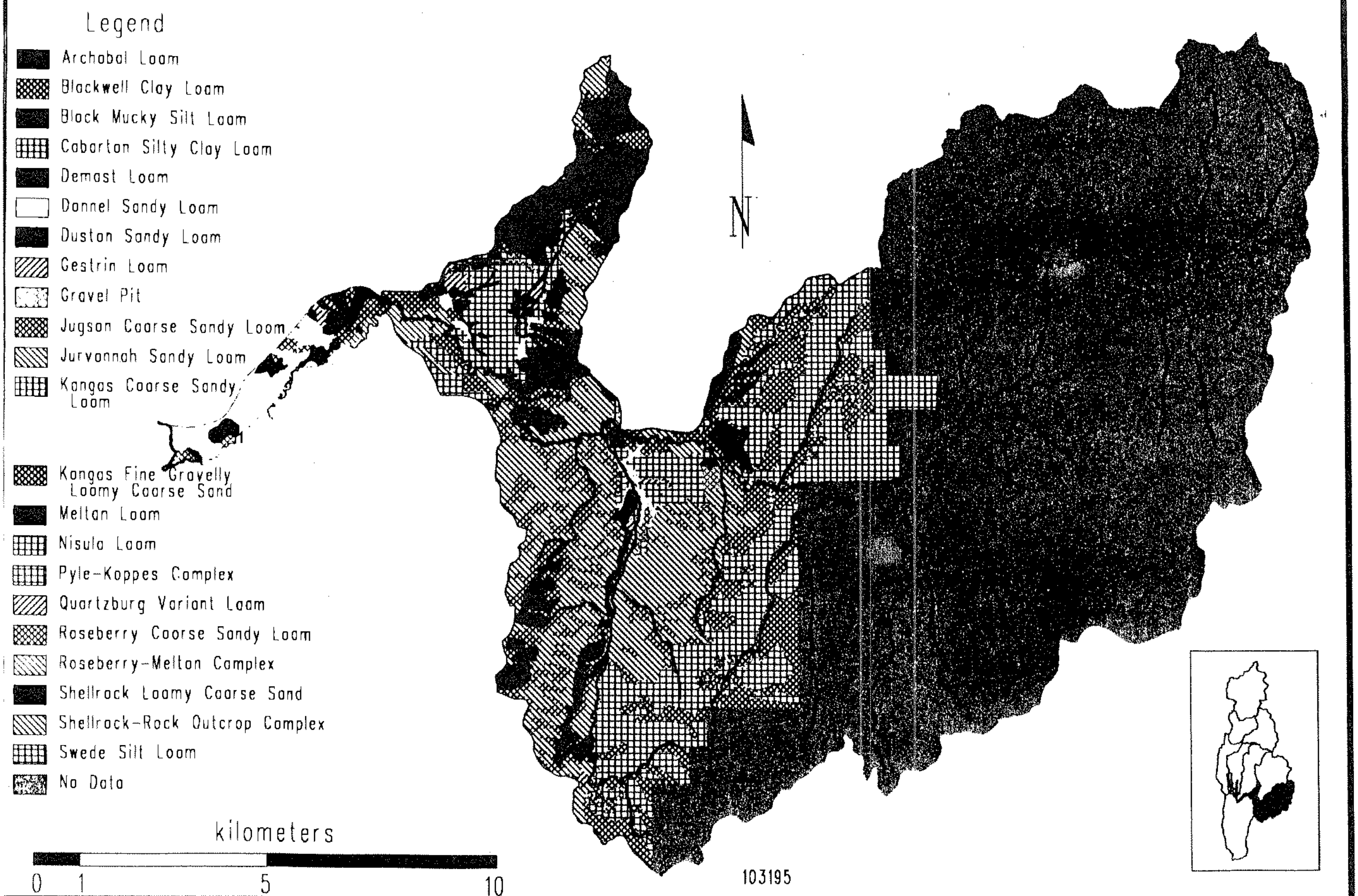

103195

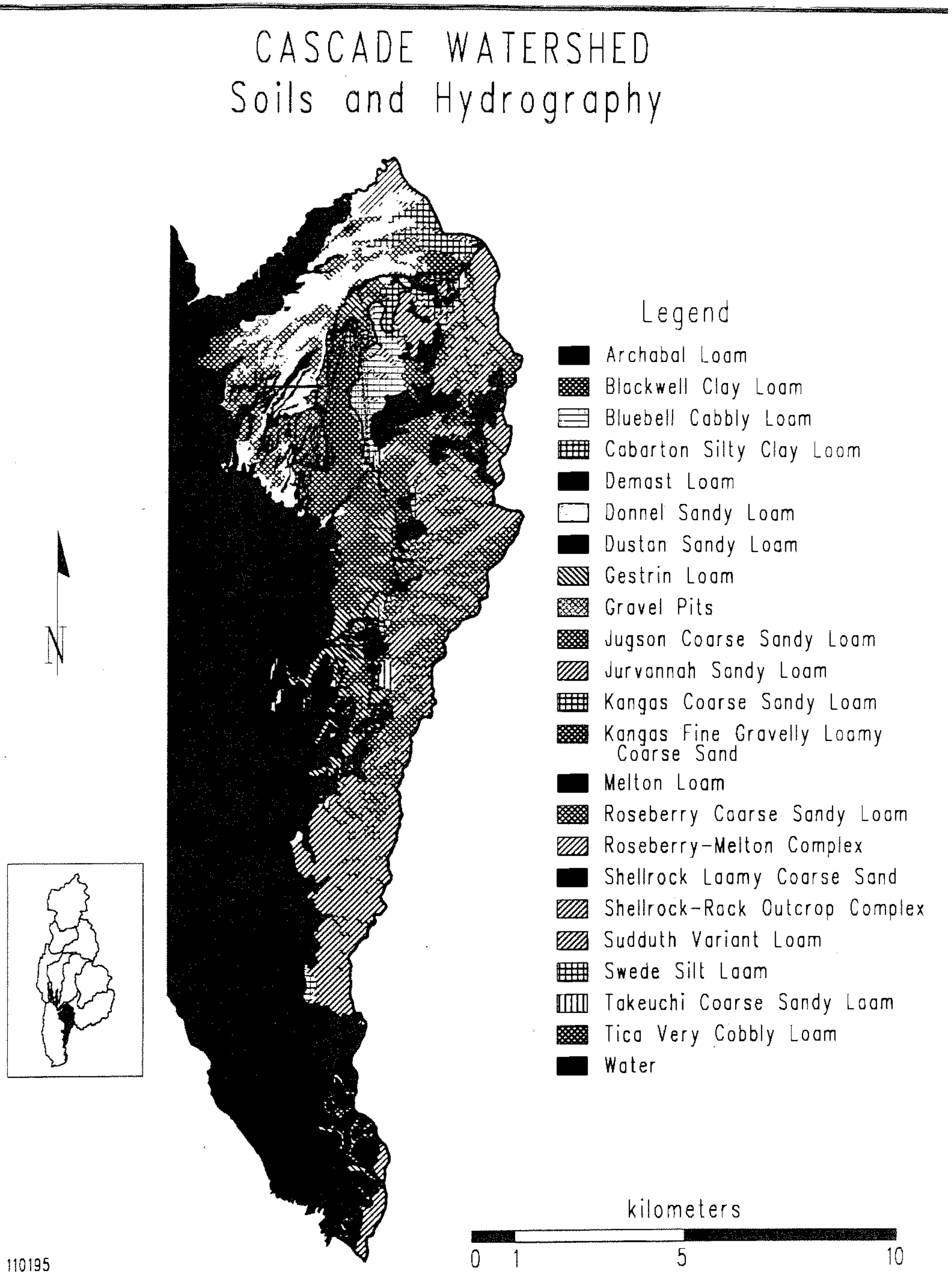
# KENNALLY CREEK WATERSHED
## Soils and Hydrography



