Paradise Creek Watershed Plan

Accomplished through the Paradise Creek Management Committee

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Paradise Creek Watershed Water Quality Management Plan

Latah County, Idaho
Whitman County, Washington

Prepared by
Palouse Conservation District
and the Paradise Creek Managment Committee

August 1997

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List of Acronyms

EQUIP	Environmental Quality Incentives Program
IDAPA	Idaho Administrative Procedures Act
IWRRI	Idaho Water Resources Research Institute
LSWCD	Latah Soil and Water Conservation District,
NRCS	Natural Resources Conservation Service
PC	Paradise Creek
PCD	Palouse Conservation District
PCEI	Palouse-Clearwater Environmental Institute
PC Plan	Paradise Creek Watershed Water Quality Management Plan
PCMC	Paradise Creek Management Committee
PCT	Pullman Civic Trust
SFPF	South Fork of the Palouse River
TMDL	Total Maximum Daily Load
UI	University of Idaho
WCC	Washington Conservation Commision
WDOE	Washington Department of Ecology
WSU	Washington State University
WWRC	Washington Water Research Center

Introduction

This plan is the result of several years of work to identify and address water quality problems in the Paradise Creek watershed in eastern Washington and northwest Idaho. In response to citizen concern over the condition of Paradise Creek, representatives from a number of local groups and agencies initiated the Paradise Creek Project. Palouse Conservation District agreed to become the lead agency and received funding from the Washington Department of Ecology to characterize the condition of the creek and to develop this plan. As part of this process, the original participants of the Paradise Creek Project formed the Paradise Creek Management Committee, which is made up of representatives from all stakeholder groups in the watershed willing to participate. The Paradise Creek Management Committee has produced this plan to characterize the watershed, to identify water quality problems and their sources, and to identify and prioritize activities which will address the water quality needs of the watershed. The participating groups committed to carry out these activities, many of which are either recently completed or currently under way. The Paradise Creek Management Committee is committed to carrying out this plan, and to continuing to work to improve the water quality of the Paradise Creek watershed. This plan represents an important step in a community-based effort to develop a healthy Paradise Creek watershed.

This plan is presented in three parts. In the first part, the watershed is characterized according to biological and physical environments and cultural characteristics. These characterizations are followed by a summary of water quality assessments conducted in the watershed to date. Part II describes the processes which led to this plan and the goals, objectives and recommendations developed by the Paradise Creek Management Committee. Part III presents the activities which make up the Paradise Creek Watershed Water Quality Management Plan. A list of works cited and letters of support and commitment are included in the appendices.

This document was prepared by the Palouse Conservation District and the Paradise Creek Management Committee. It was initially drafted by Bruce Davis, and was edited by Darin Saul.

Part 1: The Paradise Creek Watershed

A. Biological and Physical Environment[1]

Physical Geography

Paradise Creek lies within the south-east portion of the Palouse River basin in Eastern Washington and Northwest Idaho. The creek is approximately 20 miles long, flowing from its headwaters in the Palouse Mountain Range south to Moscow, where it turns west and joins the South Fork of the Palouse River (SFPR) in Pullman, Washington (see Figure 1.1).

The Paradise Creek drainage covers approximately 35 square miles. Elevations range from over 4300 feet in the headwaters to 2360 feet at its mouth. The upper portion of the watershed in the Palouse Range is steeply sloped, while the majority of the drainage basin consists of the moderately steep rolling hills characteristic of the Palouse Region.

Climate

The watershed's climate is affected primarily by westerly flows from the Pacific Ocean and Gulf of Alaska (Dixon, 1993). During winter, weather systems from the Pacific push past the Cascade Mountains, periodically dropping snow across eastern Washington. Temperatures in eastern Washington may hover between 10 and 20 degrees Fahrenheit. Winter Arctic air intrusions from Canada also affect the watershed's climate, occasionally causing temperatures to drop drastically. This is a rarity, for the northern Rocky Mountains usually obstruct such intrusions. From time to time, tropical flows originating in the Pacific enter the watershed from the southwest.

Spring marks the arrival of warmer temperatures and Chinook winds. Chinook winds can raise the temperature as much as 30 degrees Fahrenheit in a few hours. The winds are formed as warm westerly air loses its moisture on the Cascades. No longer laden with moisture, the air heats rapidly as it moves easterly over the Columbia Basin, resulting in the warm winds.

Summers in the watershed are typically hot and dry. During the summer, temperatures can reach upward of 100 degrees Fahrenheit. The average January minimum temperature is 5 degrees Fahrenheit while the average July maximum

[1] Much of the information in Part 1 is a summary of information presented in the *Paradise Creek Watershed Characterization Study* by Doke and Hashmi. For greater detail please see the original document available from Washington State University (WSU) Libraries, State of Washington Water Research Center at WSU, the Palouse Conservation District in Pullman, Washington, and University of Idaho Library.

temperature is 96 degrees Fahrenheit (Dixon et al., 1993). Table 1.1 lists by month the mean daily temperatures for Pullman, Washington and Moscow, Idaho.

Precipitation in the watershed ranges from an average 21 inches in Pullman, Washington to 24 inches in Moscow, Idaho. Nearly 40 percent of the annual precipitation falls as rain and snow during November, December, and January. July and August are the driest months of the year. July and August also mark the period of greatest moisture loss from evaporation (Table 1.2, Figure 1.2, and Figure 1.3).

Geology and Physiography of the Watershed

The Palouse Hills
The majority of the surface area of the Paradise Creek watershed is blanketed with the Palouse Loess. The loess varies in depth from zero in places along the Middle Reach (Moscow-Pullman Corridor), to about 255 feet near the Washington-Idaho border. Topographically, the loess is shaped into rolling, asymmetrical hills, which range from 100-200 feet in local relief and have an east to west elongated shape. These unique hills were sculpted by running water and wind erosion into a network of valleys. The asymmetry of the hills can also be explained, in part, by freezing and thawing action under long-lasting snowdrifts on shadier, north-east slopes. Removal of the natural vegetative cover to grow grain during the last 130 years has accelerated the erosion process (Alwin, 1984; Thomas, 1979).

Columbia River Basalt
The Yakima Formation of the Columbia River basalt underlies the deep soils of the Palouse Hills. Thickness of these distinctive horizontal basalt flows range between ten and fifty feet (Easterbrook, 1970). Between many of the lava flows, particularly near the Palouse Range, stratified layers of sedimentary rock exist (Alwin, 1984). These discontinuous layers of sedimentary material are known as the Latah Formation (Thomas, 1979). In places these basalts are exposed.

The Palouse Range
The Palouse Range north of Moscow is a distinct feature of the watershed. This range is comprised of the uplifted granitic and quartzitic rock of the Idaho batholith. Slopes of 26-40 percent are common here, and slopes of up to 70 percent occur frequently.

Topography
The Paradise Creek watershed varies in elevation from 2,300 feet at its mouth in Pullman to over 4,300 feet in the headwaters in the Palouse Range. For much of the creek's length, little local relief exists, and a 100 vertical foot difference can stretch over several miles. The lower portion of the watershed in Whitman County varies in elevation between 2,600 and 2,700 feet. Most of the uplands north of Moscow vary between 2,700 and 2,800 feet. Elevations change dramatically in the upper watershed in the Palouse Range. Here, a 100 vertical foot elevation difference may

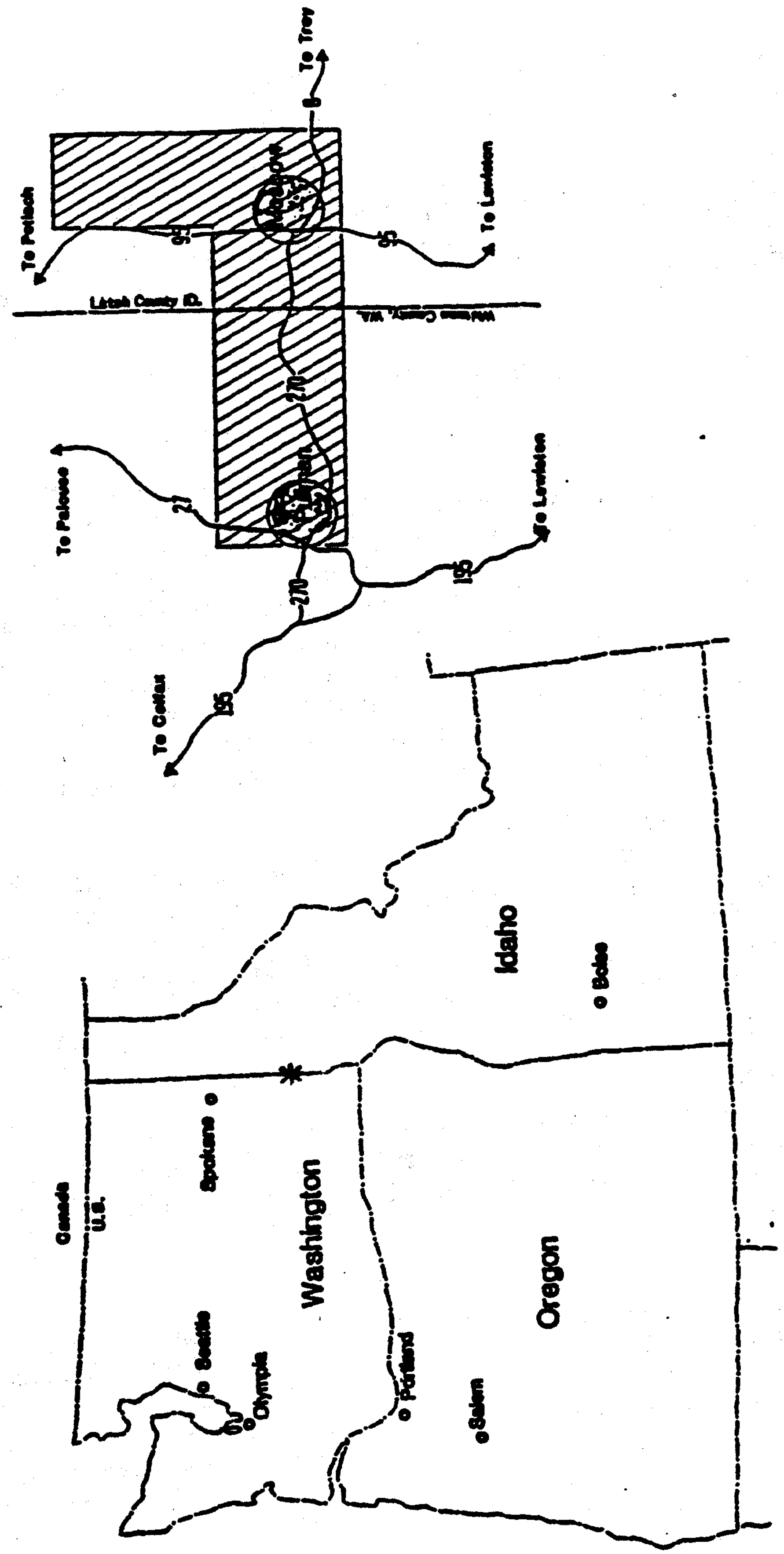

Figure 1.1. Regional Location of the Paradise Creek Watershed
(Steiner *et al.*, 1985)

Table 1.1. Mean daily temperature data for Pullman, Washington and Moscow, Idaho.

Month	Mean Daily Temperature (Fahrenheit)	
	Moscow, ID	Pullman, WA
January	28.30	28.20
February	34.30	34.30
March	38.30	38.00
April	45.60	45.90
May	53.30	52.60
June	59.70	59.10
July	66.40	65.90
August	65.70	65.50
September	59.00	58.80
October	48.80	48.90
November	37.30	37.10
December	31.40	31.70
Annual	47.30	47.10

(Dixon *et al.*, 1993)

Table 1.2. Monthly precipitation and evaporation data for Pullman, Washington and Moscow, Idaho.