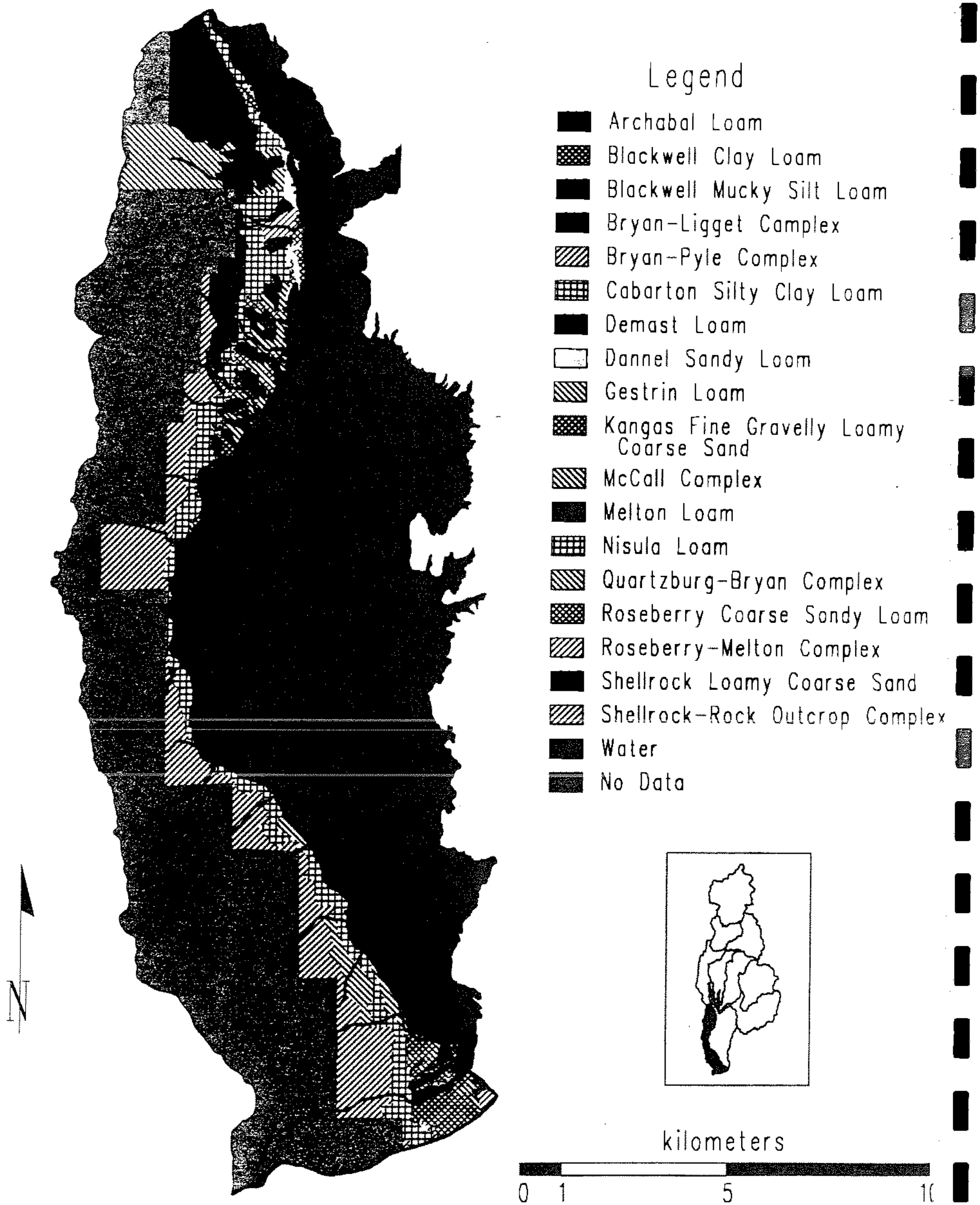

110195

# GOLD FORK CREEK WATERSHED
## Soils and Hydrography



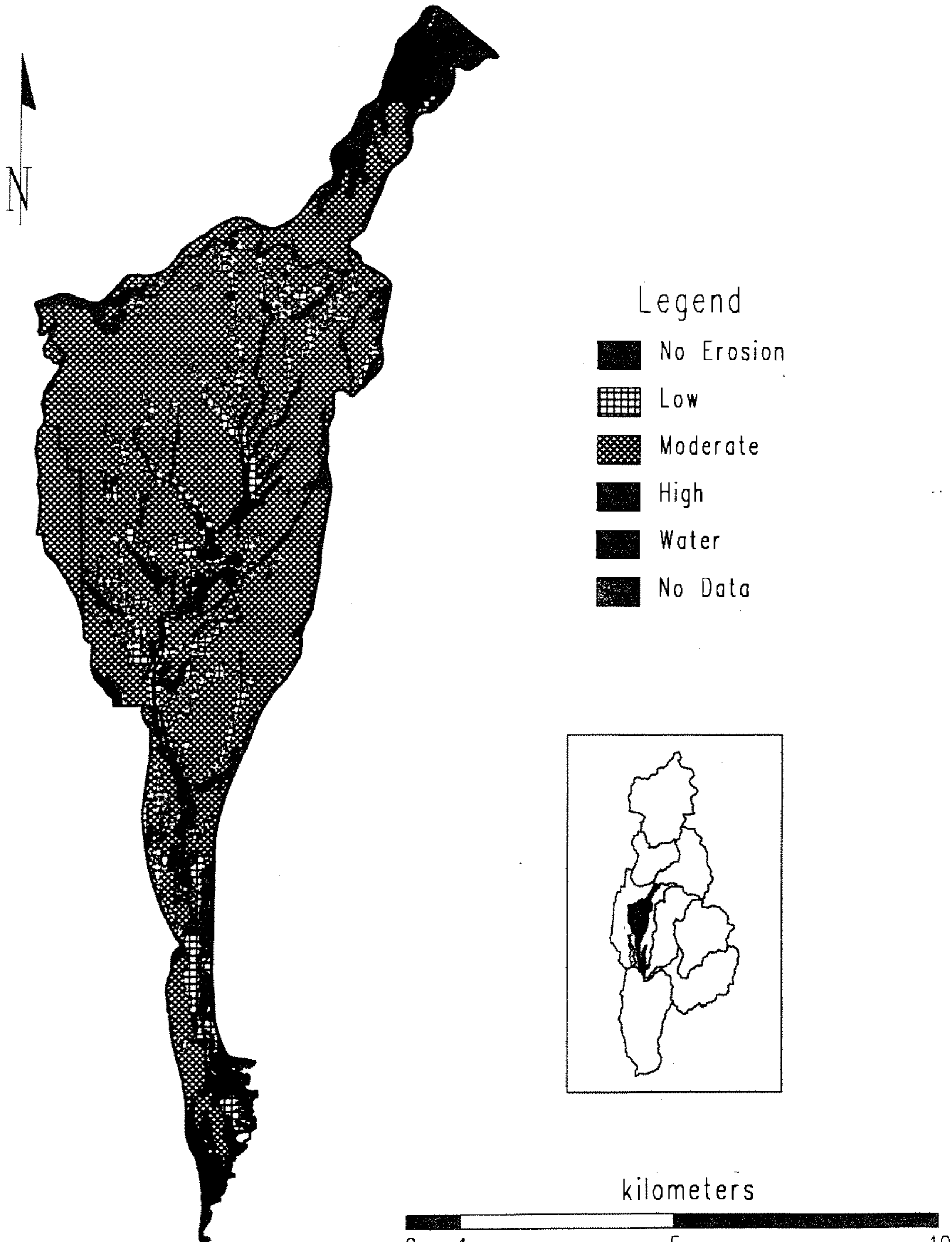

CASCADE WATERSHED
Soils and Hydrography
Legend
Archabal Loam
Blackwell Clay Loam
Bluebell Cobbly Loam
Cabarton Silty Clay Loam
Demast Loam
Donnel Sandy Loam
Dustan Sandy Loam
Gestrin Loam
Gravel Pits
Jugson Coarse Sandy Loam
Jurvannah Sandy Loam
Kangas Coarse Sandy Loam
Kangas Fine Gravelly Loamy Coarse Sand
Melton Loam
Roseberry Coarse Sandy Loam
Roseberry-Melton Complex
Shellrock Loamy Coarse Sand
Shellrock-Rock Outcrop Complex
Sudduth Variant Loam
Swede Silt Loam
Takeuchi Coarse Sandy Loam
Tica Very Cobbly Loam
Water
N
kilometers
0
1
5
10
110195

# WEST MOUNTAIN SUBWATERSHED
## Soils and Hydrography



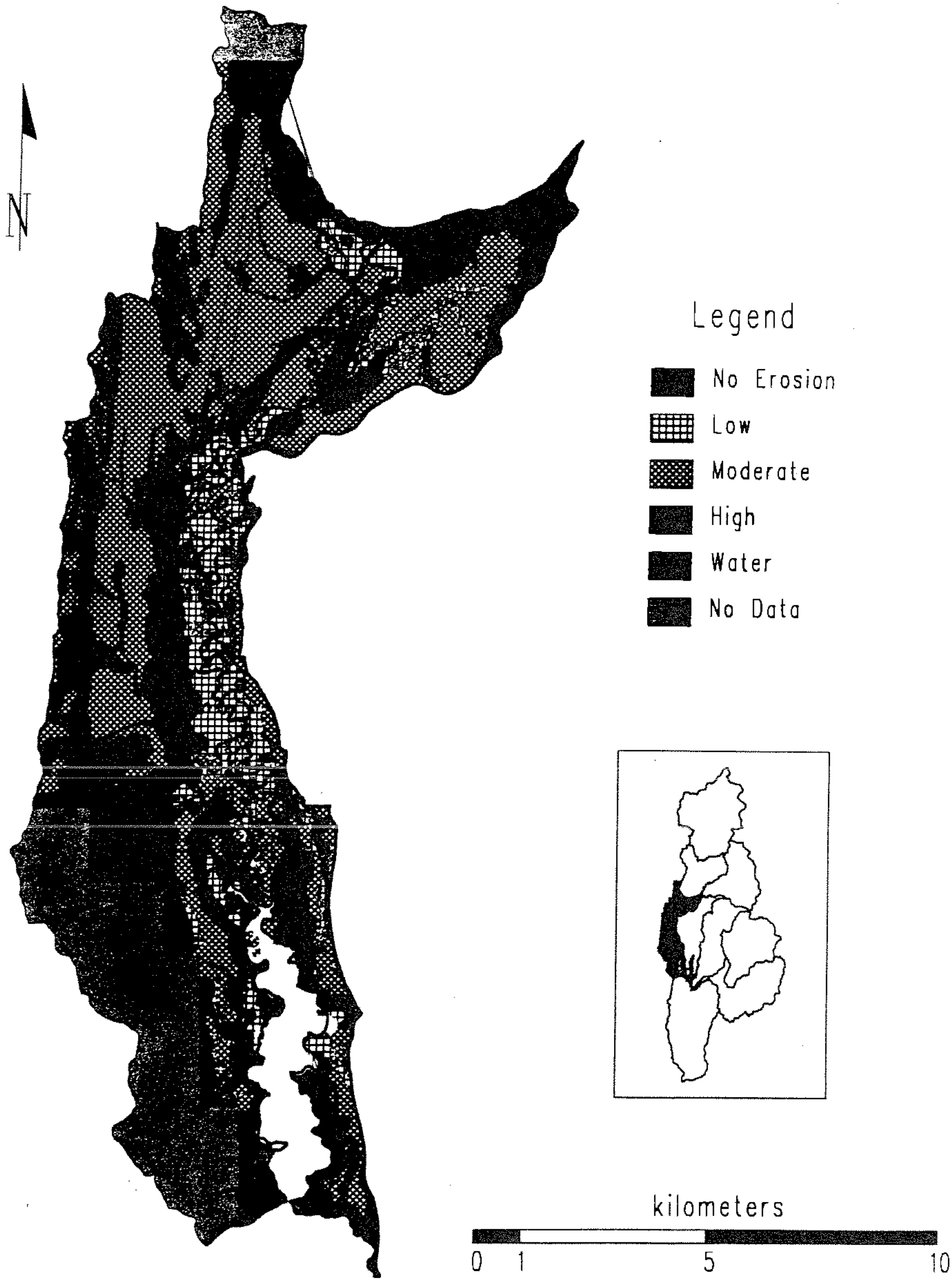

110195

# MUD CREEK SUBWATERSHED
## Soils Erosion Sensitivity with Hydrography



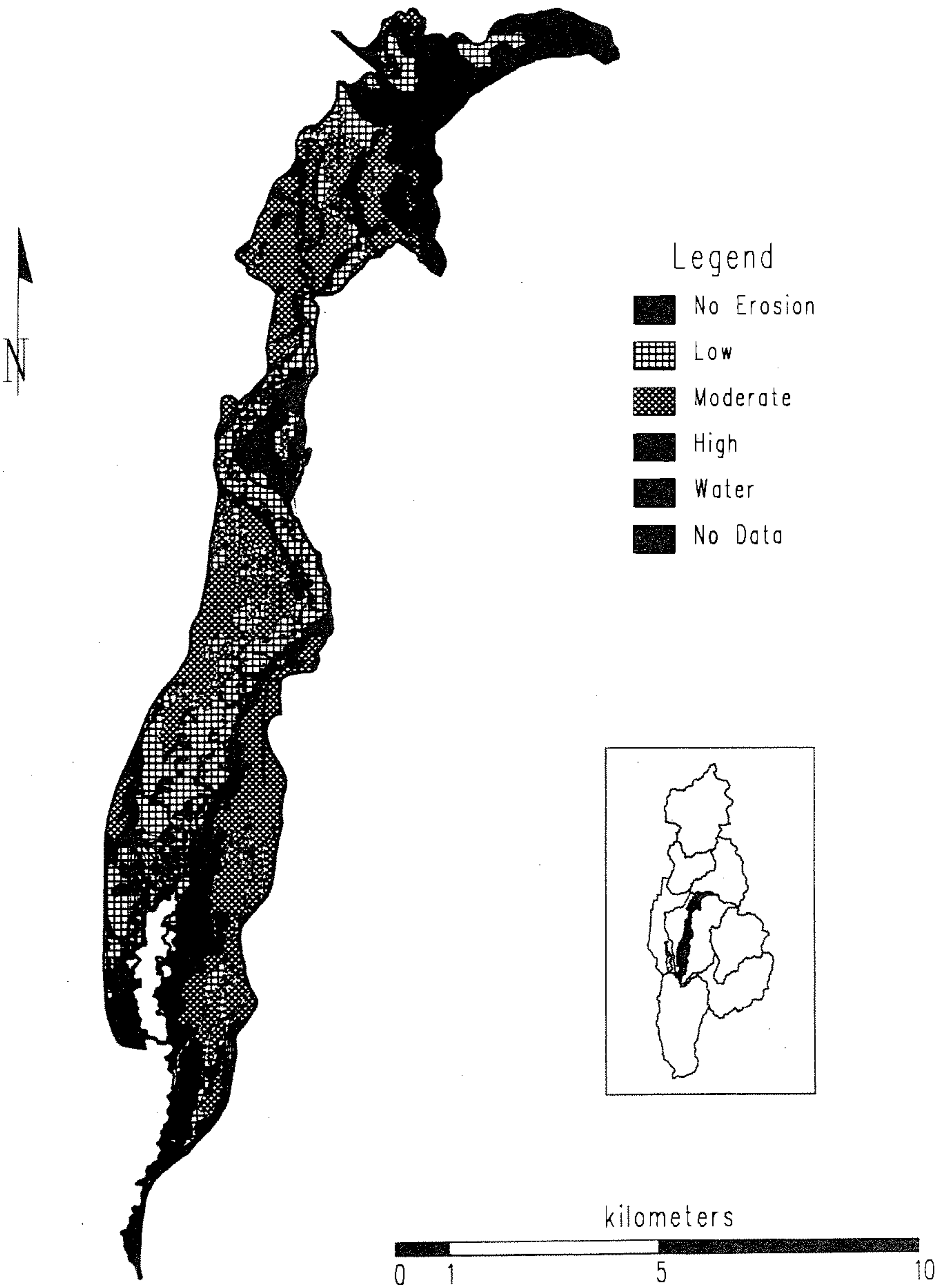

120495

# NORTH FORK PAYETTE WATERSHED
## Soils Erosion Sensitivity with Hydrography



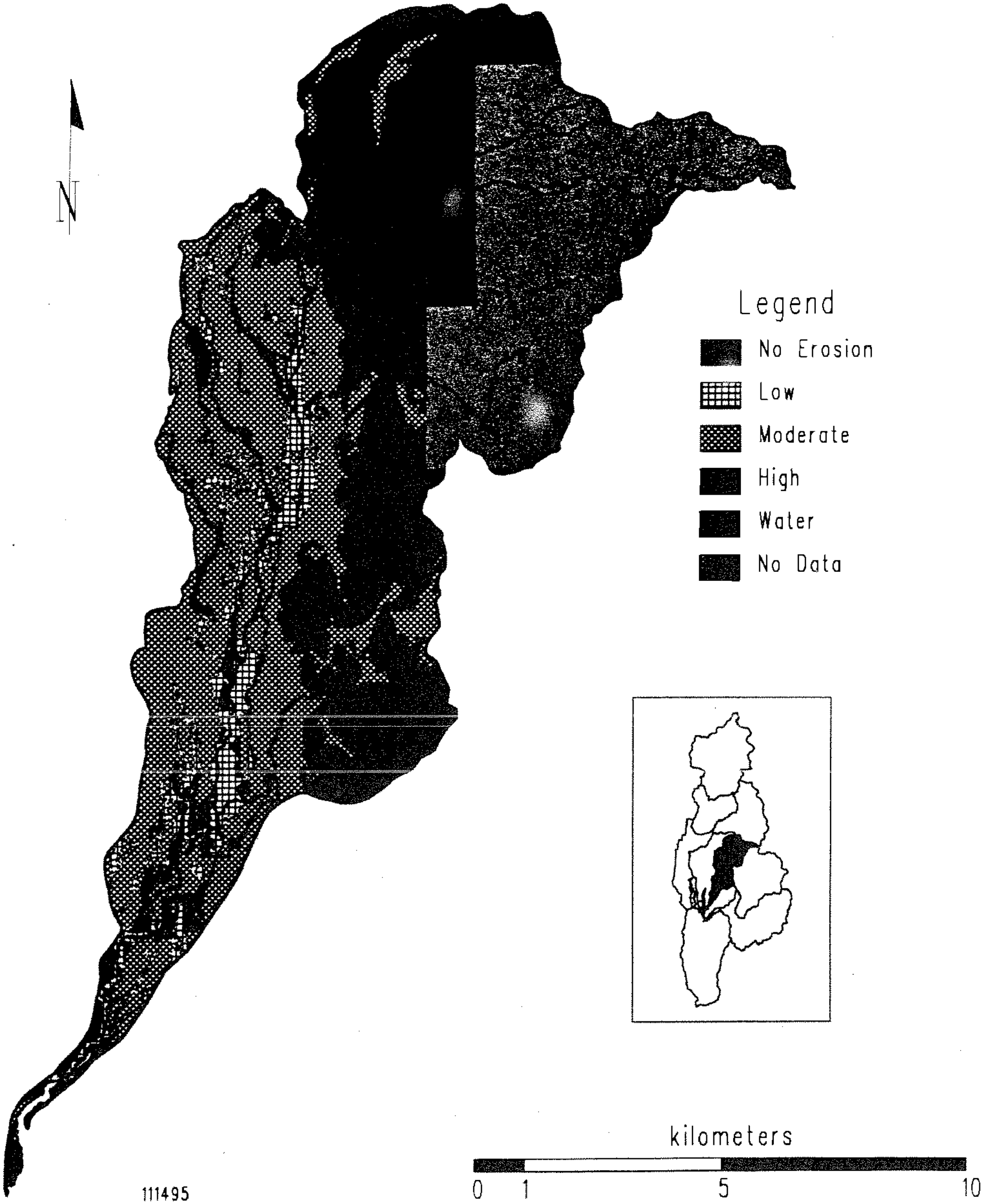

120495

# LAKE FORK CREEK SUBWATERSHED
## Soils Erosion Sensitivity with Hydrography

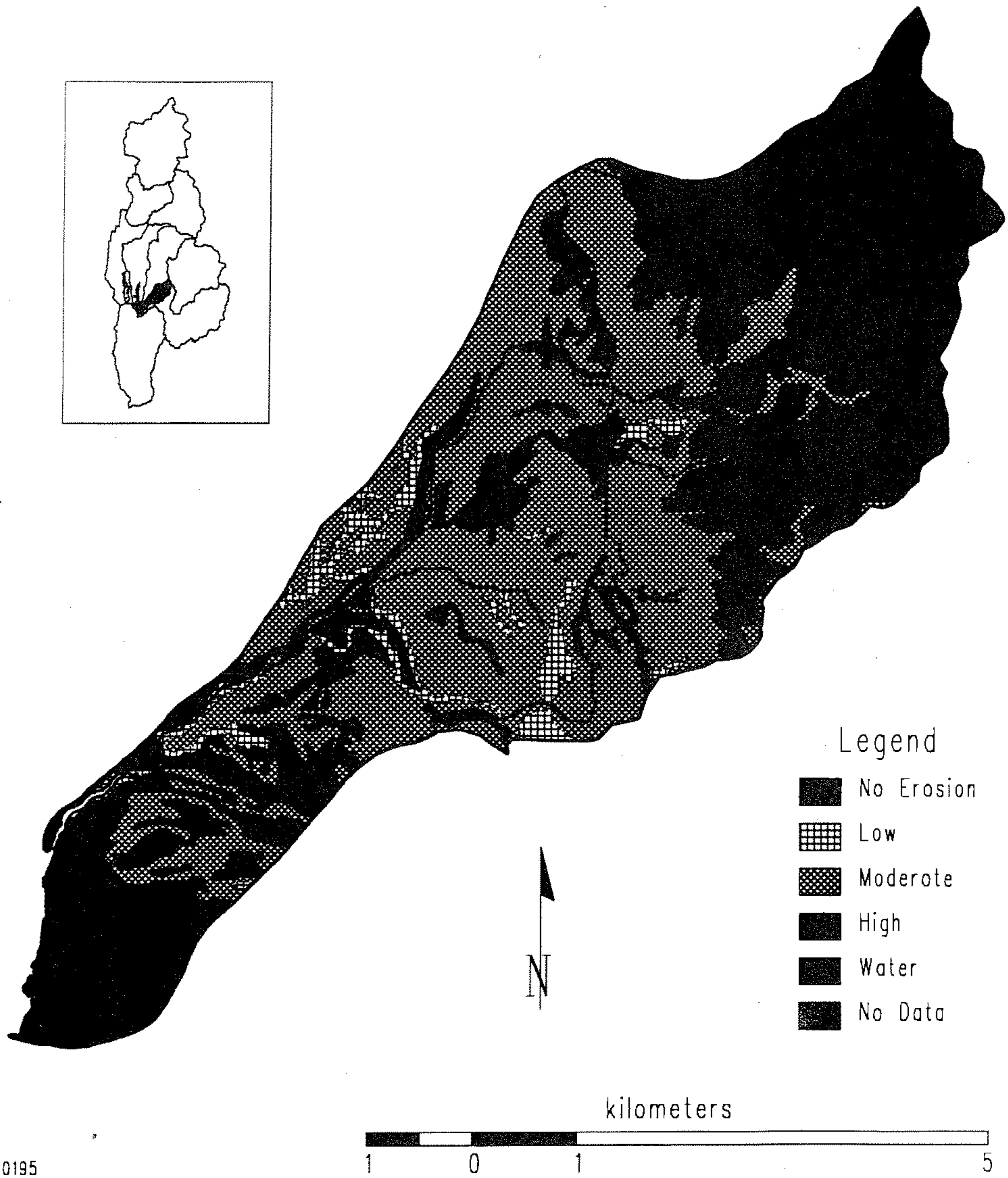



110195

# BOULDER CREEK WATERSHED
## Soils Erosion Sensitivity with Hydrography

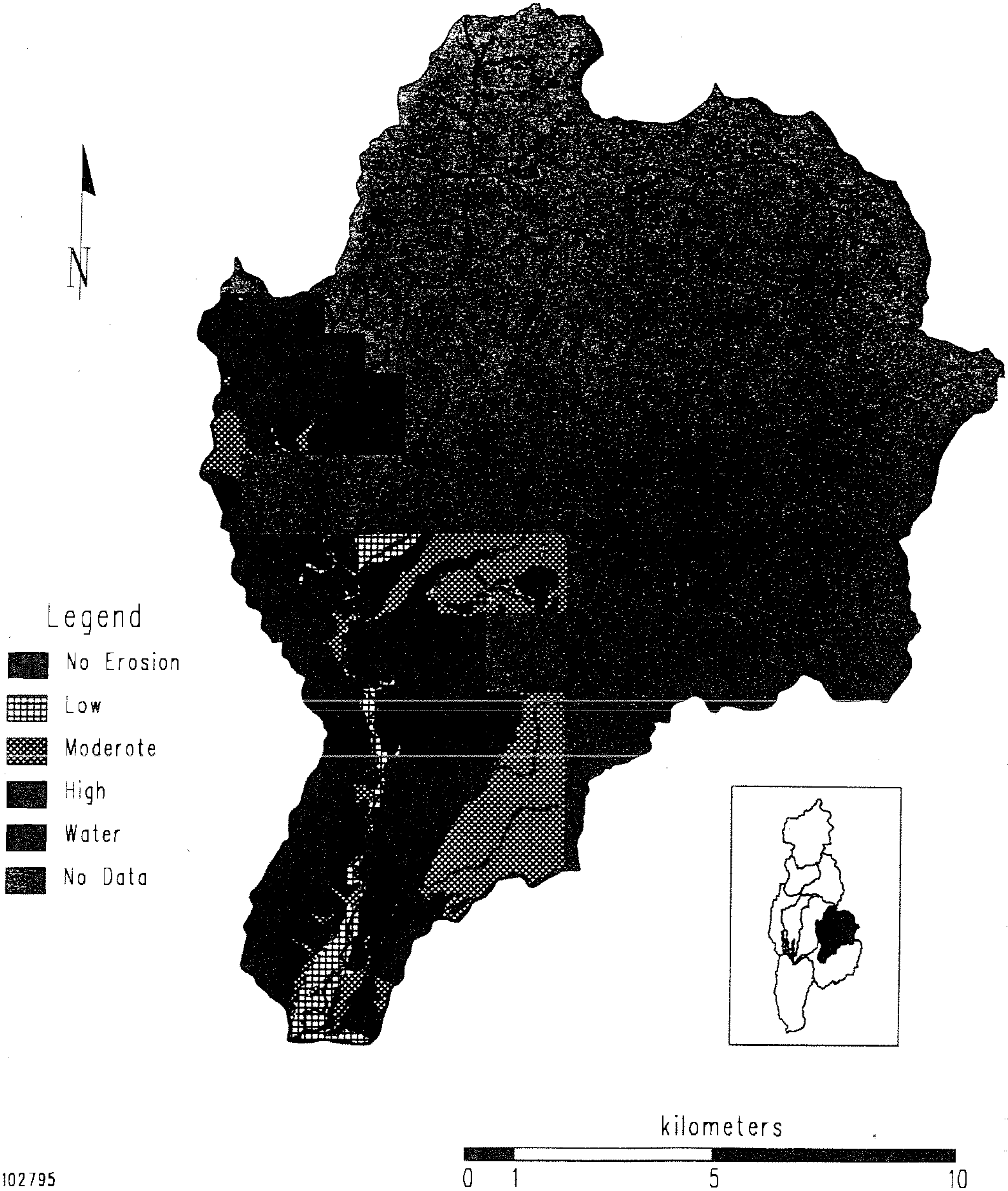


# WILLOW CREEK SUBWATERSHED
## Soils Erosion Sensitivity with Hydrography



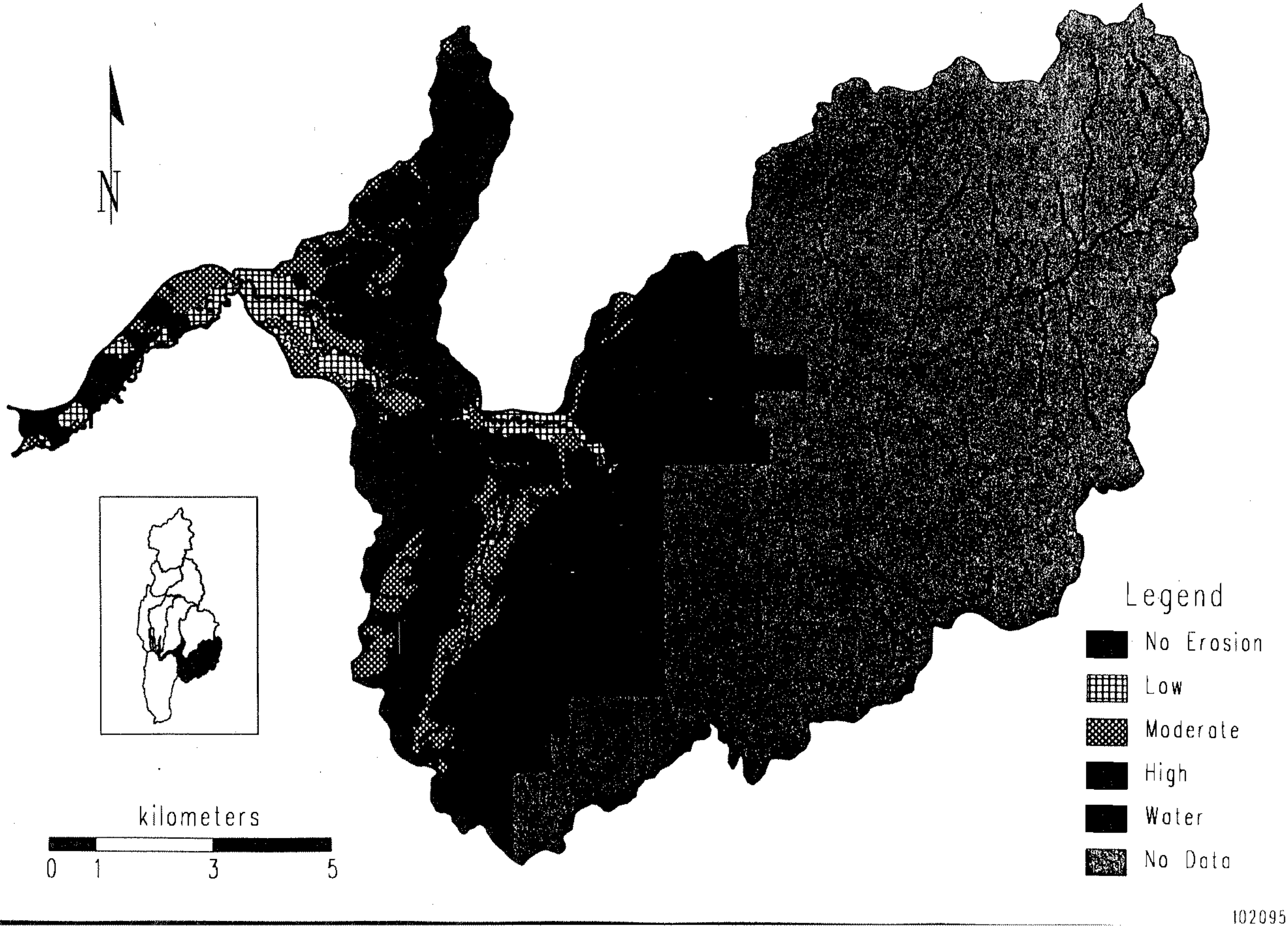

110195

# KENNALLY CREEK WATERSHED
## Soils Erosion Sensitivity with Hydrography

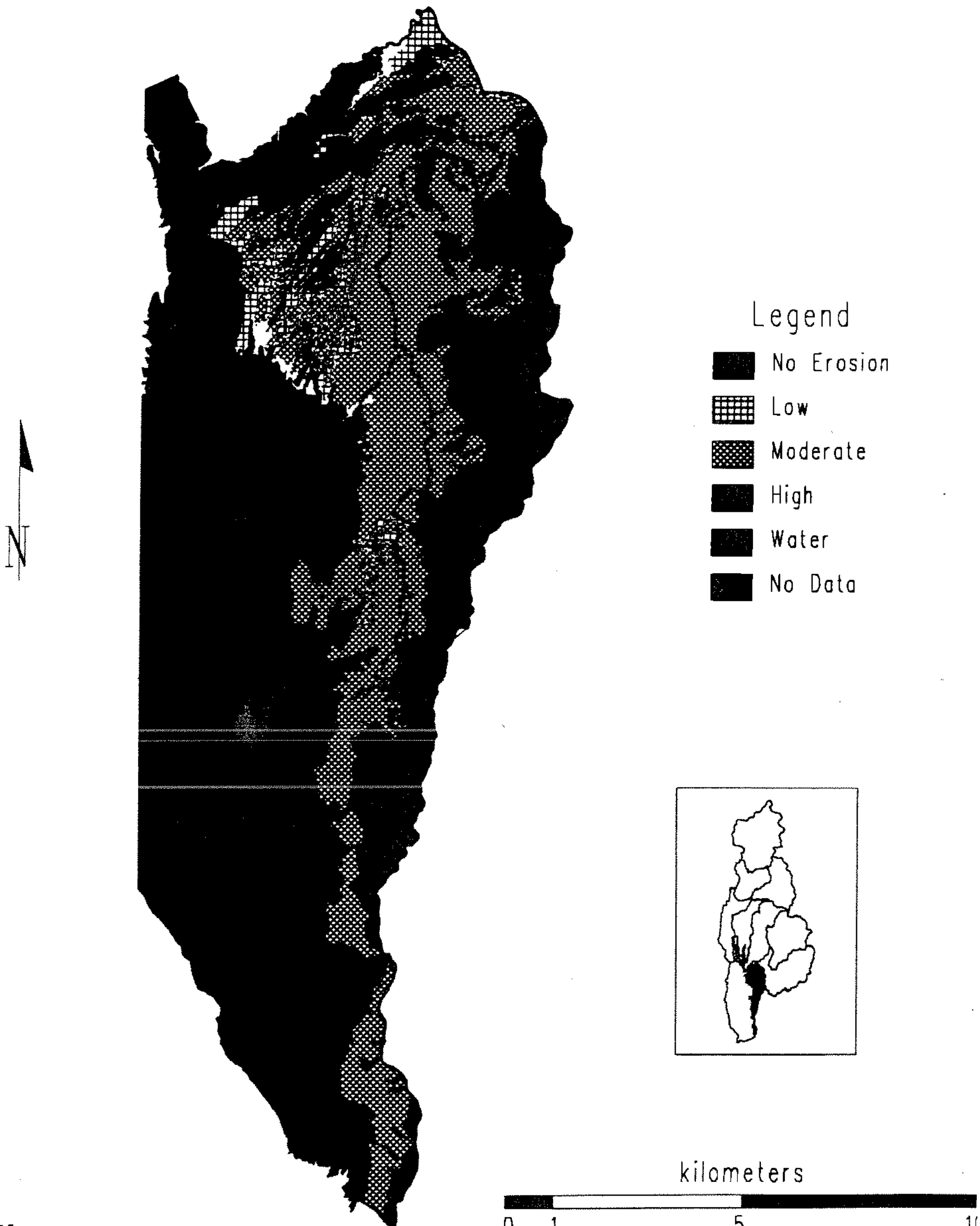



102795

# GOLD FORK CREEK WATERSHED
## Soils Erosion Sensitivity with Hydrography

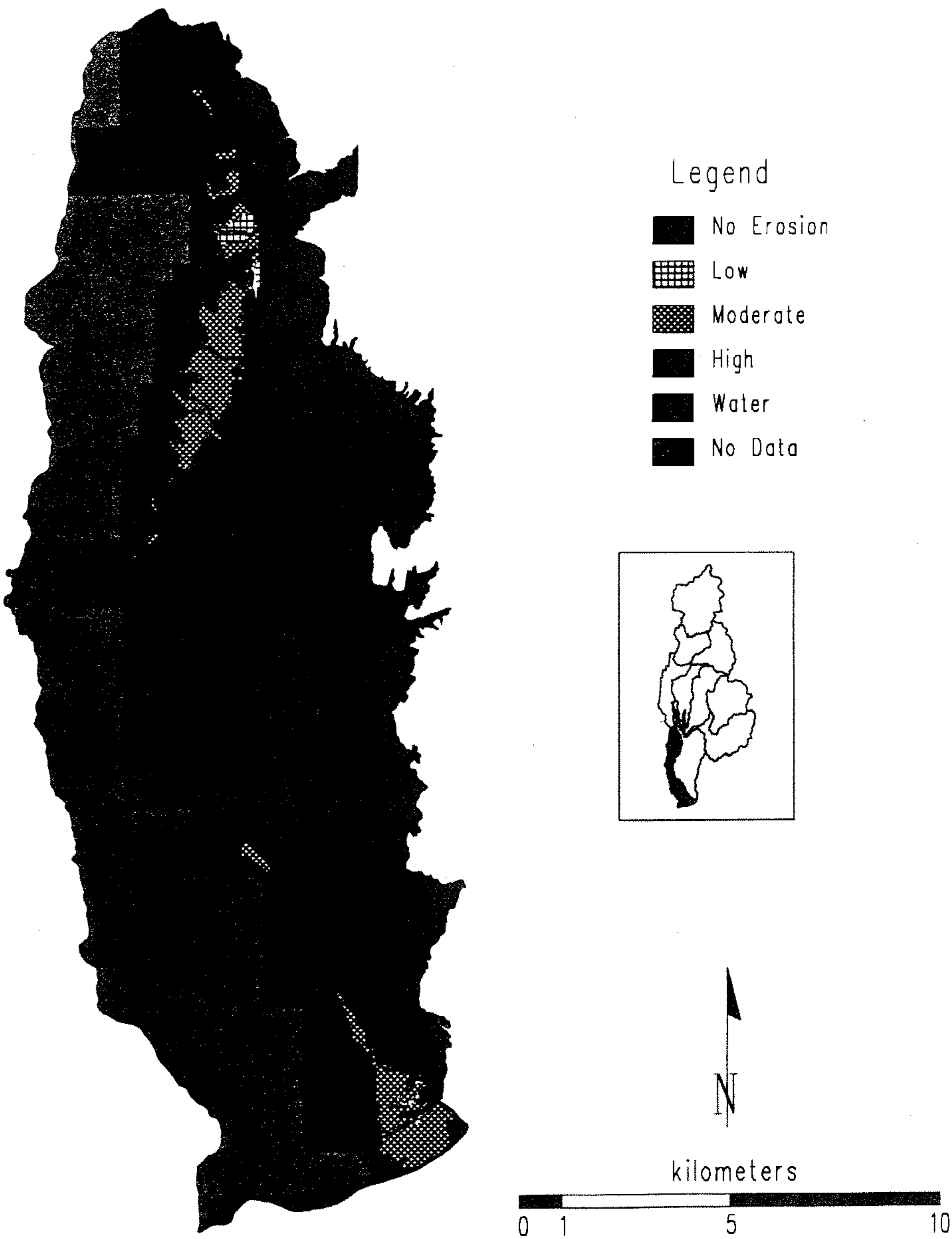


# CASCADE SUBWATERSHED
## Soils Erosion Sensitivity with Hydrography




102795

# WEST MOUNTAIN SUBWATERSHED
## Soils Erosion Sensitivity with Hydrography




102795

WATER BUDGET FOR CASCADE RESERVOIR: WY 1993

FLOW ACFT

Estimated values based on BOR Inflow Data

| DATE | Int, # days | Cumulative Inflows (acft) BC1 | QF1 | LF | NC | NFPB | 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 | 3208 | 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 | 71 | 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 | 5,634 | 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 | NC | NFPB | 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 DC1 | GF1 | LF | MC | NFPR | PC | MC | Net. 