Month	Mean Precipitation (inches)		Mean Evaporation (inches) Moscow, ID
	Moscow, ID	Pullman, WA	
January	3.21	2.89	
February	2.12	2.09	
March	2.04	1.96	2.53
April	1.98	1.58	3.86
May	1.99	1.52	5.52
June	1.65	1.49	6.51
July	0.71	0.53	8.68
August	1.07	0.95	8.15
September	1.1	0.99	5.29
October	1.83	1.61	3.1
November	2.95	2.64	1.88
December	3.31	3.07	
ANNUAL	23.96	21.32	37.49

(Dixon *et al.*, 1993)

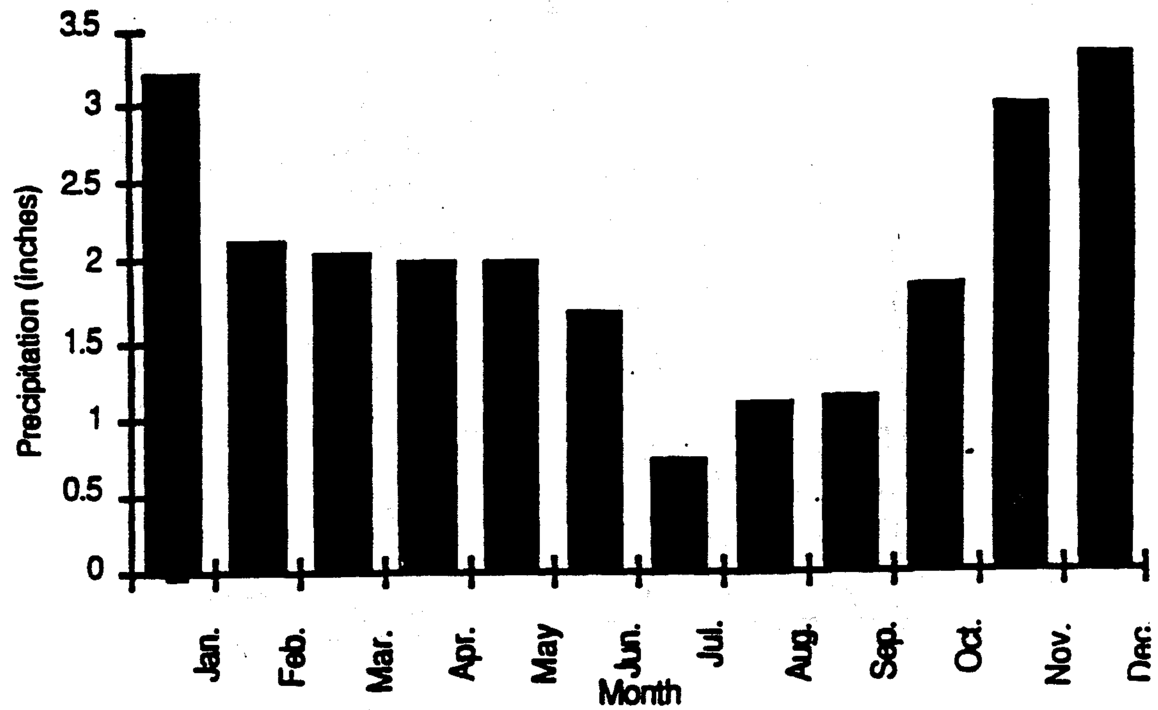

Figure 1.2. Mean Monthly Precipitation: Moscow, Idaho (Dixon *et al.*, 1993).

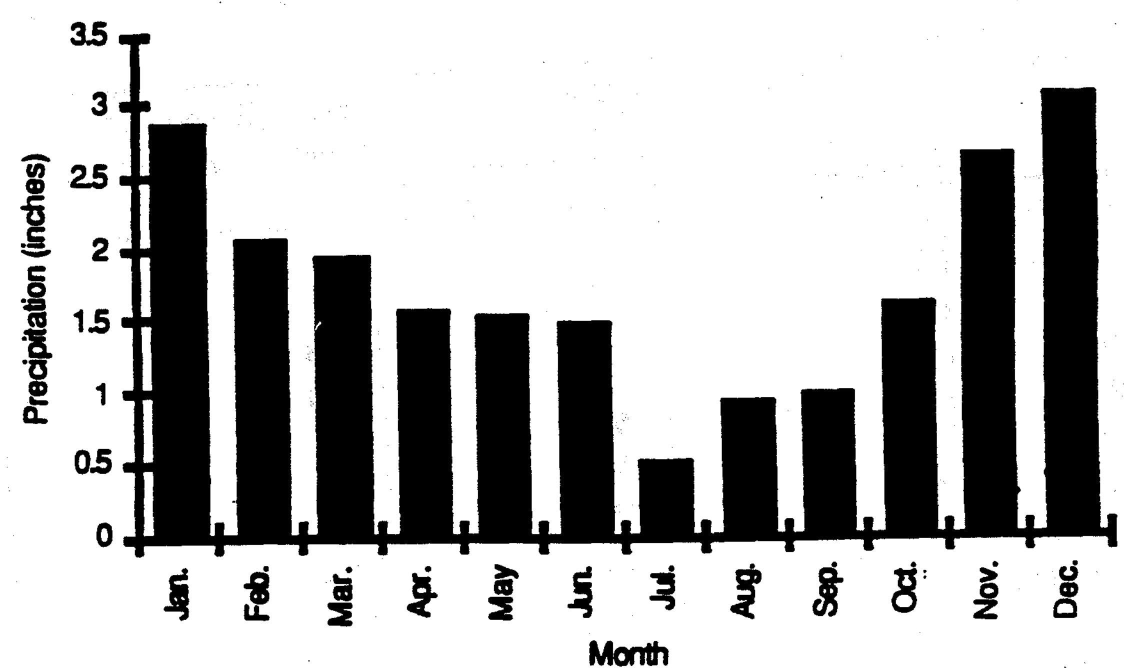

Figure 1.3. Mean Monthly Precipitation: Pullman, Washington (Dixon et al., 1993).

occur within a short horizontal distance. Beginning at 2,900 feet, elevations rise rapidly to over 4,300 feet.

Soil Associations

Six different soil associations have been identified by the Natural Resource Conservation Service in the Paradise Creek watershed. In Latah County, Vassar-Uvi, Taney-Joel, Southwick-Larkin, and Palouse-Naff associations dominate. The Palouse-Thatuna and Palouse-Athena associations dominate in Whitman County. (See Figure 1.4, Figure 1.5, Figure 1.6, Figure 1.7).

The soils of the mountainous Palouse Range developed in granitic residuum from the underlying intrusive igneous rock of the Idaho batholith (Figure 1.6). The Vassar-Uvi association formed on the Palouse Range in granitic residuum and volcanic ash. The slopes are steep and forested, and the soils are well drained. Annual precipitation averages 28 to 45 inches. This soil is found on slopes ranging from 5 to 65 percent and at elevations from 2,800 to over 4,300 feet. The Spokane series occurs on steeper slopes (15-65 percent) than the Uvi, but at the same elevations.

The Taney-Joel association of very deep silt loam soils can be found on gently to moderately steep uplands at the base of the Palouse Range, between 2,600 to 2,800 feet, in areas with an average annual precipitation of 25 inches. Farming is still the primary land use with coniferous forest covering non-cultivated land. Limitations of this association for cropland and grazing include a seasonal perched water table and the hazard of erosion. These soils are moderately permeable.

At a slightly lower elevation--2,700 feet--on the same slopes, the Southwick-Larkin association occurs. These soils are very deep, well to moderately well-drained, and formed of loess. Annual precipitation averages about 23 inches. These soils are mainly cultivated, with coniferous trees being found on non-cultivated land. Erosion is a hazard on the steeper slopes.

The Palouse-Naff association occurs at a similar elevation on gently sloping to moderately steep upland locations, with 21 inches average precipitation. These soils are well drained, very deep, and formed in loess. Most areas are used for cropland with a few areas being used for hay and pasture. Side slopes which are unsuitable for cultivation often provide wildlife habitat.

The Palouse-Thatuna association includes soils that are well to moderately well-drained silt loams formed from loess. They are found in the irregularly oriented hills that are typical of the Paradise Creek watershed. The Thatuna series usually occurs on north and east facing slopes, while the Palouse series occurs mostly on south and west facing slopes and at foot-slopes. Latah and Caldwell series dominate the nearby level valleys, or flood plains. These soils formed in alluvium. They occur at the watershed's lowest elevations of less than 2,500 feet. The annual precipitation