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 | 103 | 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 | 5,554 | 12,200 | 6,759 | 1,101 | 22,733 | 306 | 1,257 | 3,021 | 52,639 |
| Measured<br>April 1 - Sept 30 | 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 | | | | | | | | | | 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] | [illegible] | PCI [illegible] | [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 | 14,760 |
| 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 | 7,536 | 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 | 636 | 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 | 15,135 | 82 | 40 | 790 | 23,158 |
| 10-May-94 | 5 | 148 | 5,638 | 3,138 | 33 | 11,225 | 124 | 4 | 1,198 | 21,383 |
| 23-May-94 | 13 | 487 | 8,200 | 3,404 | 88 | 21,092 | 126 | 59 | 1,219 | 34,547 |
| 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] | [illegible] | WEST SIDE | TOTAL |
| Total | 364 | 8,006 | 66,095 | ******* | 4,730 | 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 INFLOW LOAD IN KG | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DATE | [illegible] | [illegible] NGI | [illegible] GFI | [illegible] LKI | [illegible] MGI | [illegible] NFPR | [illegible] PCI | [illegible] 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 | 44 | 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 | 362 | 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 |
| | Days | NGI | GFI | LKI | MGI | NFPR | PCI | WCI | WEST SIDE | TOTAL |
| 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 | |

* PC1 not included in total - West Side Included.

# APPENDIX D

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

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## 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**<br><br>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**<br><br>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**<br><br>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**<br><br>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.

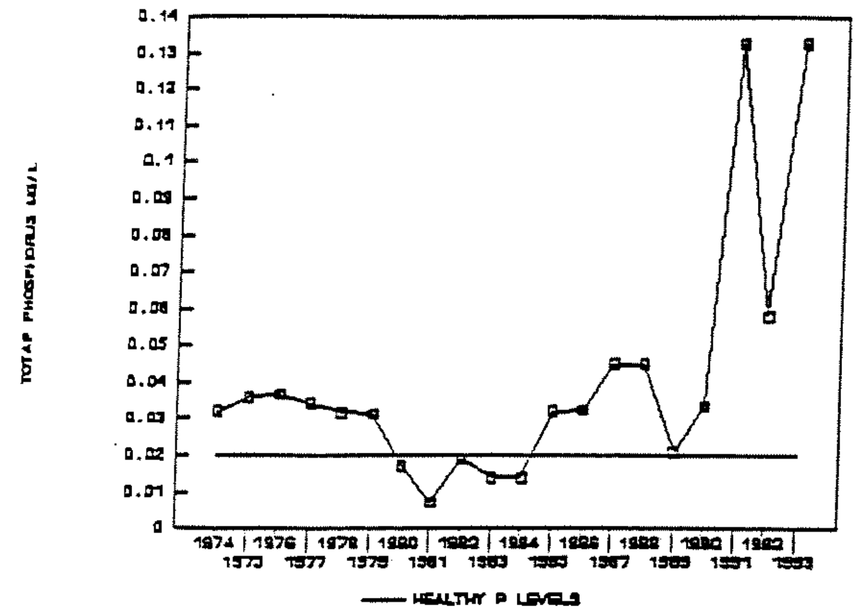
Long term monitoring indicates phosphorus concentrations within the reservoir have increased during the past decade (1984 -1994) with a corresponding increase in algal production (Figure 1). Although the phosphorus loading to the reservoir varies greatly depending on the annual rainfall and snowfall 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).

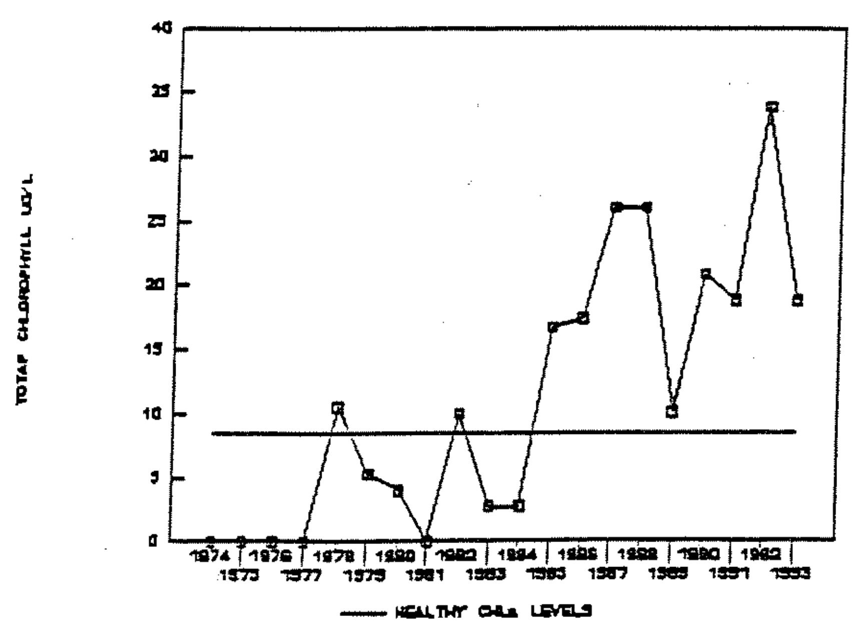
Soluble forms of phosphorus (SP) are more readily available for algal uptake and have a potential to stimulate growth (Bostrum, Pearson and Broberg, 1988). Particulate forms of phosphorus (PP), P bound to organic particles and sediments, generally comprise the largest source of P enrichment. Although 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

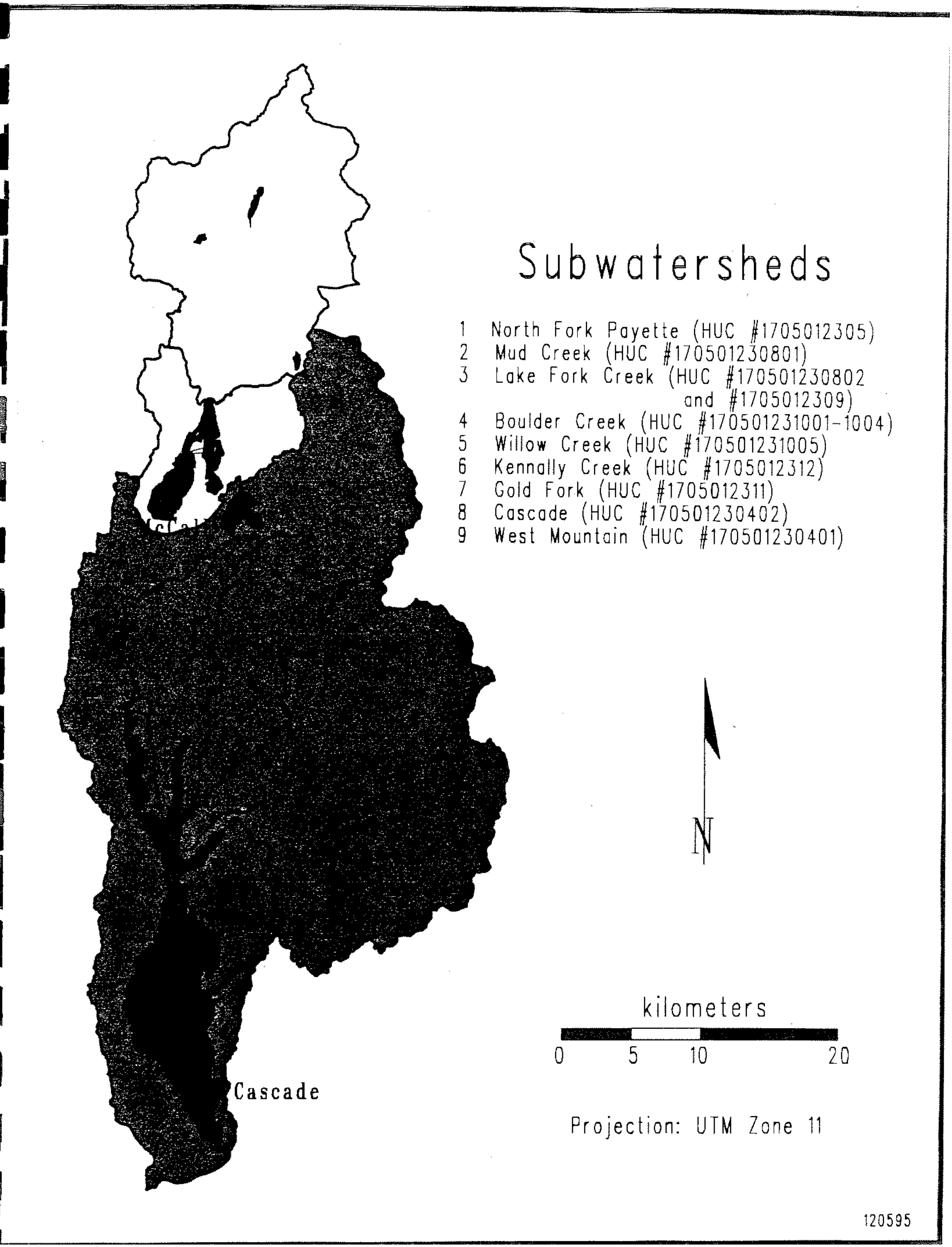
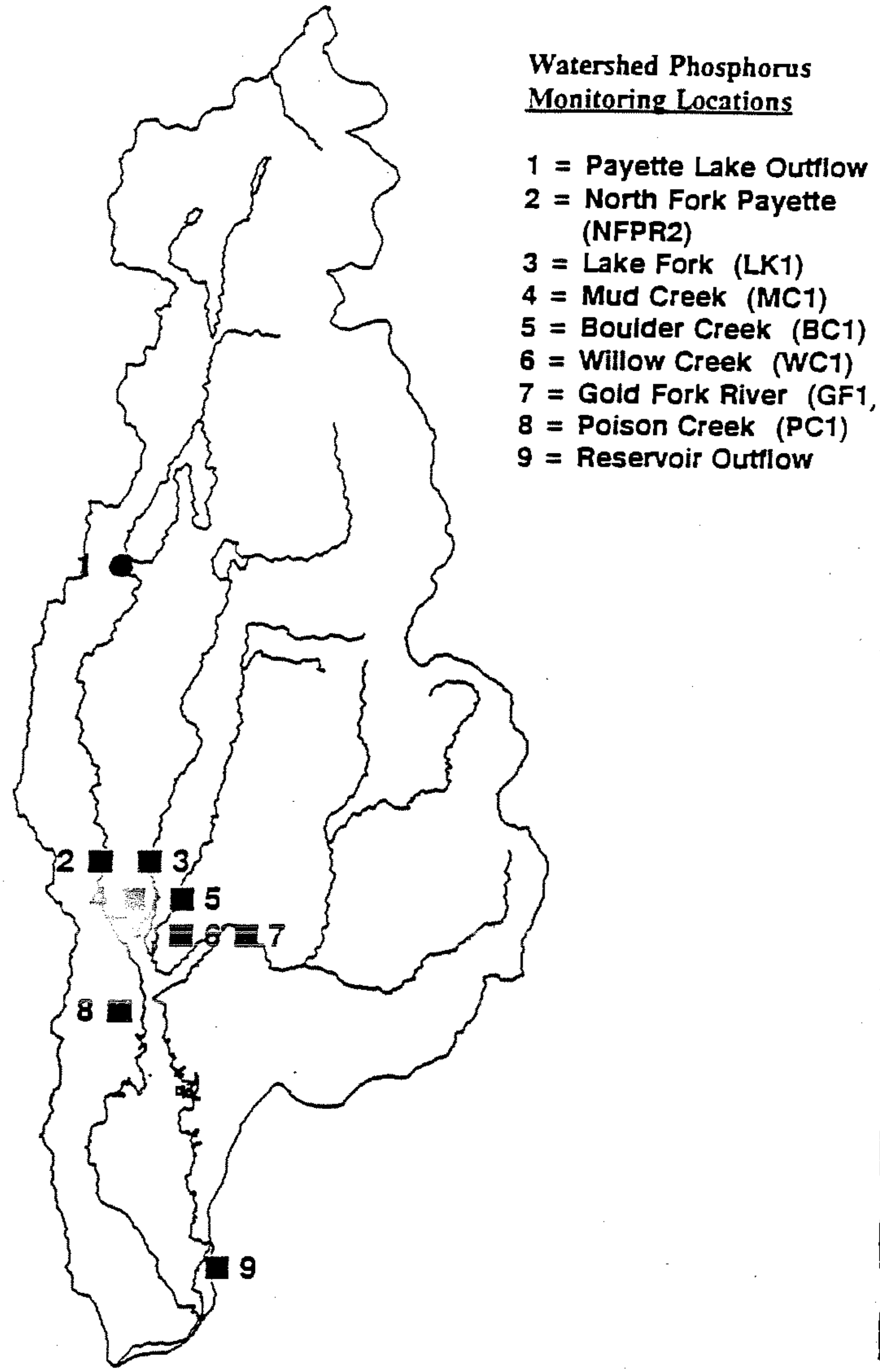

Subwatersheds
1 North Fork Payette (HUC #1705012305)
2 Mud Creek (HUC #170501230801)
3 Lake Fork Creek (HUC #170501230802 and #1705012309)
4 Boulder Creek (HUC #170501231001-1004)
5 Willow Creek (HUC #170501231005)
6 Kennally Creek (HUC #1705012312)
7 Gold Fork (HUC #1705012311)
8 Cascade (HUC #170501230402)
9 West Mountain (HUC #170501230401)
N
kilometers
0 5 10 20
Cascade
Projection: UTM Zone 11
120595

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.

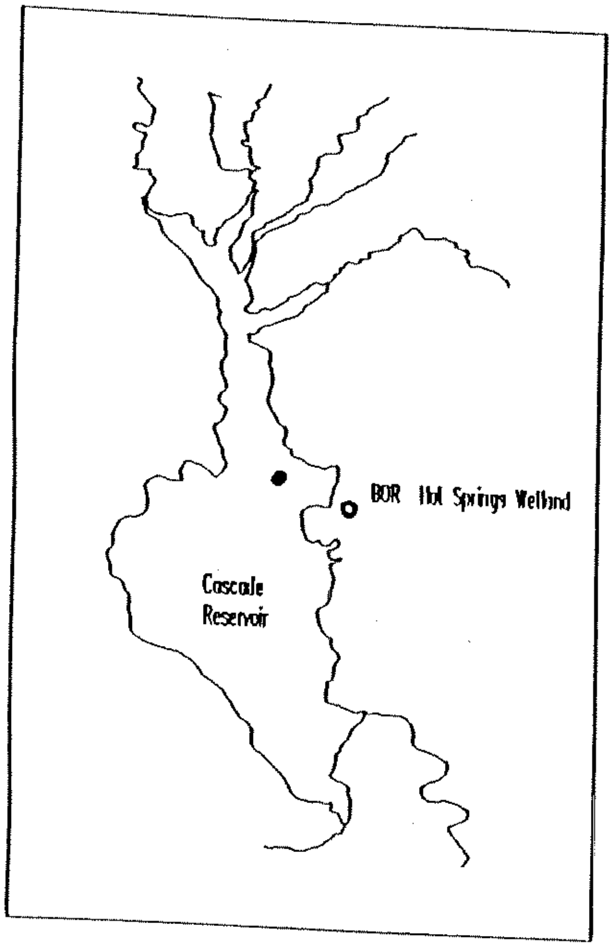
Background: Valley Soil and Water Conservation District (VSWCD) is currently implementing BMPs within the 6,826 acre Boulder Creek watershed draining to Cascade Reservoir. The Cascade Water Quality Management Plan (Entranco Engineers, 1991) identified this watershed as a major contributor of phosphorus 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.

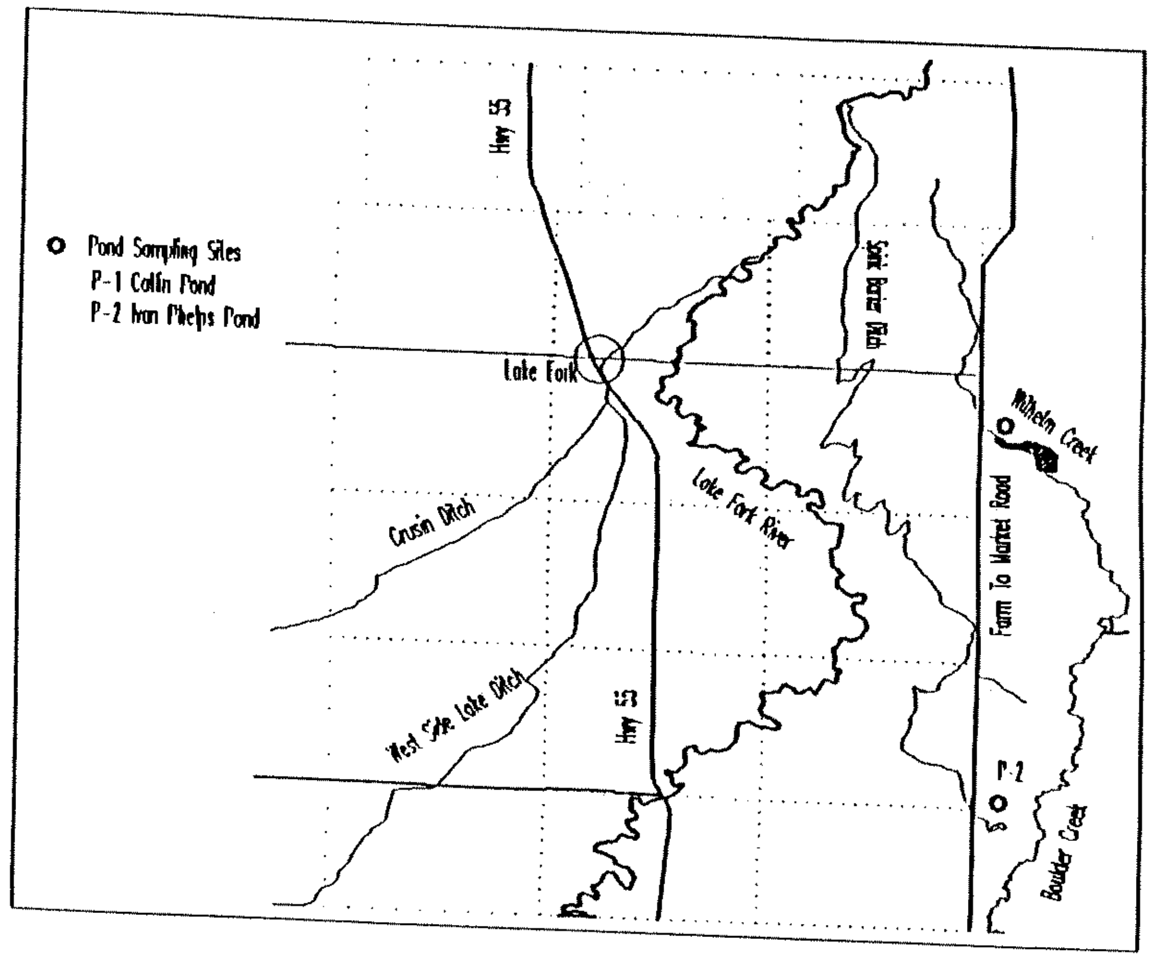
The project design includes construction of several wet detention basins in the Boulder Creek Watershed and modification of a third detention pond that will be replanted with wetland plants to increase uptake of nutrients. These facilities will utilize an existing network of irrigation and drainage channels 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.