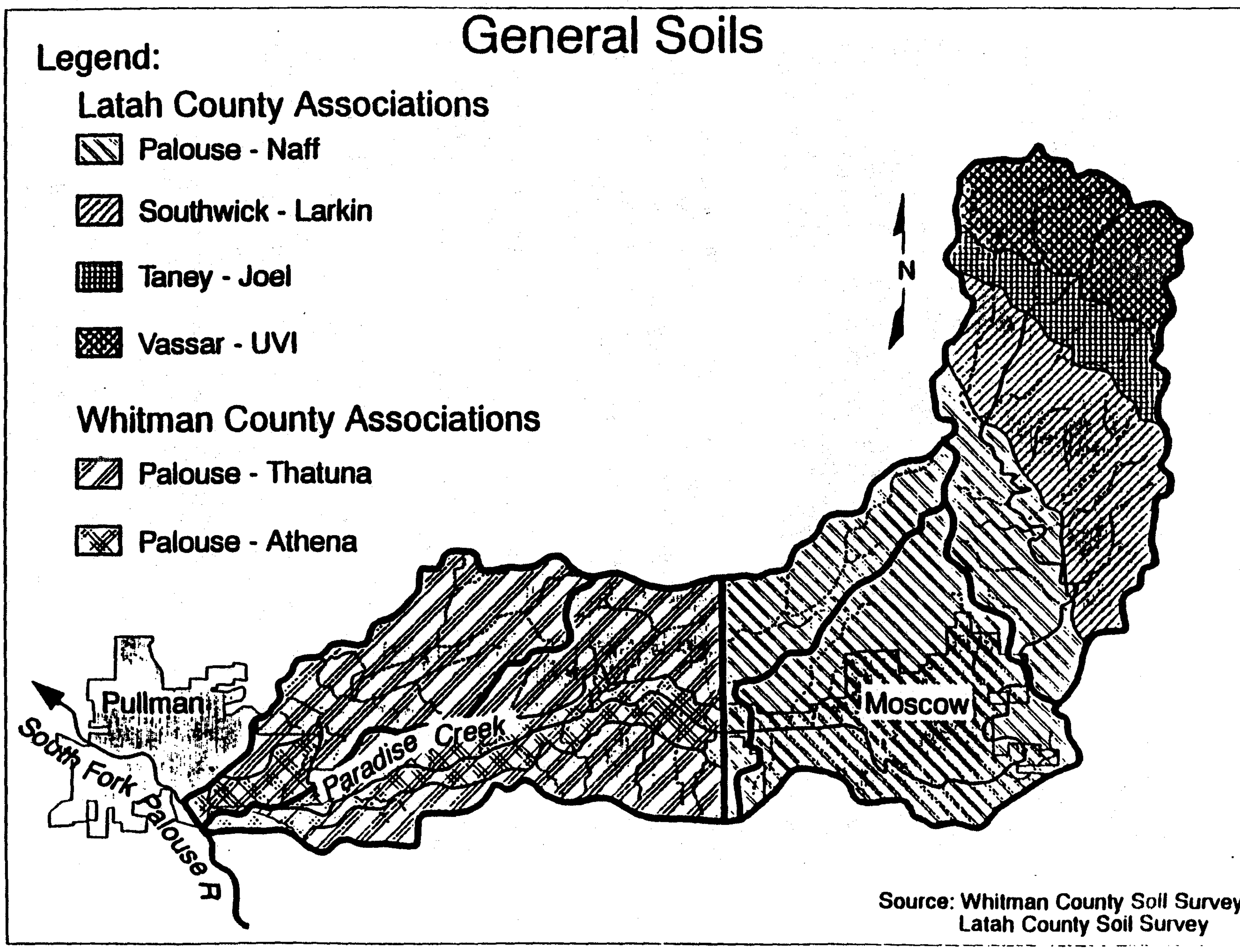

Figure 1.4. General Soils Map

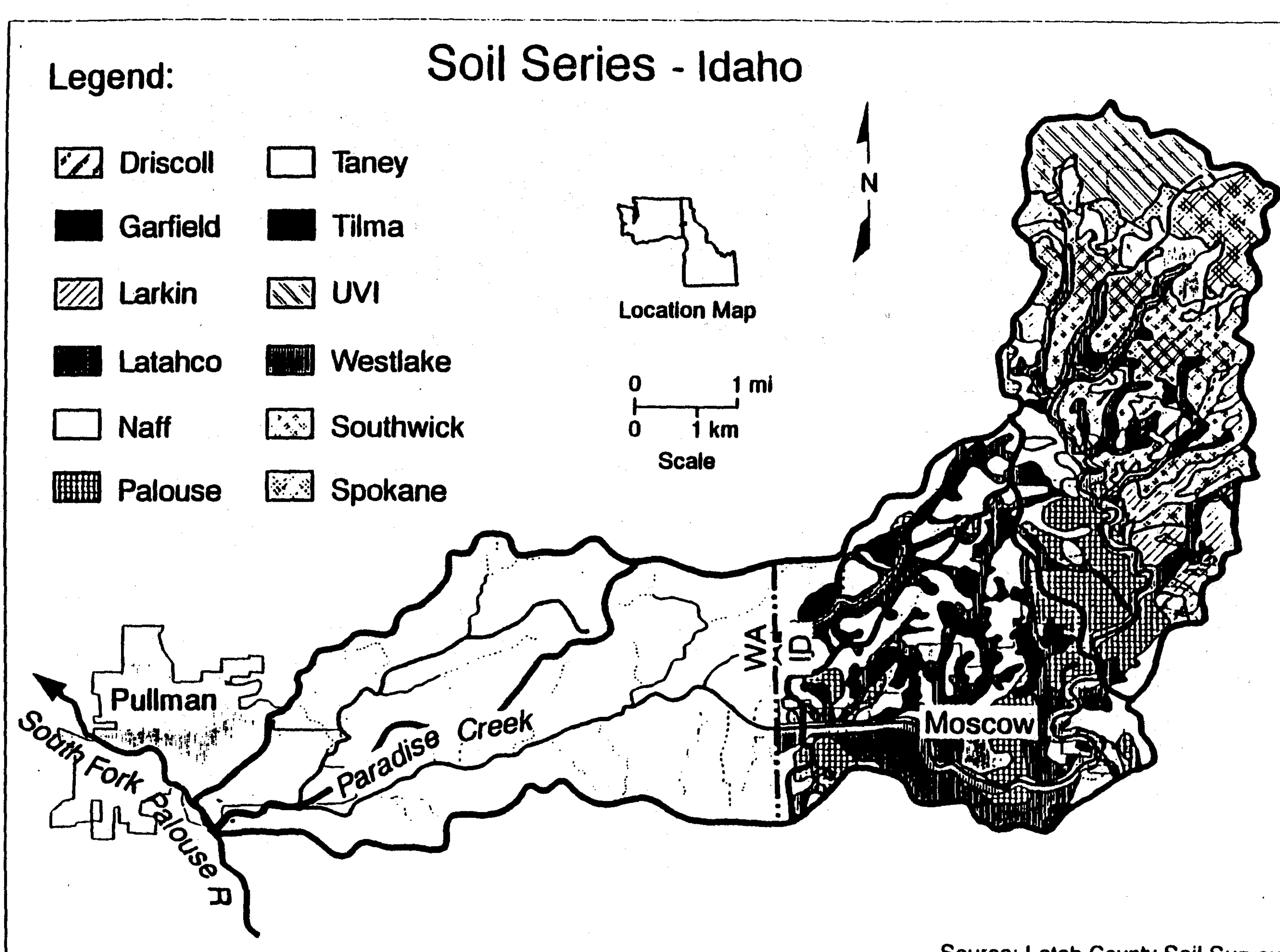

Figure 1.5. Soil Series Map - Idaho

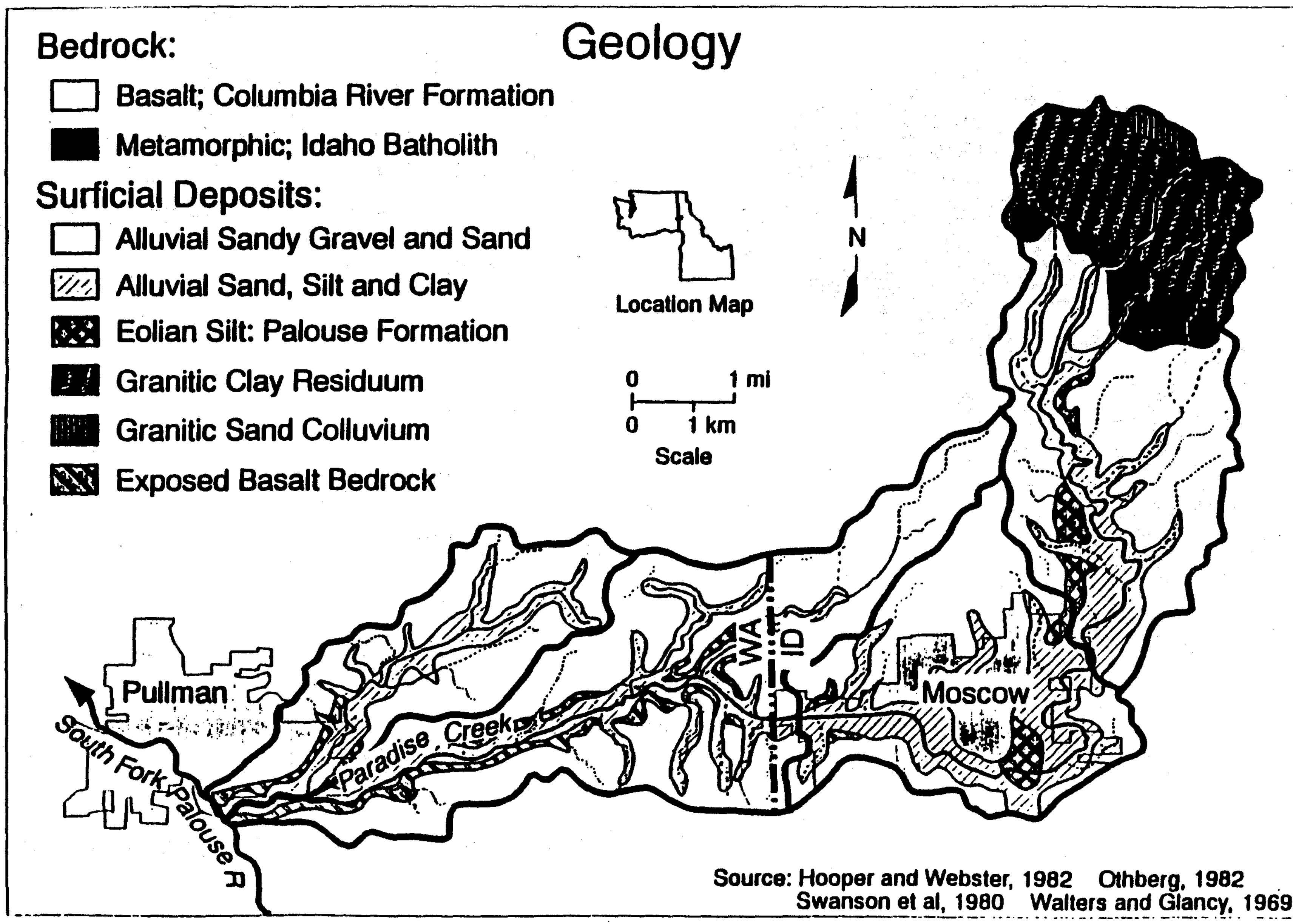

Figure 1.6. Geology Map

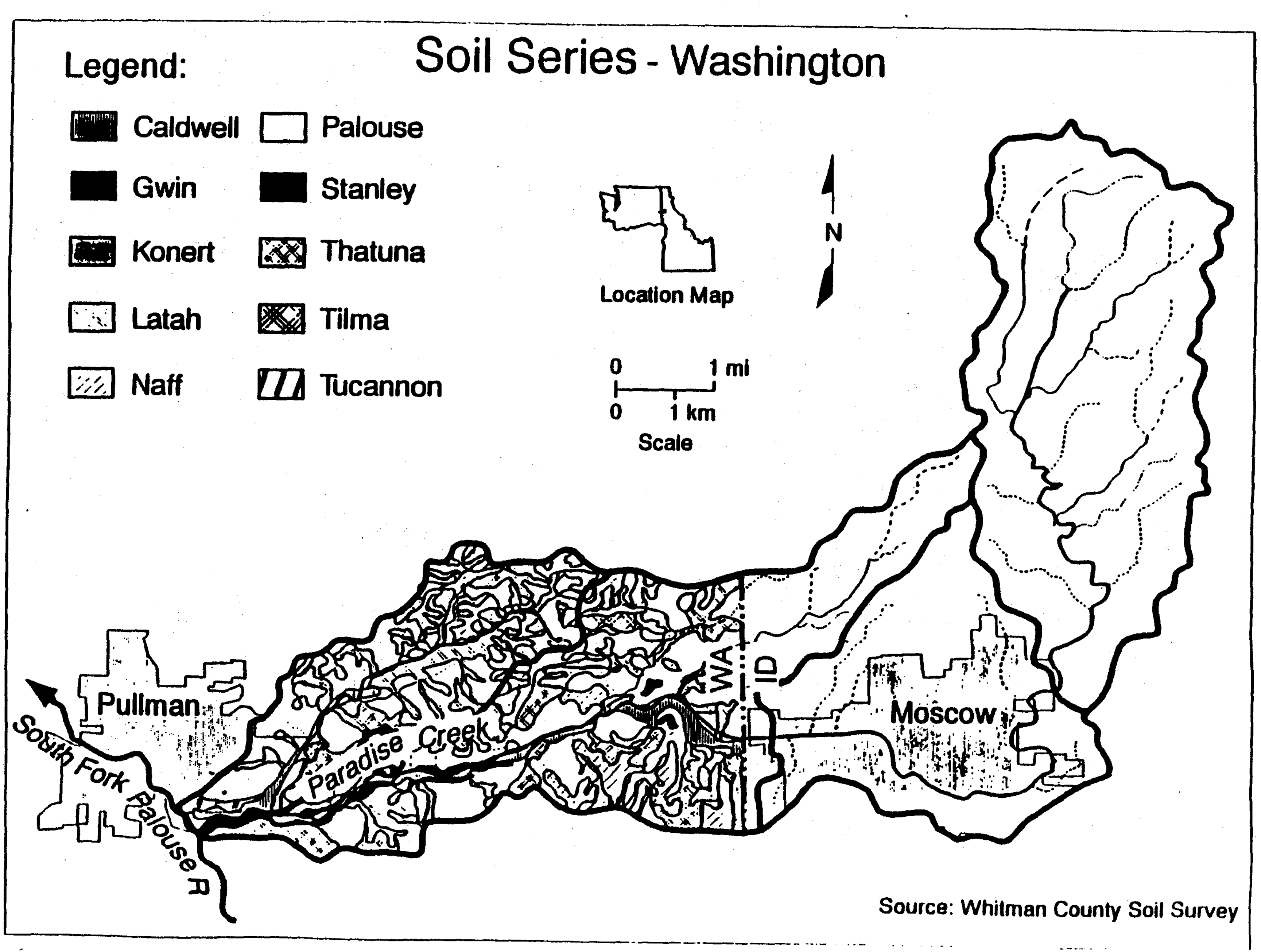

Figure 1.7. Soil Series Map - Washington

is 19 to 22 inches and elevation ranges from 2,200 to 2,900 feet. Dry land farming is the dominant land use for these very deep soils, although in some steeper areas natural vegetation still exists.

The Palouse-Athena association is characterized by very deep soils formed from loess. These soils are found in valleys and drainages. The silt loam soils of this association are well-drained, moderately permeable and are used for farming while the steeper side slopes are left for grazing or wildlife habitat. Annual precipitation is 14 to 23 inches and the elevation ranges from 2,300 to 2,700 feet in the watershed.

Hydrology

Paradise Creek is a fourth order stream draining forest, agricultural, and urban land. Of its 55 stream linkages, 49 flow through agricultural fields (Figure 1.8). Paradise Creek is characterized as a youthful stream with indistinct drainage channels and little topographic relief between adjacent drainage basins. The small and scattered wetlands within the watershed further characterize Paradise Creek as a youthful stream. The morphology of the stream channel is "v" shaped as it runs down Moscow Mountain and rectangular through much of the lowland agricultural areas. Where Paradise Creek runs through agricultural fields, the stream banks are highly unstable and susceptible to channel erosion due to the fine loess soil and lack of vegetation along the banks.

Water does not flow in all of Paradise Creek's sub-basins throughout the year. Near the headwaters, Paradise Creek is ephemeral, running for several months from the spring thaw until May or June. In the summer, flow reaches zero, reducing the stream to a series of small pools, separated by stretches of dry creek-bed. In the upper portions, Paradise Creek typically freezes, thaws, and re-freezes several times during the winter, resulting in intermittent flows during the months of November-March.

The largest source of flow to Paradise Creek is the effluent from the Moscow wastewater treatment plant (MWWTP) located in Moscow. Moscow drinking and municipal water supplies, pumped from the Moscow-Pullman aquifer, enter the sewer system after use and are discharged into Paradise Creek following treatment. During periods of low flow, MWWTP effluent contributes greater than 90% of the flow of Paradise Creek (Figure 1.9). In Figure 1.9, the solid portion of the bar graph represents the flow of Paradise Creek (as measured above the MWWTP). The patterned portion represents the percent of the flow that is effluent from the MWWTP. The natural flow plus the effluent represent the total flow of Paradise Creek measured downstream from the MWWTP. Below the MWWTP out fall, Paradise Creek becomes perennial.