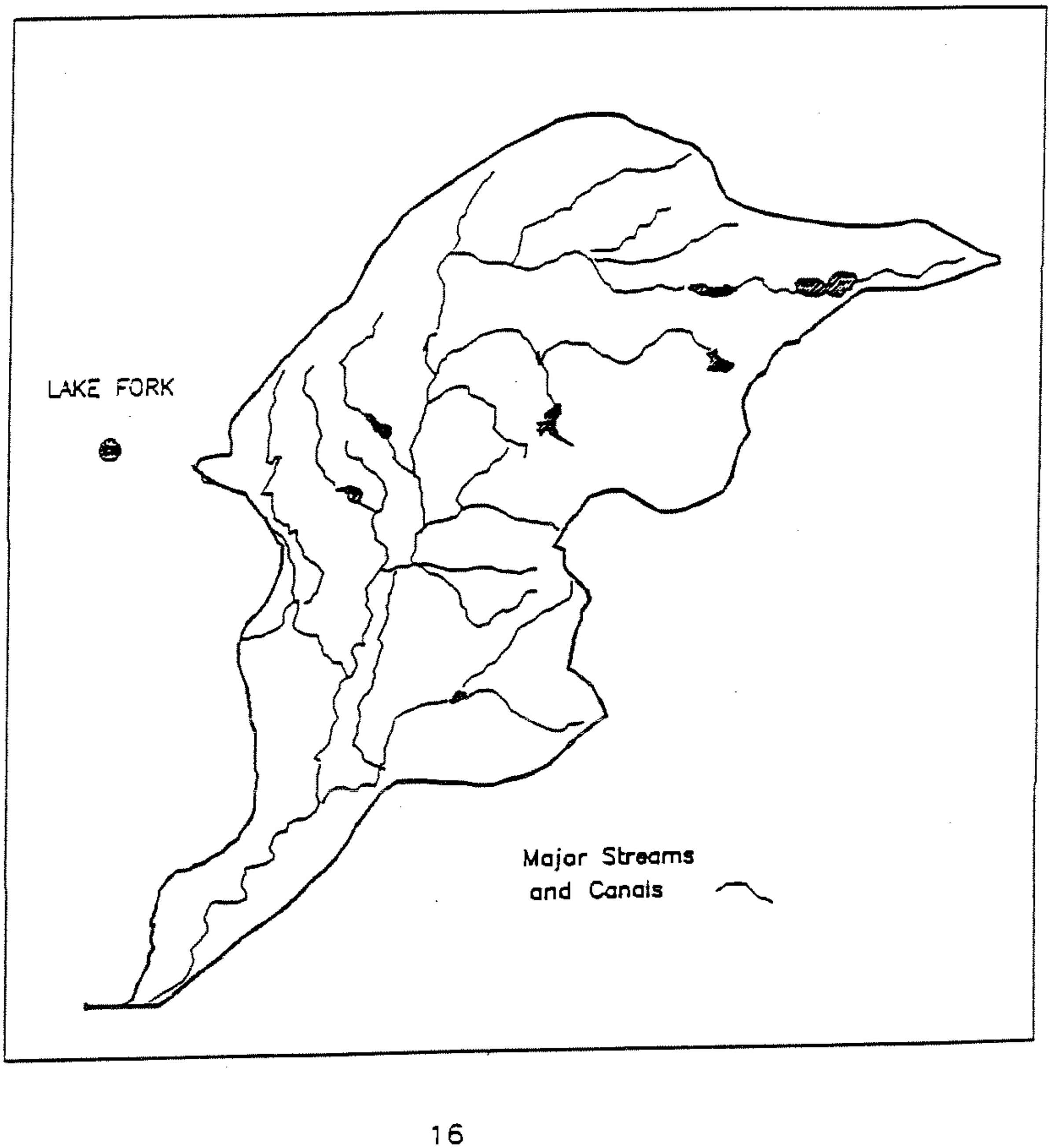
Background: A portion of an existing Phase II 314 Clean Lakes grant has been directed to evaluation of BMP effectiveness at the individual farm level in Boulder Creek (see BMP Effectiveness Monitoring). Implementation of agricultural BMPs are voluntary, requiring a 25% match by the local land owner and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

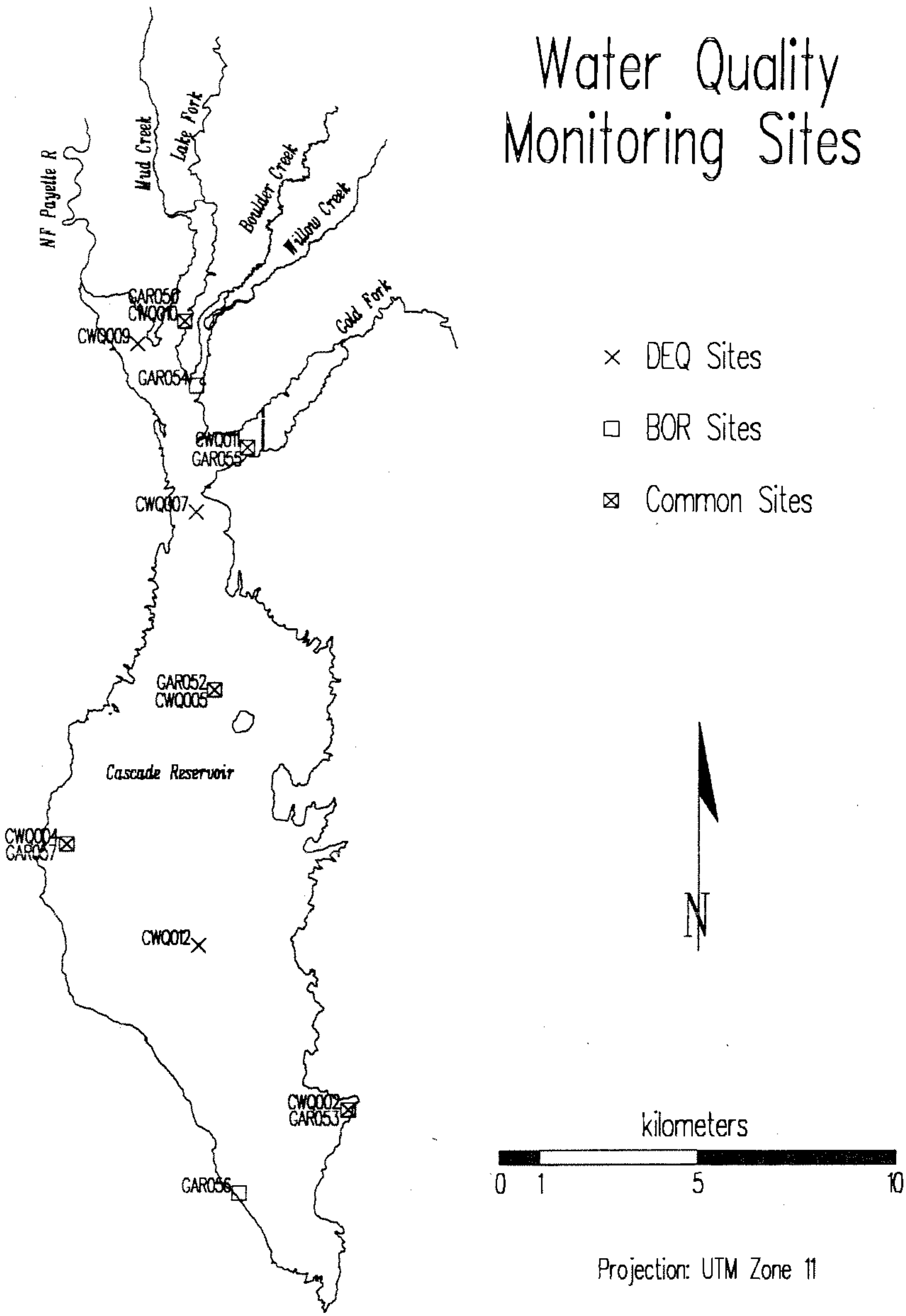
**Rationale:** Predictive models are frequently used to evaluate potential impacts of nutrient loading and estimate how increases or decreases in supply of nutrients could result in changes in the biological productivity of a receiving lake or reservoir. Models are often used in the TMDL process as a 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