In the Middle Reach Sub-basin (Figure 1.8), approximately 16 ephemeral or intermittent tributaries contribute flow to Paradise Creek, mainly in the spring. Most of these tributaries dry up by late spring or early summer. Airport Creek,

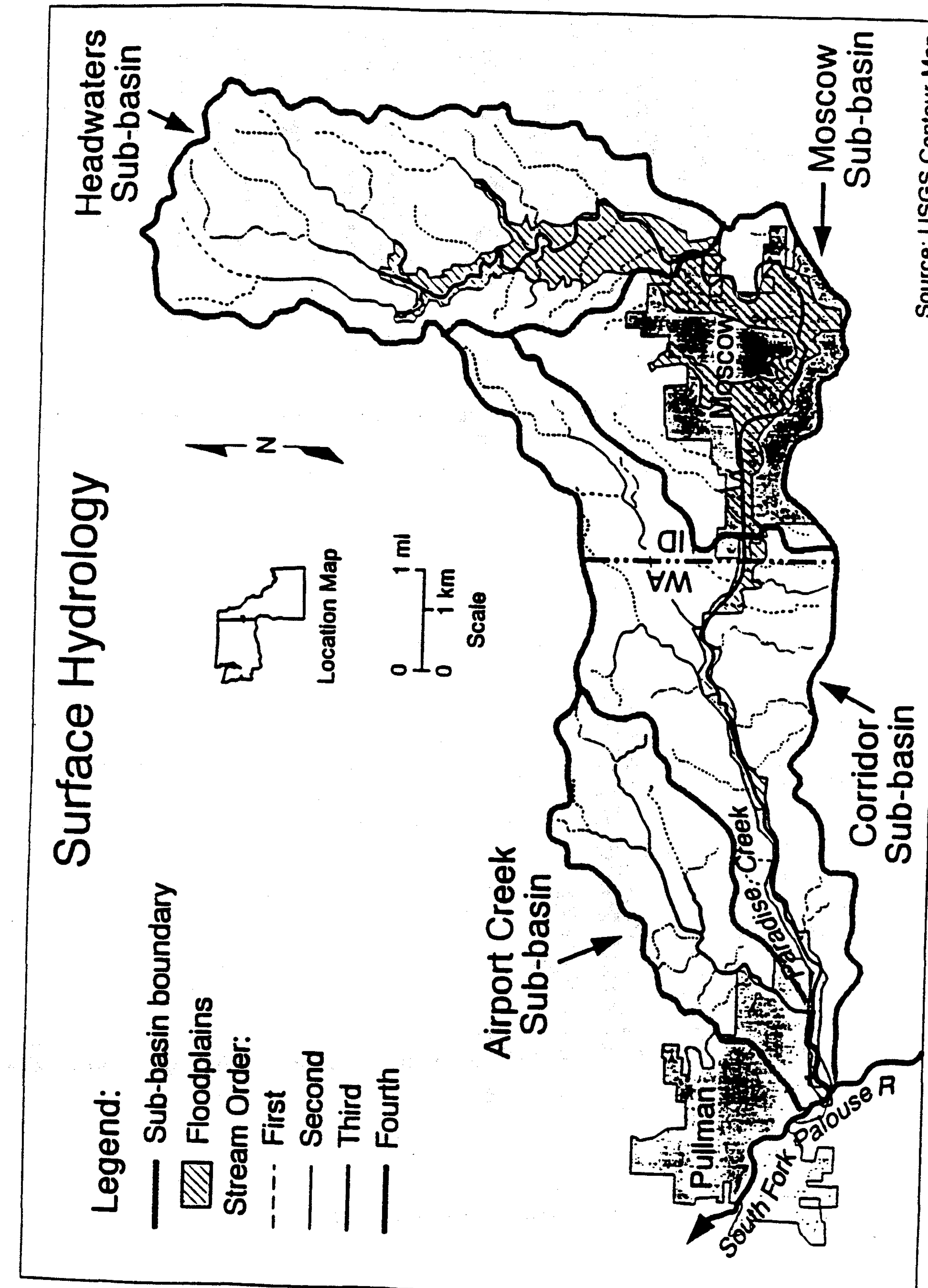

Figure 1.8 Surface Hydrology Map

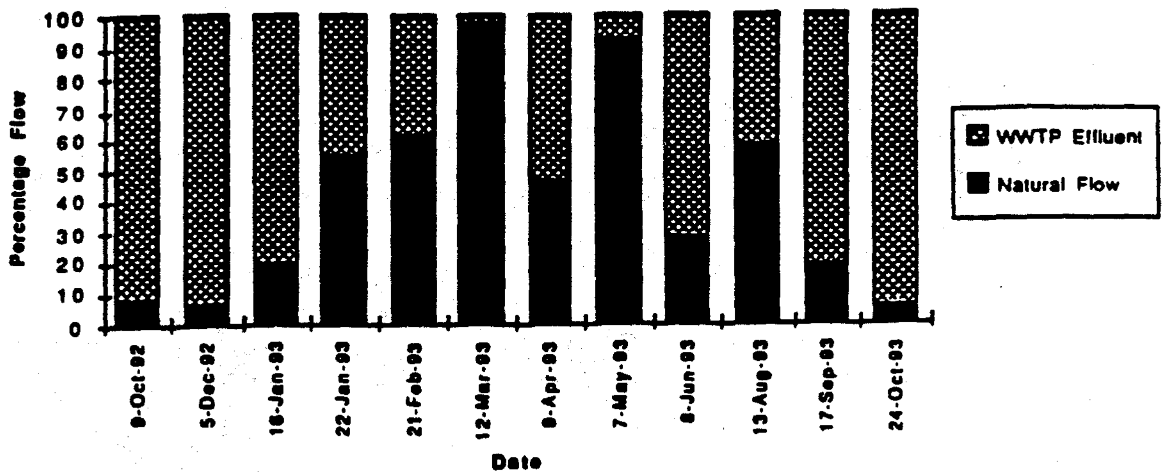

Figure 1.9. Relative contribution of Moscow WWTP effluent to total flow of Paradise Creek near the state line.

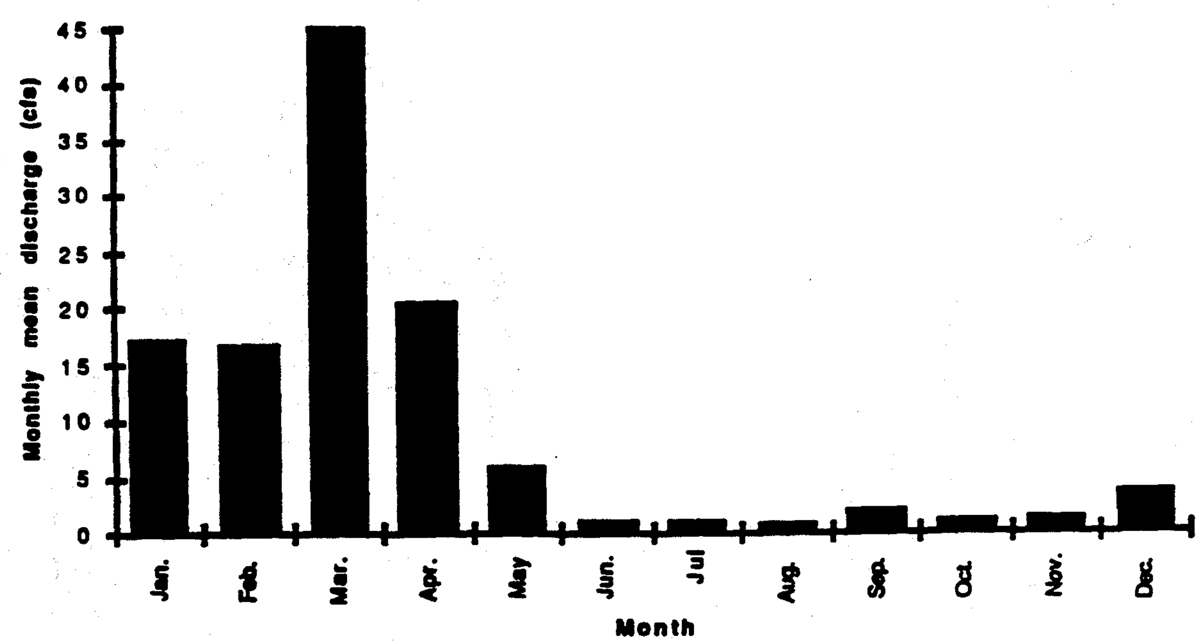

Figure 1.10 Paradise Creek monthly mean discharge.

located within the Pullman-Airport Creek Sub-basin, is a third order tributary of Paradise Creek. It is the largest natural tributary and contributes substantial flow in the spring but may run dry by mid-summer. The relative flow contributed can be seen from data taken on Paradise Creek above Airport Creek and from Airport Creek. The data is in cubic feet/second (Table 1.3).

Table 1.3 Flow in Airport Creek and Paradise Creek

Date	Airport Creek	Paradise Creek
10/9/92	0	7.63
12/5/92	0.21	5.89
1/22/93	2.45	9.48
2/21/93	0.40	9.97
3/12/93	1.23	24.14
4/9/94	1.10	23.30
5/7/94	14.93	39.37
7/13/94	0.13	4.59
9/24/94	0.05	2.86

Mean values for Paradise Creek were calculated from flow data collected by the United States Geological Service (USGS) during the period from 1934 to 1938, along with a limited number of measurements taken on selected dates from 1972 to 1984 (Dixon et al., 1993). Discharge measurements were taken from the USGS station located in the city of Moscow upstream from the MWWTP. According to Figure 1.10, flow begins to rise in response to increased precipitation in the form of rain and/or snow in December and reaches 16-17 cfs in January and February. Although precipitation is highest in December and January, discharge does not peak during these months since most of the precipitation falls as snow and does not enter the stream until melted by the warmer temperatures in spring. In March, the stream flow increases dramatically and peaks around 45 cfs. From June through October, flows are very low, averaging 1.32 cfs during this five-month period (Figure 1.10).

Habitat: Vegetation and Wildlife

The vegetation of the Paradise Creek watershed has been classified into eight different plant communities to categorize wildlife habitat conditions. Wildlife usually responds to vegetative structure rather than plant species composition.

Structurally similar communities thus are grouped together. Using this method Steiner et al. (1985) identified eight plant communities in the Paradise Creek watershed (Figure 1.8). Each plant community provides unique environmental conditions for wildlife. The eight distinct plant communities provide an equal number of habitat types, supporting over 240 vertebrate wildlife species in the watershed. The eight habitats and associated wildlife are briefly described below.

Mixed Conifer Habitat and Ponderosa Pine Habitat
The mixed conifer community and the Ponderosa Pine community are found in the Palouse Range (Figure 1.11) The mixed conifer community combines the ecosystems associated with Douglas fir, larch, ponderosa pine, lodgepole pine, grand fir, and western red cedar. Mixed conifer stands have a structure that is reasonably consistent and diverse compared with relatively pure timber stands. The Ponderosa Pine community is primarily found on south-facing slopes of the Palouse Range. Some isolated stands remain in the uplands areas. These isolated stands may not be sufficiently large to provide habitat for species that require larger stands of trees. Many of the same species may be found in both habitat types. Bobcat and elk are some of the larger animals who find this habitat to their liking. Many smaller mammals are also found here.

Shrub-Steppe Habitat
The shrub-steppe community is associated with steep slopes and basalt outcrops. This plant community is most prevalent along Paradise Creek and other third-order streams (Figure 1.11). Black hawthorn and snowberry dominate this plant community. Badger, deer, and some species of reptiles are found in this habitat type.

Meadow-Steppe Habitat
This habitat provides a look at many of the plants which "once dominated" the Palouse (Steiner et al., 1985). Native grasses cover these areas where many small rodents can be found. Larger animals which use this habitat include mule deer and coyote.

Quaking Aspen Habitat
Quaking aspen is the rarest habitat type in the watershed. Found on the foothills of Moscow Mountain this habitat usually occurs near riparian areas. Mammals which occupy the quaking aspen habitat include muskrat, raccoon, and deer. Many species of birds also enjoy this habitat.

Riparian Habitat
Riparian communities occur along the streams of the watershed (Figure 1.11). This community includes deciduous shrubs and trees, such as wild roses and willows, but is comprised mostly of grasses and forbs. Ruffed grouse, beaver, muskrats, and gopher snakes are some of the many species found in this habitat. Riparian habitat can be adjacent to or include quaking aspen habitat

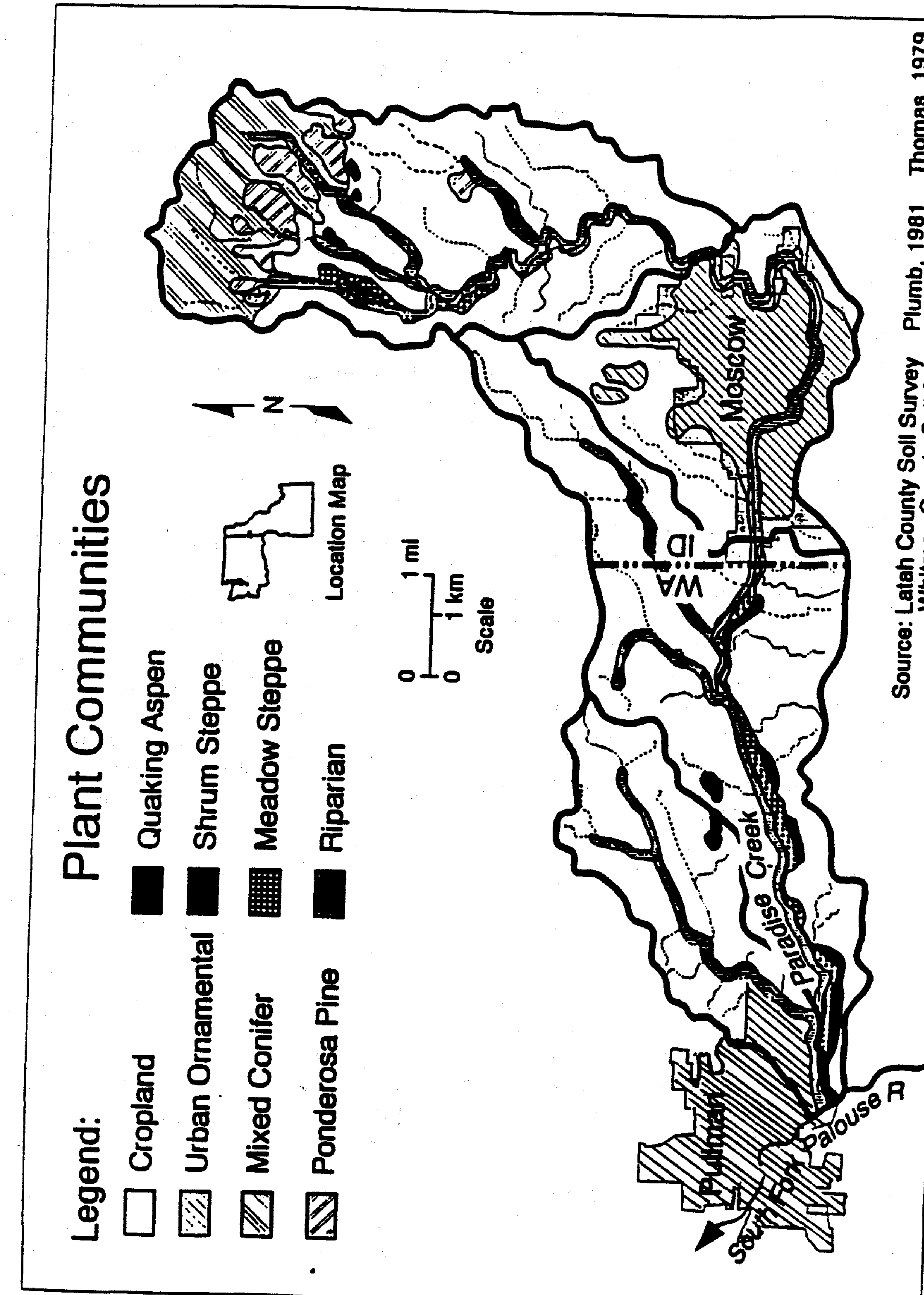

Figure 1.11 Plant Communities Based on Wildlife

Cropland Habitat
The majority of the surface area of the watershed supports the cropland community which consists of dry land agriculture (Figure 1.11). Cropland community typically consists of a three year rotation including winter wheat, barley, and peas or lentils. In the western portion of the watershed, summer fallow is often included in large areas within the crop rotation. Cropland provides poor habitat due to periodic disturbance, lack of structure, and low species diversity, and few wildlife find cropland suitable as habitat. Native vegetation is rare, but is sometimes found along fences, ditches, and roads, providing some variety in this homogeneous landscape. Ringneck pheasants, and rodents use cropland as well as larger animals such as deer and coyotes.

Urban Ornamental Habitat
The second largest habitat in the watershed is urban ornamental. This is largely found in Moscow and Pullman. While few wildlife mammal species use this habitat type, many species of birds are attracted to it (Figure 1.11).

Paradise Creek Fisheries

Historically, Paradise Creek supported several species of trout into the first half of the twentieth century. (Wertz, 1993), (Rabe, 1992). Brook trout may still survive in Paradise Creek and its tributaries in the Palouse Mountain Range (Wertz, 1993). Although stream temperatures in Paradise Creek occasionally exceed 20 degrees C in the summer, these temperatures are less than the thermal maximum that can be tolerated by trout (Bennett, 1993. Personal Communication). These high temperatures limit spawning success and may adversely impact juvenile trout, reducing the viability of the species within the watershed. High temperatures combined with excess sediment currently exclude trout from permanently inhabiting most of Paradise Creek. Other species are addressed in the water quality assessment section, pages 40-41.

B. Cultural Environment

History

Based on artifacts found along the Snake River, Native Americans have lived in the watershed and surrounding areas for at least 12,000 years (Erickson, 1985). The Palouse Indians occupied the watershed seasonally at the time of European settlement. The Palouse Indians were hunter-gatherers existing by fishing, digging camas and biscuit root, gathering berries, and hunting. The Nez Perce also visited the Paradise Creek watershed periodically to gather camas root.

The first non-Indians in the area were members of the Lewis and Clark expedition traveling along the Snake River in 1804. Shortly after them, trappers from the Northwest Company entered what is known today as Latah County.

The development of steamboat transportation on the Snake River made moving to the Palouse easier. Settlers began claiming the land along the Snake River and during the 1860's began migrating to claim the bottom lands of lesser rivers north of the Snake. With the help of the Homestead Act of 1862 and the Timber Culture Act of 1873, more people were drawn to the Northwest Territories. In 1871, a group of settlers, attracted by abundant grasslands and timber for building, traveled from Walla Walla to the foothills of Moscow Mountain.

The grasses and forbs covering the hills were nutritious as well as plentiful for cattle. It was the perfect feed for the winter as well as for grazing in the spring, summer, and fall. The cattle and sheep industry boomed until it was pushed west to less fertile land by farmers in the 1870s. To compensate for the lack of rainfall, farmers practiced dry-land farming, a process of initial deep plowing followed by frequent cultivation which helped the soil retain moisture.

By the 1870's Moscow had become a major trading center. In 1885 the coming of the railroad was extended from Pullman to Moscow. This development boosted Moscow's population to 2,000 by 1890 at which time another railroad was brought into Moscow, the Northern Pacific. Mining also drew a great number of people to the area around Paradise Creek. Gold, silver, copper, coal, and opal were all found. Although many of the gold finds were initially rich, none proved extensive and all were exhausted before 1900.

Present Day Land Uses

Paradise Creek watershed contains a mosaic of many different land uses. Urban, agriculture, transportation, educational facilities, industry, and forested areas all occur in the watershed. In an effort to make the patterns of land use clearer, Doke and Hashmi divided the watershed into four "sub-basins." The sub-basins are loosely defined by sub-drainage's of the Paradise Creek watershed, but do not strictly adhere to hydrologic boundaries. The four sub-basins are 1) The Headwaters, 2) Moscow, 3) Middle Reach, and 4) Airport Creek and Pullman (See Figure 1.12). Table 1.4 lists the approximate acreage of the each sub-basin.

Table 1.4. Approximate acreage by sub-basin

Sub-basins	USGS Quads	Approximate Acreage
Headwaters	Robinson Lake	6443
Moscow	Moscow East, Robinson Lake, Moscow West	3507
Middle Reach	Viola, WA, Robinson Lake, Moscow West	6690
Airport Creek and Pullman	Pullman, Moscow West	2137

Headwaters
The headwaters sub-basin includes a large portion of coniferous forested land on Moscow Mountain. The rest of the sub-basin consists of agricultural land. Land ownership within this sub-basin is privately owned. Homes and agricultural buildings dot the landscape. The Nature Conservancy owns and manages 30 acres alongside Idler's Rest Creek (a tributary of Paradise Creek) as an old growth forest preserve.

Moscow
Urban uses dominate the Moscow sub-basin. As a group, the residents of Moscow own the majority of land. The largest individual land owner is the State of Idaho. State ownership consists primarily of the University of Idaho (UI) campus. The remainder of public land is federally owned or city property. Not all of the Moscow sub-basin falls under what would normally be considered strictly urban use. UI is a major agricultural research university and a portion of the campus is devoted to agricultural and animal husbandry research. In addition, approximately 300 acres of open space are included in the campus, largely in fields, lawns, arboreta, and a golf course.

Middle Reach
The Middle Reach covers the land between Moscow, Idaho and Pullman, Washington. Here dry-land agriculture dominates the landscape. Scattered throughout this sub-basin are structures belonging to rural families. For the most part, land use other than dry-land agriculture tends to border Paradise Creek and Washington State Highway 270. Notable land use includes gravel mining, a nursery, and stables. The majority of land ownership is private.

Airport Creek and Pullman
The Airport Creek watershed derives its name from the creek originating near the Pullman-Moscow Airport. Agriculture predominates in this sub-drainage. Much of the creek is lined by a road, which often provides the edge of the flood plain. The Pullman-Moscow Airport lines both sides of the creek for close to a mile, followed by over a mile of substantial agriculture, wildlife and livestock research activities on Washington State University's campus. The Pullman sub-basin is dominated by various urban uses of the City of Pullman.

Social and Economic Characteristics

Population
The majority of the watershed's population resides within Moscow, Idaho and Pullman, Washington. Moscow has a population of 18,519 and Pullman of 23,478 (Bureau of the Census, 1992 and 1993). Moscow and Pullman are home to major universities, and large numbers of students reside in these cities. Enrollment at the UI, Moscow campus is approximately 10,250 (Personal communication with UI

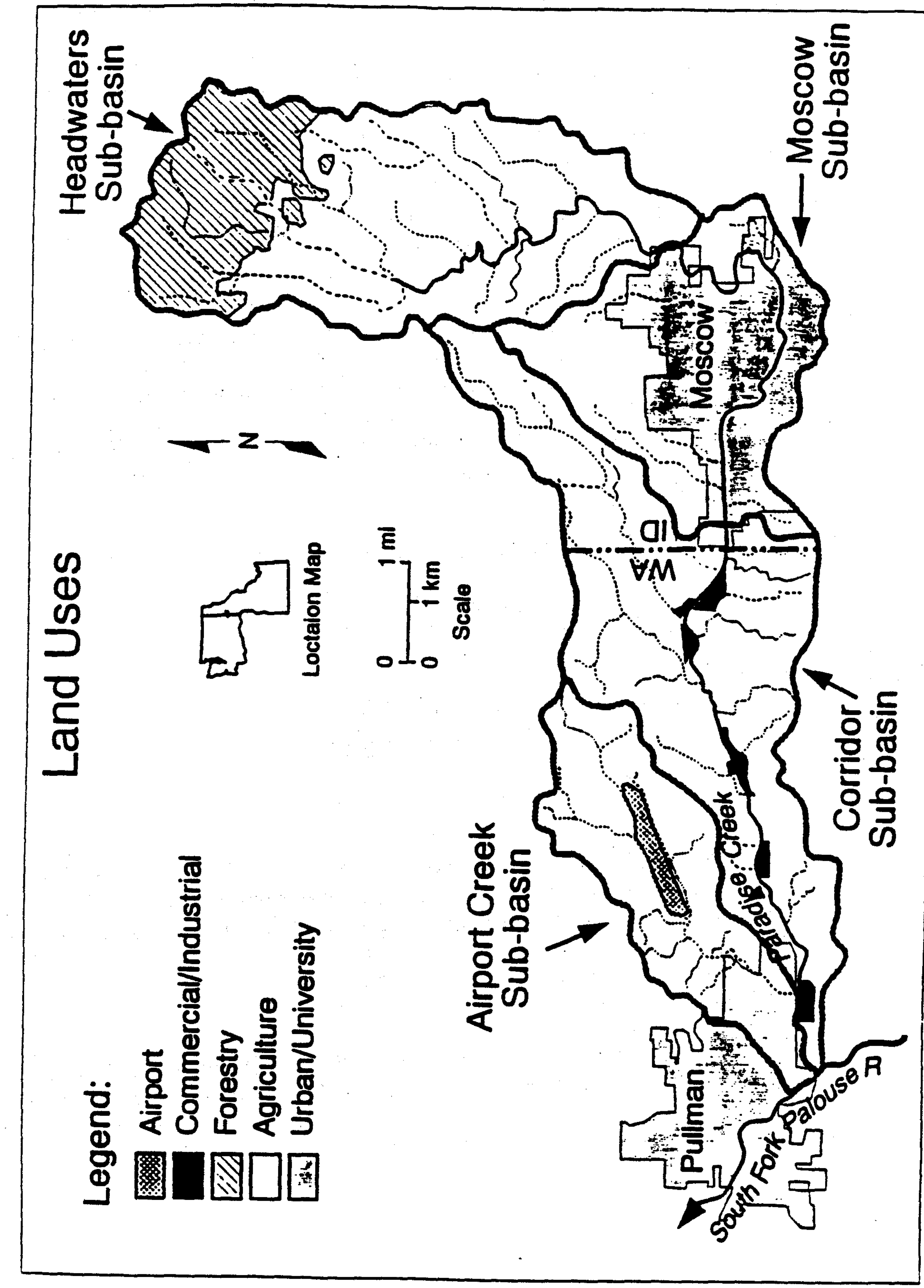

Figure 1.12. Land Uses Map (Steiner et al., 1995)

Registrar Office, 1993) and enrollment for WSU is 15,522 (WSU Institutional Research, 1993).

Outside Moscow and Pullman the rural population is comprised of farming families and ex-urban residents. These people make up a very small portion of the total population. The average density for these portions of the watershed is 26 persons per square mile (Dixon et al., 1993).

Future population growth within the watershed is expected for Moscow and Pullman. For both cities this relates to university growth and to people moving here because of the cultural amenities and the advantages of living in a university town.

Low projections for Moscow growth show a population of 20,525 by the year 2000. High projections show growth to a population of 21,024 by the year 2000. The projections were loosely based on Moscow's long record of steady predictable growth and recent upswings in new housing being built in the city (Pernula, 1993). Pullman's future population will continue to be dependent upon WSU. Pullman's growth projections for the years 2000 and 2010 are shown in Table 1.5. These projections are based on expected WSU enrollment figures.