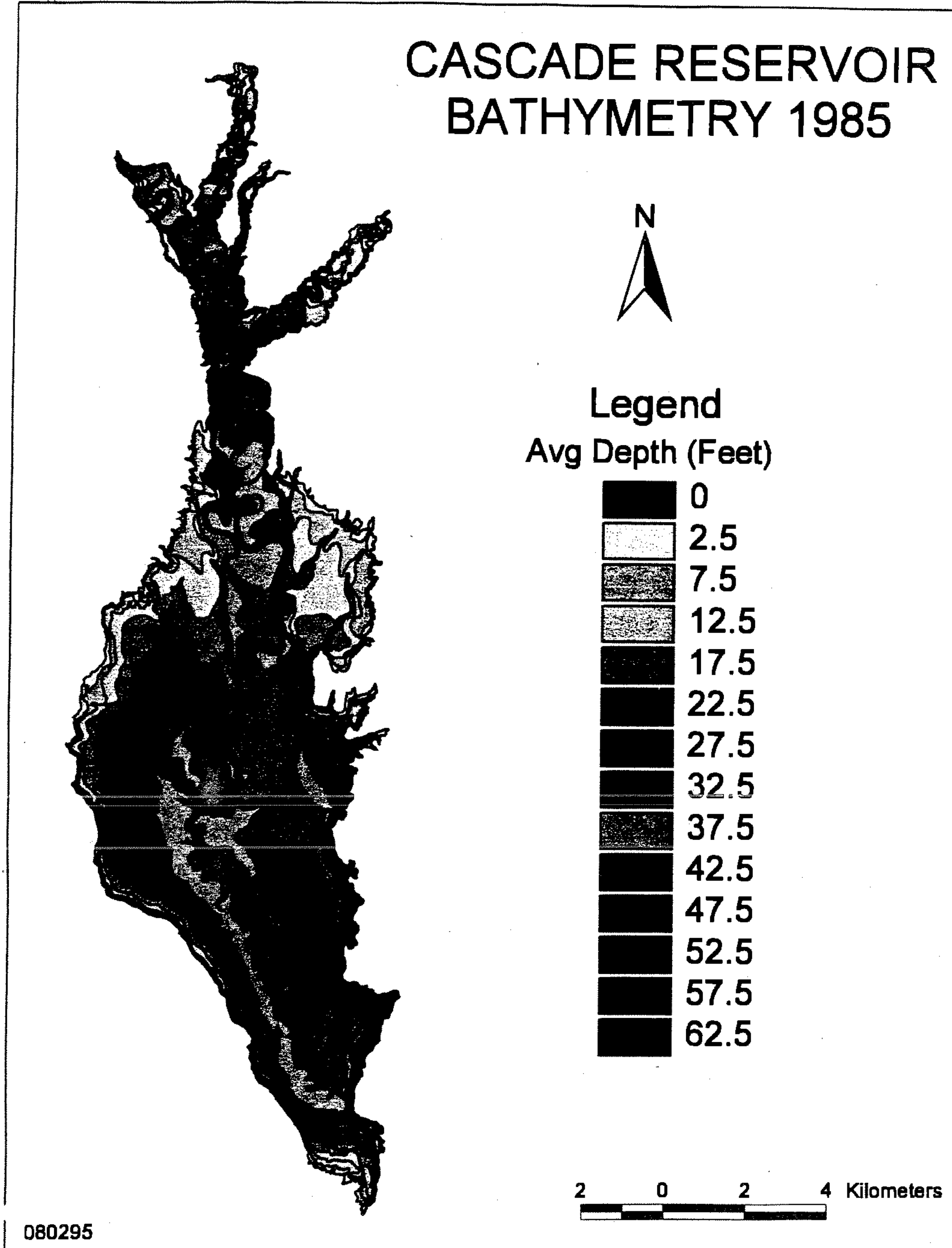

Water Quality Monitoring Sites
NF Payette R
Mud Creek
Lake Fork
Boulder Creek
Willow Creek
Gold Fork
GAR050
CWQ010
CWQ009
GAR054
CWQ011
GAR055
CWQ007
GAR052
CWQ005
Cascade Reservoir
CWQ004
GAR057
CWQ012
CWQ002
GAR053
GAR056
DEQ Sites
BOR Sites
Common Sites
N
kilometers
0 1 5 10
Projection: UTM Zone 11

11695

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
BATHYMETRY 1985
N
Legend
Avg Depth (Feet)
0
2.5
7.5
12.5
17.5
22.5
27.5
32.5
37.5
42.5
47.5
52.5
57.5
62.5
2 0 2 4 Kilometers
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.

Sampling Point Location: ______

EPOES NO.:

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

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

Time of Collection (If No Clock, Circle One) AM PM

Depth (Meters)

Submitted by: D. WORTH

TYPE OF SAMPLES (Check appropriate boxes)

[ ] Wastewater [ ] Raw [ ] Flow [ ] Chemical
[ ] Grab [X] Cross Composite [ ] Depth Integrated
[ ] Composite Begin End

PURPOSE OF SAMPLING (Check One)

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

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

## RESIDUE (mg/L)

| STORET CODE | | |
|---|---|---|
| (00500) | [X] | Total Residue ______ |
| (00530) | [X] | Non-filterable Residue (105 C) (Suspended Solids) ______ |
| (70300) | [ ] | Filterable Residue ______ |
| (00154) | [ ] | 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. 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. ______ |

## 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.:

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

Time of Collection (24 Hr Clock) 2:18 Depth (Meters) BOTTOM — Circle one: OH OBM OVH

Sampling Point Location: ______
SURFACE

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

Submitted By: D. NORTH

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

TYPE OF SAMPLES (Check appropriate boxes)
- [ ] Wastewater
- [ ] Raw
- [ ] Flow
- [ ] Chlorinated
- [x] Grab
- [ ] 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] H2SO4
- [ ] NaOH
- [ ] Other

### RESIDUE (mg/L)

| STORET CODE | | |
|---|---|---|
| (00500) | [x] | Total Residue ______ |
| (00530) | [x] | Non-Filterable Residue (105 C) (Suspended Solids) ______ |
| (70300) | [ ] | Filterable Residue ______ |
| (00154) | [ ] | Non-Filterable Residue (110 C) (Susp. Sediments) ______ |
| ( ) | [ ] | Other Residue ______ |

### DEMAND (mg/L)

| STORET CODE | | |
|---|---|---|
| (00310) | [ ] | BOD5 (Ex ______ |
| (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) | [ ] | Fluoride ______ |
| (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 ______ |
| (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 ______ |
| ( ) | [x] | Other CHLOROPHYLL a |
| ( ) | [ ] | Other ______ |

RETURN TEST RESULTS TO

Name
DEWEY NORTH

Address
1420 N. HILTON

City: BOISE  State: IDAHO  Zipcode: 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 | | | | | | |
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| 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 |
|---|---|---|---|---|---|---|---|---|
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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

Sampling Point Location:

Date Submitted (Yr., Mo., Day)

Submitted By: DON LEE

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

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

( ) [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 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| * 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| * 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| * 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| * 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| * 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |
| * 00116– | | | | | | 1 | | | | | |
| | | | | | OM | 2 | | | | | |
| | | | | | OBMI OVMI | 3 | | | | | |

COPIES OF RESULTS TO

Name

Address

City, State, Zip

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

Remarks

Microbiologist

*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.

West Mountain/North Fork Payette River Sub-Watershed

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.

Gold Fork River/Kennally Creek Sub-Watersheds

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.

| Gold Fork River - Station # 4 (Boise NF at Boundary) | | | | |
|---|---|---|---|---|
| Description | 1992 | 1993 | 1994 | 1995 |
| 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 | 285 |
| 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.

West Mountain/North Fork Payette River Sub-Watershed

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

Gold Fork River Sub-Watershed

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

Gold Fork River/Kennally Creek Sub-Watershed

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. Irrigation Land Leveling (464)** | |
| A. Land Preparation | |
| 1. Herbicide Treatment | 50% |
| 2. Rototilling | 50% |
| B. Land Leveling | 50% |
| **13. Sprinkler(442)** | |
| 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. Pasture and Hayland Planting (512)
- A. Herbicide Treatment (510) 65%
- B. Nutrient Management (ID-590) 65%
- C. Seedbed Preparation and Seed Appl. 65%
- D. Seed 65%

21. Planned Grazing System (556) 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. Pond, Excavated/Embankment (378)
- A. Earthwork Excavation 75%
- B. Earthwork Embankment 75%
- C. Structure for Water Control 75%

23. Proper Grazing Use (528) N/C
(See Planned Grazing System)

24. Proper Woodland Grazing (530) N/C
(See Planned Grazing System)

25. Pumping Plant for Water Control (533)
- A. Electric (includes pressure tank) 75%
- B. Solar 75%

26. Streambank Protection (580)
- 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. Spring Development/Water Development (574)
- 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

Ken Roberts
12765 Hwy. 55
Donnelly, Idaho 83615

*Representing Agriculture*

---

Tom Olson
Valley County Commission
P.O. Box 487
Cascade, Idaho 83611

*Representing the Valley County Commission*

---

Wayne Van Cour, President
Cascade Reservoir Association
P.O. Box 569
Donnelly, Idaho 83615

*Representing the Cascade Reservoir Association*

---

Gerry Ikola
14179 Hwy. 55
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*Representing Lumber*

---

Bob Jones
505 Iowa
Boise, Idaho 83706-4220

*Representing Citizen's Interests*

---

William Kline
Cascade City Council
P.O. Box 902
Cascade, Idaho 83611

*Representing the City of Cascade*

---

Ron Lundquist
P.O. Box 396
Cascade, Idaho 83611

*Representing Sporting and Recreational Interest*

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

| Official TAC Members | Alternates |
|---|---|
| Dave Tuthill, Regional Manager<br>Idaho Department of Water Resources<br>2735 Airport Way<br>Boise, ID 83705-5082 | |
| Ronn Julian<br>USFS BNF<br>P.O. Box 696<br>Cascade, ID 83611 | cc: Jennie Fischer<br>USFS BNF<br>P.O. Box 696<br>Cascade, ID 83611 |
| Domoni Glass<br>PNW Watershed Program<br>Boise Cascade Corp.<br>P.O. Box 50<br>Boise, ID 83728 | |
| Jeffrey Lappin<br>Central District Health Dept.<br>P.O. Box 1448<br>McCall, ID 83638 | cc: Tom Turco, Director, EHS<br>CDHD<br>707 N. Armstrong Place<br>Boise, ID 83704-0825 |
| Richard Uberuaga<br>Fisheries Biologist<br>NMRD PNF<br>Drawer J<br>New Meadows, ID 83654 | cc: D. Alexander/R. Hamilton<br>Forest Supervisor<br>PNF<br>P.O. Box 1026<br>McCall, ID 83638 |
| Barry Albert<br>NRCS<br>P.O. Box 580<br>Cascade, ID 83611 | cc: Randy Phelan, Dist. Cons.<br>NRCS<br>1805 Hwy. 16, Rm. 1<br>Emmett, ID 83617 |
| Warren Sedlacek<br>Natural Resource Specialist<br>BOR<br>P.O. Box 270<br>Cascade, ID 83611 | cc: Dr. David Zimmer<br>USDI BOR<br>PN6538<br>1150 N. Curtis Rd.<br>Boise, ID 83706-1234 |

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Dr. James Baker
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Ralph Myers
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Bruce Prud'homme
EPA
1435 N. Orchard
Boise, ID 83706

cc: Warren McFall
EPA
1435 N. Orchard
Boise, ID 83706

CASCADE RESERVOIR RESTORATION PROJECT
WATERSHED WORK GROUPS
8/95

*Gold Fork/Cascade Watershed*

Mike Little, Co-Chair
13887 Hwy. 55
McCall, Idaho 83638

Ken Roberts, Co-Chair
12765 Hwy. 55
Donnelly, Idaho 83615

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*Boulder Creek/Willow Creek Watershed*

Paul Kleint, Co-Chair
P.O. Box 42
Donnelly, Idaho 83615

---

*Lake Fork/Mud Creek*

Herbert Hatcher, member
Donnelly, Idaho 83615

Ralph Kangas, member
Donnelly, Idaho 83615

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

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