Table 1.5. City of Pullman Population Projections

Projections	1980	1990	2000	2010
U.S. Census	23,579	23,478		
Low			25,400	27,300
Medium			27,400	29,550
High			29,200	31,800

(Pullman 1993 Comprehensive Plan Update)

Economy

UI and WSU substantially effect the economy of the watershed. These schools are the largest employers in the watershed with WSU employing 5,043 people (WSU Institutional Research, 1993) and Ul employing 2,556 (Ul, Human Resources Office, 1993). Student populations also contribute to the economy of the watershed. Their presence contributes to the economy via rent and by supporting retail, food, and service industries.

Moscow and Pullman are also important commercial centers for the Palouse. Equipment, feed, pesticide, and fertilizer companies supporting the local agriculture industry are all located within the cities in the watershed. Retail trade is also an important part of the economy of the watershed.

The Politics of Paradise Creek

One of the greatest challenges facing any project to improve the water quality and habitat of Paradise Creek watershed lies in the history of land use planning of the area and in the legal frameworks within which agencies in the watershed must operate. For the Paradise Creek watershed, this challenge is increased because the watershed is divided between Idaho and Washington, between Latah County and Whitman County, and between Moscow and Pullman. Most important, the two states have different classification systems and different water quality standards that apply to the creek.

Washington's portion of Paradise Creek is classified as a Class A stream and is protected for domestic, industrial, and agricultural water supplies; primary contact recreation and aesthetic enjoyment; and salmonid and other fish spawning, migration and rearing habitat; and wildlife, commerce and navigation (Wertz, 1994).

Since 1980, Idaho's designated beneficial uses have been secondary contact recreation and agricultural water supply. These require the least stringent water quality standards. In January 1994, Idaho's Division of Environmental Quality (DEQ) completed a report entitled, *Paradise Creek Use Attainability Assessment*. The assessment found that cold water biota is an existing use in the Idaho portion of Paradise Creek and that salmonid spawning is an attainable use. As a result of this assessment, Idaho is predicted to include cold water biota and salmonid spawning as two additional designated uses in the Idaho Water Quality Standards (Wertz, 1994). Because of the difference in stream classification schemes, Idaho must meet Washington's water quality standards at the state line.

C. Water Quality Assessment

Introduction

The Palouse Conservation District and the State of Washington Water Research Center (WWRC) collaborated in a joint water quality and research effort to monitor stream flow, temperature, conductivity, dissolved oxygen, pH, alkalinity, nitrate and nitrite-nitrogen, ammonia, total phosphorus, fecal coliform and streptococci bacteria, and suspended solids in Paradise Creek and the South Fork of the Palouse River (SFPR) on a monthly basis between October, 1992 and November, 1993. Monitoring also took place following several storm events to measure peak loading of pollutants to Paradise Creek.[2] This study is recorded in the *Paradise Creek Watershed Characterization Study* (1994).

In this study, the Paradise Creek watershed was sub-divided into five sub-watersheds to better understand the relationship between water quality, land uses and pollution sources. These sub-watersheds are referred to as the Headwaters,

[2] Storm events are defined as precipitation events that resulted in over 0.5 inches of rainfall.

Moscow, Middle Reach, and Airport Creek sub-basins (Figure 1.13). The Pullman Sub-basin, which lies outside of the Paradise Creek watershed, was included as a fifth sub-basin to measure the impact of Paradise Creek on the water quality of the SFPR.

Beneficial Uses Affected

Washington water quality standards (Chapter 173-201 WAC) classify Paradise Creek as a Class A, "excellent" waterbody. It receives this classification by default as an unclassified tributary to a Class A surface water--the South Fork of the Palouse River. Class A waters are to be protected for all water uses including domestic, industrial, and agricultural water supply; stock watering; fish--including salmonid and other fish spawning, rearing, migration and harvesting--shellfish and wildlife habitat, primary contact recreation (including swimming and wading); and aesthetic enjoyment. Several of these uses such as domestic water supply, salmonid spawning and rearing, and primary contact recreation currently are not supported by Paradise Creek (United States Environmental Protection Agency, 1993). Similarly, Idaho's listed beneficial use of secondary contact recreation for Paradise Creek is not currently supported.

Wertz, in *Paradise Creek: Use Attainability Assessment*, confirmed secondary contact recreation as an existing use in the Idaho portions of the creek, primarily because of its low flow and small channel size. However, high fecal coliform bacteria levels occur at several points along the creek and could preclude this use.

Agricultural water supply was also confirmed as an existing use. Irrigation pipes were found in the creek near Mountain View Park and it was observed that livestock have access to the water at several points along the creek.

Cold water biota was determined to be an existing use in Paradise Creek. Most of fish were found in the upper reaches of the creek where the water quality is fairly good. Since it is an existing use, all water quality standards for cold water biota apply to the creek even though this use is not specifically designated in the Standards. To fully support the cold water biota ammonia levels need to be reduced and temperature, dissolved oxygen, and habitat improvements are needed.

Salmonid spawning was determined to be attainable for future use for Paradise Creek. Potential habitat can be found along several portions of the creek and with improvements in water and habitat quality, the creek can once again support a healthy trout population.

Applicable Water Quality Criteria

Washington State standards for Paradise Creek state that dissolved oxygen concentrations must meet or exceed 8.0 mg/l, temperature shall not exceed 20 degrees C and fecal coliforms shall not exceed a geometric mean concentration of 100

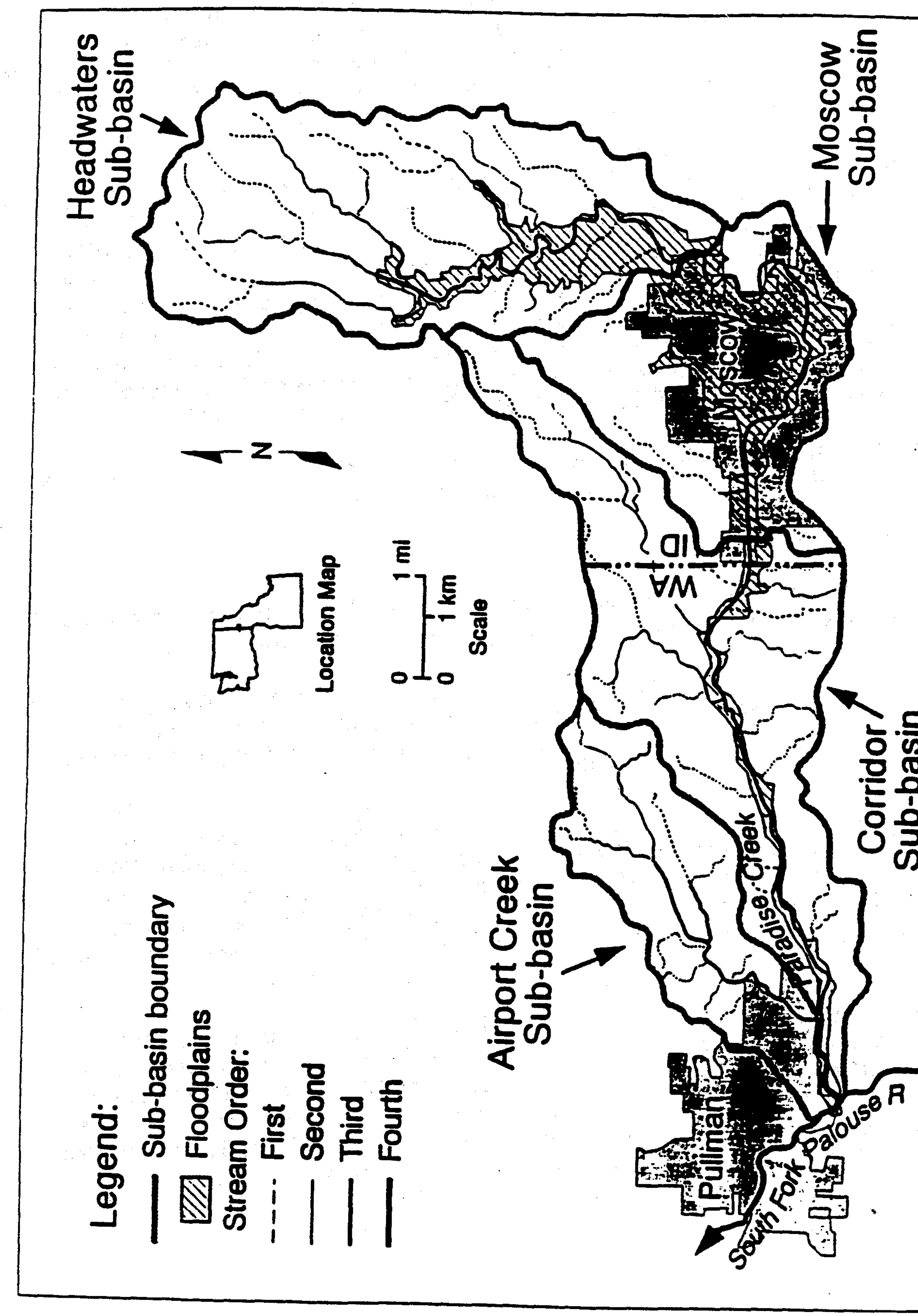

Figure 1.13 Sub-basins within the Paradise Creek watershed

fecal coliforms/100 ml. Idaho water quality standards state that during the recreation season (May-September) fecal coliform bacteria shall not exceed a geometric mean concentration of 200 fecal coliforms/100 ml or 800/100 ml at any one time. Idaho's standards for cold water biota are a minimum of 6 mg/l dissolved oxygen, temperature shall not exceed 22 degrees C or an average of 19 degrees C. These standards are frequently violated in Paradise Creek.

Neither Washington nor Idaho have numeric water quality standards for nutrients, but Idaho has a narrative water quality criterion to protect from "excess nutrients" which might cause nuisance algae and aquatic plant growth (IDAPA 16.01.02205). Additionally, Idaho has recently specified standards for turbidity: turbity "shall not exceed background turbity by more than 50 ntu's instantaneously or more than 25 ntu's for more than ten consecutive days (IDAPA 16.01.02.250.02.C.IV) To date, Washington has no numeric water quality standards that include suspended solids. Both states have narrative criterion which may be interpreted to protect against excess suspended solids (IDAPA 16.01.0020-07 and WAC 173-201-045).

For additional information concerning water quality standards refer to Appendix A of the *Paradise Creek Watershed Characterization Study.*

Available Monitoring Data

Several observations can be made from the 1992-1993 Washington Water Research Center water quality data which apply to the entire watershed.

Low flows characterize Paradise Creek for much of the year except during periods of heavy rain or snow-melt in the winter and spring. During these periods of high runoff and peak flows, suspended solids from eroding agricultural fields heavily impact Paradise Creek (Figure 1.14).

In the summer and fall, the greatest source of flow and point source pollution to Paradise Creek is the effluent from the Moscow Waste Water Treatment Plant (MWWTP). Upstream from Mountain View Park, Paradise Creek is characterized as having intermittent flows: running dry in the summer and fall and freezing periodically in the winter. Paradise Creek runs throughout the year from Mountain View Park downstream.

Based on five month geometric mean concentrations, fecal coliforms exceeded Idaho State standards at two sites and Washington State standards at six sites during the 1992-1993 monitoring project (Figure 1.15). A high bacteria count was observed at the 6th and Deakin monitoring station in Moscow. Bacterial contamination also was noted in Airport Creek and below the Pullman Waste Water Treatment Plant. Bacteria observed below the Pullman Waste Water Treatment Plant probably came from the private horse pastures bordering the SFPF, not the treatment plant. The

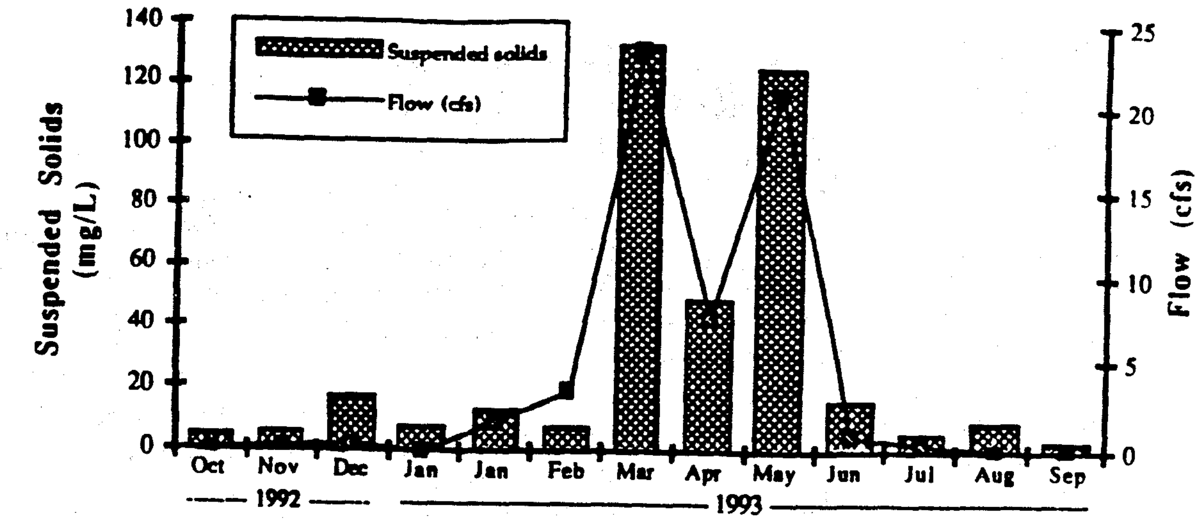

Figure 1.14 Comparison of mean suspended solids concentration and mean flow in Paradise Creek above the MWWTP.

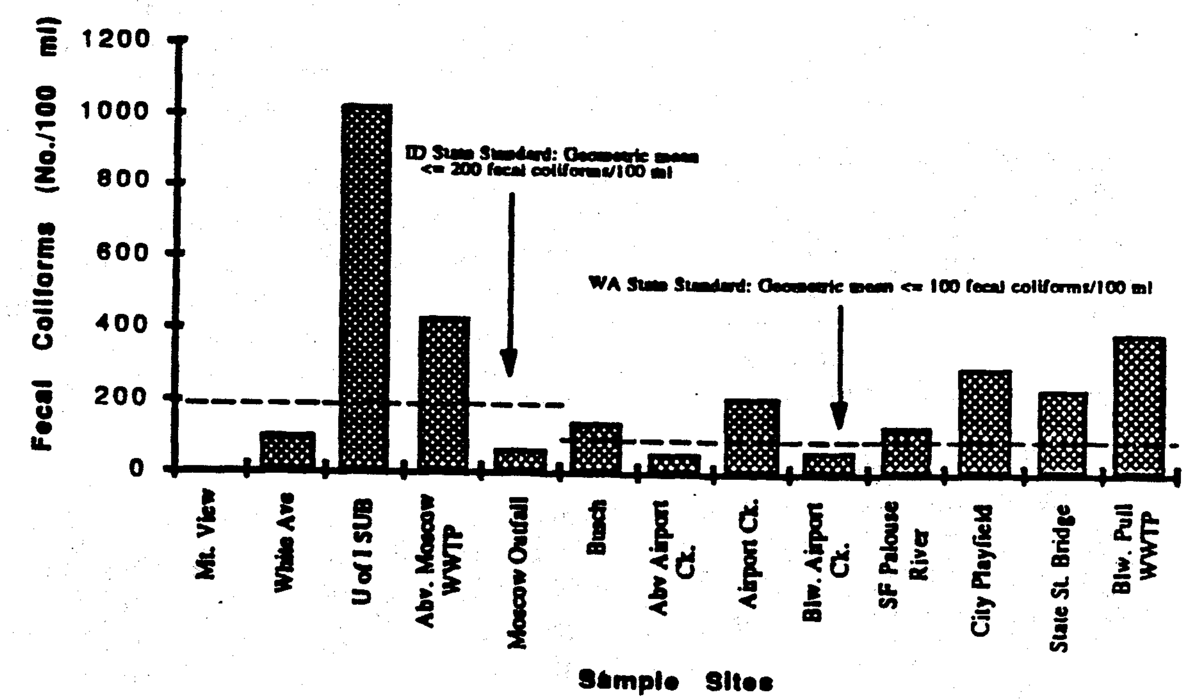

Figure 1.15 Geometric mean concentrations of fecal coliforms/100 ml (May through September 1993).

source of the bacterial contamination at the SFPR, City Playfields and State Street Bridge test sites was not determined.

Headwaters Sub-basin
The Headwaters Sub-basin includes the portion of the watershed within the Palouse Mountain Range as well the agricultural areas that lie between the mountains and the city of Moscow (Figure 1.13). Sampling stations in this sub-basin include Idler's Rest Creek and Mountain View. Based on loading estimates, the Headwaters Sub-Basin contributed more suspended solids to Paradise Creek than any other sub-basin. This probably results from steeper slopes, residential and agricultural uses, and greater amounts of precipitation in this portion of the watershed. Temperature and dissolved oxygen concentrations (Figure 1.16) in this sub-basin are influenced primarily by intermittent stream flows and not pollution sources. Ammonia concentrations in this sub-basin were consistently low (Figure 1.17).

Moscow Sub-basin
The Moscow Sub-basin includes the city of Moscow, residential and agricultural areas surrounding the city, and the MWWTP (Figure 1.13). The WWRC had five monitoring stations in the Moscow Sub-Basin at Sixth Street, at White Avenue, at Sixth and Deakin, above MWWTP and at the MWWTP out-fall. At the Sixth Street, White Avenue and the Sixth and Deakin sampling stations, Paradise Creek showed evidence of low dissolved oxygen concentrations, nutrient enrichment, and high ammonia and fecal coliform concentrations. A broken sewer pipe at this site was fixed in May 1994, but subsequent data suggests a second source of nutrient enrichment may exist. The source of the high fecal coliform and ammonia concentrations at the Sixth and Deakin site was unknown (Figure 1.15 and 1.17).

The MWWTP is the largest point source of pollution to Paradise Creek. It discharges elevated levels of ammonia and phosphorus throughout the year. Figures 1.17 and 1.18 show a substantial increase in ammonia and phosphorus concentrations below the MWWTP at the Busch site compared to those at the site above the MWWTP, indicating that the treatment plant is the source of the pollution. Based on loading estimates, the Moscow Sub-Basin contributes more phosphorus and nitrogen to Paradise Creek than any other sub-basin.

Middle Reach Sub-basin
Commonly known as the Moscow-Pullman Corridor, the Middle Reach Sub-basin refers to the stretch of land between Moscow and Pullman that includes Highway 270 (Figure 1.13). The Middle Reach is comprised mainly of agricultural fields with several rock quarries, commercial businesses and residential homes located along the highway. Sampling stations in the Middle Reach include the Busch site and the Above Airport Creek site.

Data from the Washington Department of Ecology (WDOE) 1991 intensive surveys and 1992 ambient monitoring of Paradise Creek show that dissolved oxygen

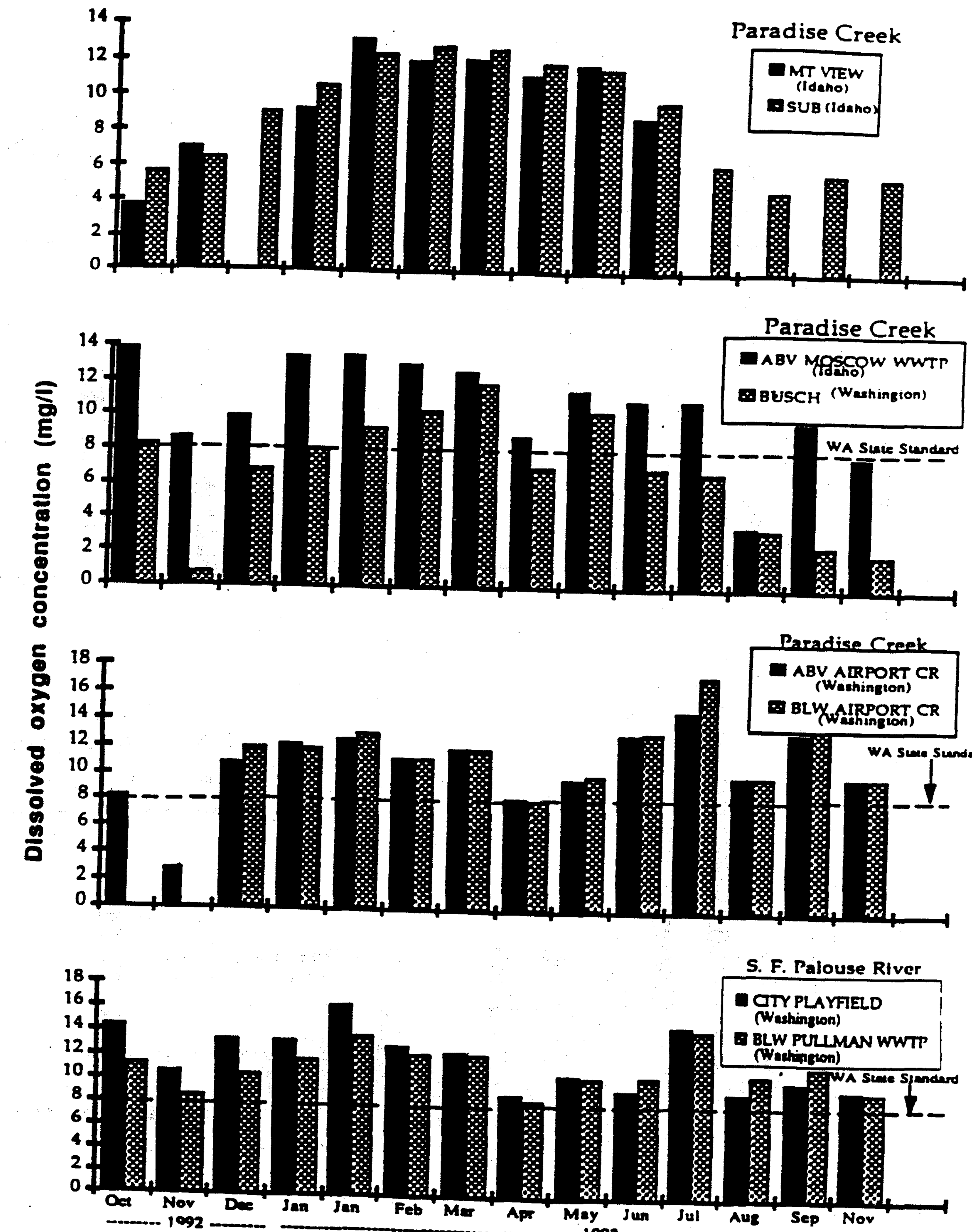

Figure 1.16 Dissolved oxygen concentrations of selected sites from Paradise Creek and the South Fork of the Palouse River. (Note: the y-axis values in each of the graphs vary in size).

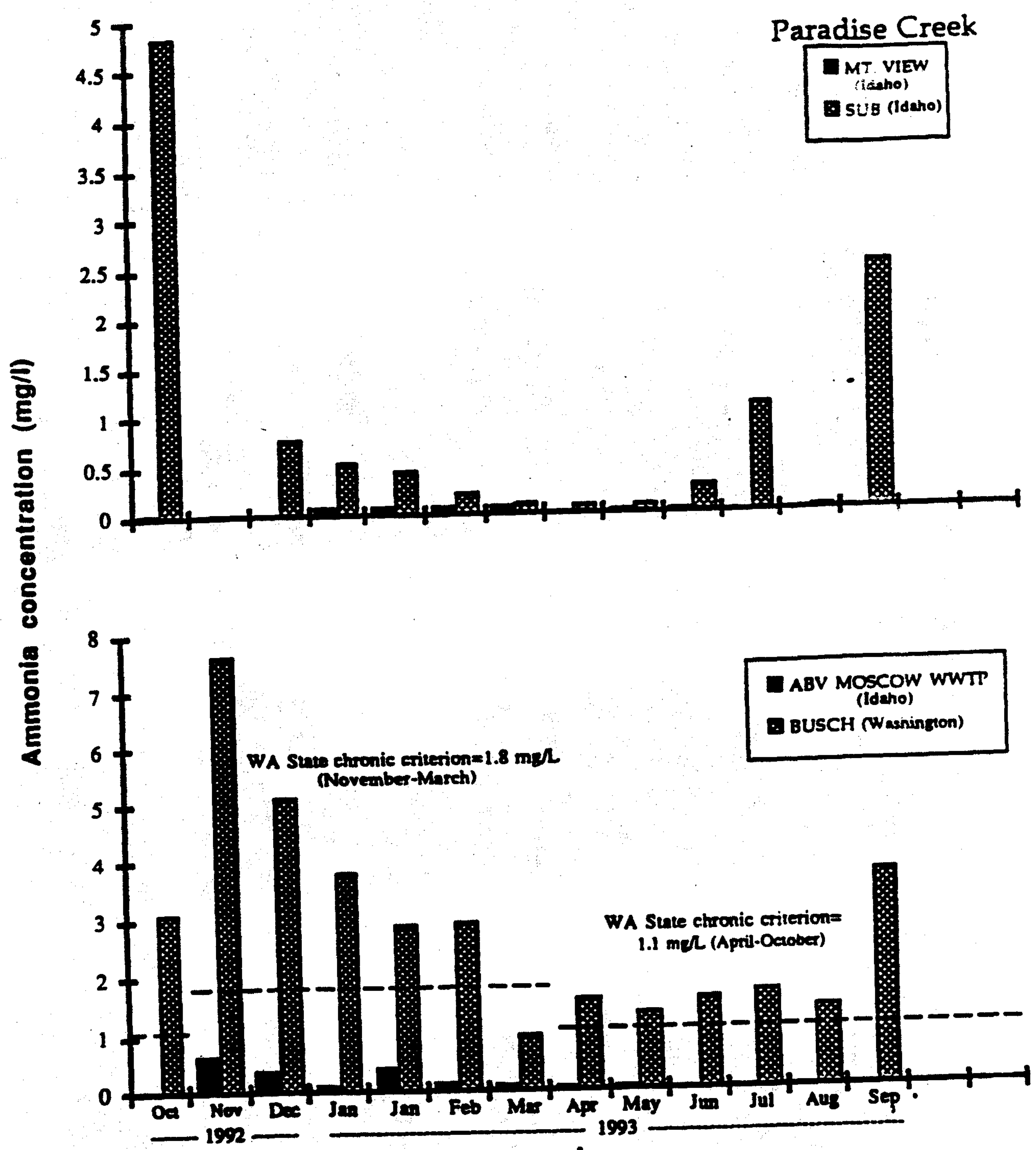

Figure.1.17 Ammonia concentrations at selected sites from Paradise Creek. (Note: the y-axis values in each graph vary in size)

concentrations were below the Washington State standard (8.0 mg/L) at the state border every time this parameter was measured. The 1992-93 WWRC data show that dissolved oxygen concentrations at the Busch site near the state-line were below thestandard in 9 of 14 samples over a one-year period, with values ranging from 0.9 to 12.0 mg/L (Figure 1.16). The main cause of the low dissolved oxygen concentrations at the Busch Site were due to the release of oxygen-demanding substances (ammonia and nitrite) from the MWWTP effluent.

The remainder of the Middle Reach sample stations, including the Above Airport Creek site, also showed substantial contamination of the water quality due to phosphorus (Figure 1.18), bacteria, suspended solids, and ammonia (Figure 1.19).

Airport Creek Sub-basin

Included in the Airport Creek Sub-basin are agricultural fields, the Moscow-Pullman Airport, and numerous livestock and research-wildlife animals located in pastures within the WSU campus. Water quality was monitored at two sites on Airport Creek and below Airport Creek on the main stem of Paradise Creek.

As a tributary, flows from Airport Creek are a fraction of the flow of Paradise Creek. Phosphorus concentrations were consistently lower in Airport Creek than on the main stem of Paradise Creek. Like the Moscow and Middle Reach Sub-basins substantial contamination occurred from nitrates, suspended solids, and bacteria at the Airport Creek and Below Airport Creek stations. Dissolved oxygen concentrations were generally acceptable in this sub-basin (Figure 1.16).

The Washington Water Resource Center data shows that Airport Creek contributes nitrates (NO_3) ranging from 0.49 mg/L to 5.72 mg/L; nitrites (NO_2) ranging from < 0.01 mg/L to 0.06 mg/L; suspended solids ranging from < 0.5 mg/ L to 41.4 mg/L; and, fecal coliforms ranging from 0 CFC/100ml to >707 CFU/100ml (Doke and Hashmi, 1994).

Pullman Sub-basin

Pullman was included as part of the study to identify problems and solutions to enhance water quality within the city limits of Pullman, even though Paradise Creek joins the SFPR shortly after entering the Pullman city limits. The Pullman "Sub-basin" is not a true sub-basin but refers to that portion of the city of Pullman that drains into the SFPR. Sampling stations were located at SFPR (above Paradise Creek), the City Playfields, State Street, and Below PWWTP. The Missouri Flat Creek sampling station was located at the intersection of Stadium Way and Grand Avenue.

The highest water temperature readings observed during the 1992-1993 monitoring project occurred below the PWWTP (20.8 degrees C). The WDOE has measured water temperature as high as 26.9 degrees C above the PWWTP on the SFPR.

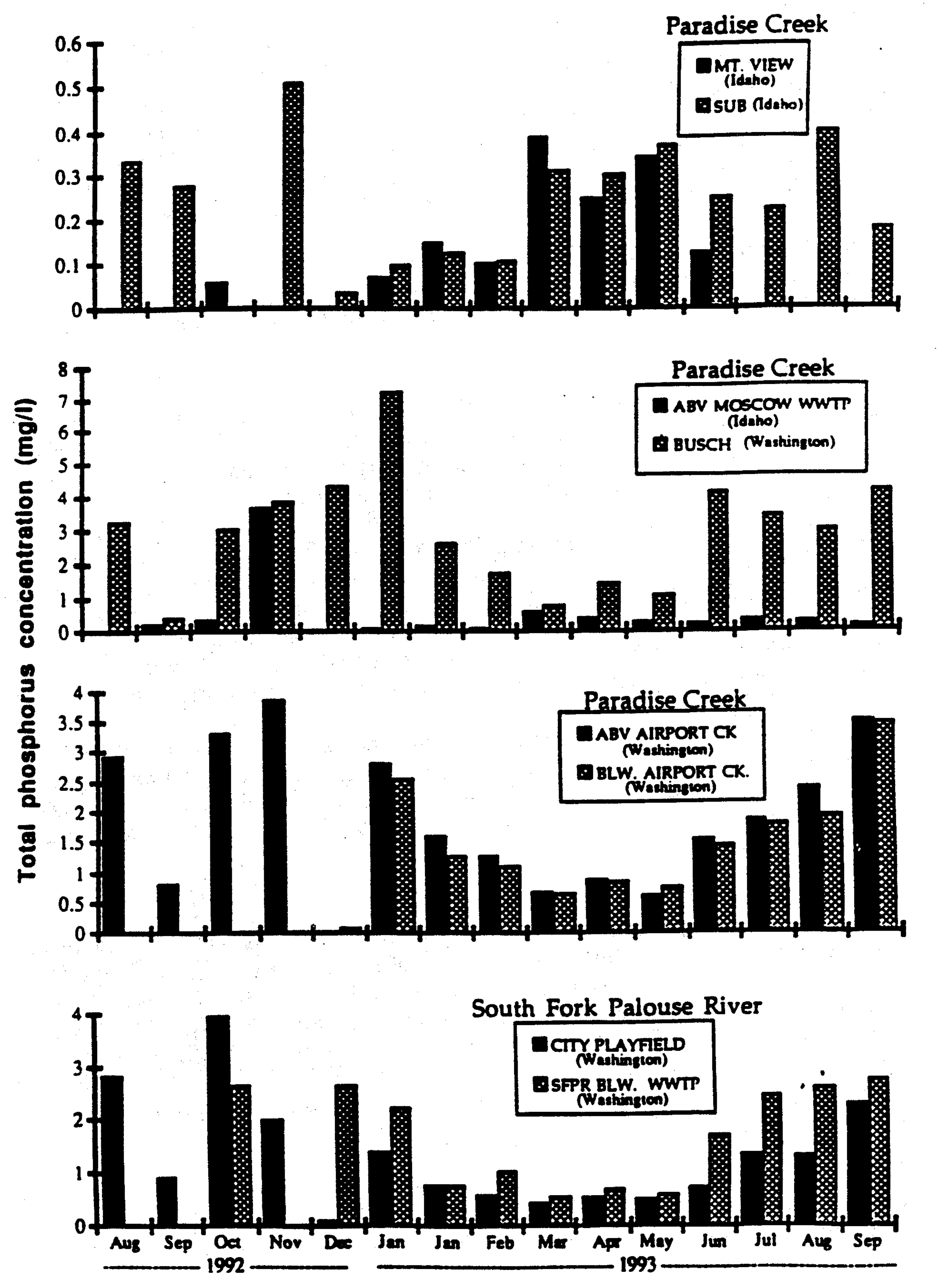

Figure 1.18 Total phosphorus concentrations of selected sites from Paradise Creek and the South Fork of the Palouse River. (Note: the y-axis values in each of the graphs vary in size).

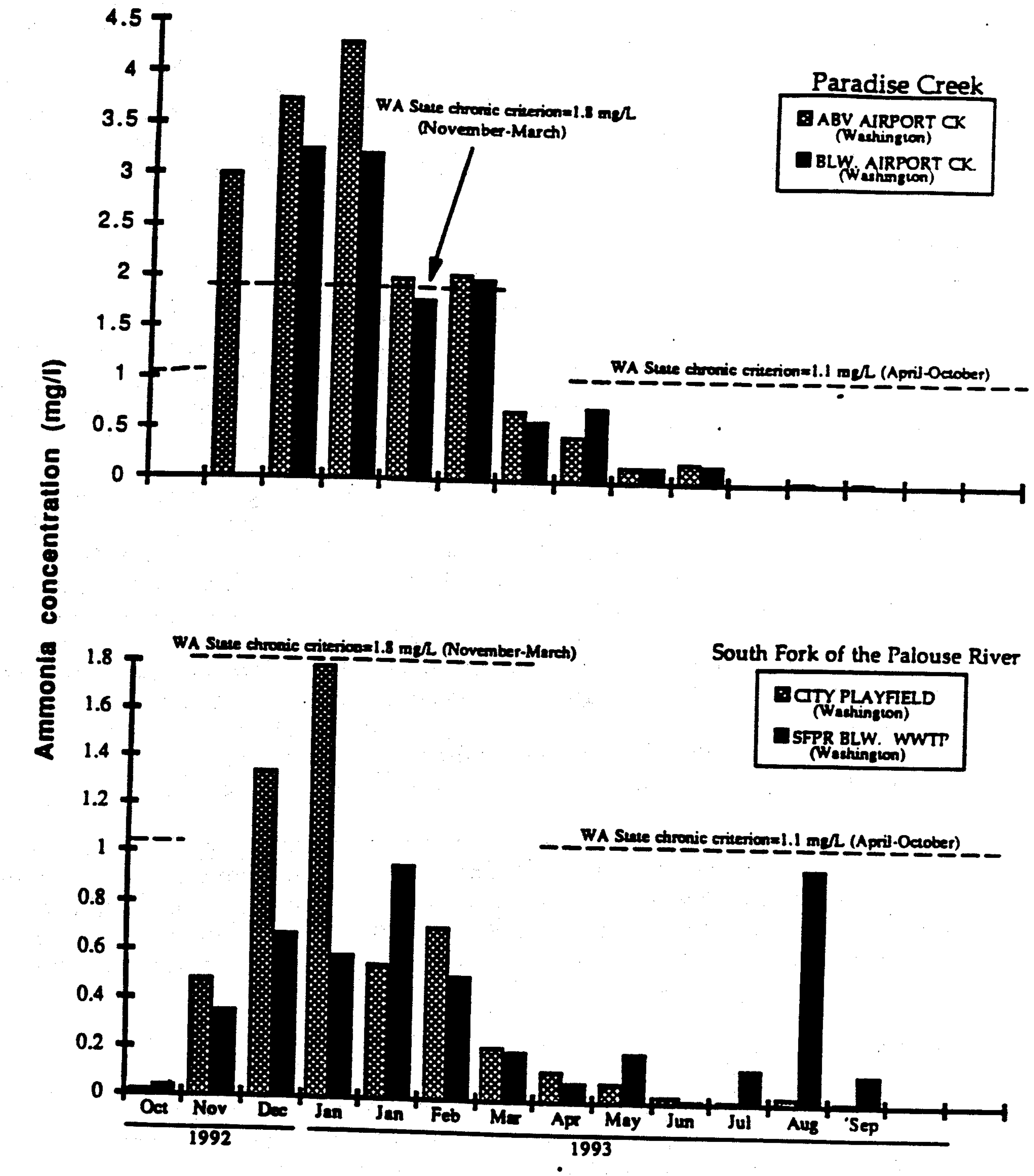

Figure 1.19 Ammonia concentrations of selected sites from Paradise Creek and the SFPR. (Note: the y-axis values in each of the graphs vary in size).

Based on WWRC data, only one violation of the dissolved oxygen standard was observed in the Pullman "Sub-basin", however, intensive surveys of the SFPR through Pullman conducted by the WDOE in July and October of 1991 show more frequent violations of the dissolved oxygen standard.

Like the Paradise Creek sub-basins, there was substantial degradation of the water quality due to phosphorus (Figure 1.18), nitrate, bacteria and suspended solids in the SFPR. WWRC data measured concentrations as high as 15.2 and 25.88 mg/L at the Below PWWTP station.

Water Quality Problems

Of the twelve water quality parameters monitored, seven--phosphorus, nitrate-nitrogen, dissolved oxygen, ammonia, water temperature, suspended solids, and fecal coliform--are of concern because they exceed Washington and/or Idaho water quality standards, stimulate eutrophic conditions, or threaten the designated uses of the stream.

Phosphorus and nitrate-nitrogen are present in high enough concentrations to stimulate massive algal and macrophyte populations that cover up to 100% of the stream bottom in some places during the summer. This, in turn, causes large diurnal and seasonal fluctuations in dissolved oxygen concentrations. Ammonia, which is found in elevated concentrations in the majority of the sub-basins, can be toxic to aquatic organisms and consumes dissolved oxygen during nitrification. Dissolved oxygen and water temperatures are both parameters of concern because they often fail to meet Washington State standards which are designed to support salmonids and healthy macroinvertebrate populations. The high suspended solids concentrations observed during peak runoff and stream flow are of great concern because they degrade the water clarity and fish habitat of Paradise Creek.

The fecal coliform concentrations observed in the Headwater and Moscow Sub-basins were as high as 7.5 times greater than the maximum limits set by Idaho water quality standards. In the Middle Reach and Pullman Sub-basins, fecal coliform concentrations have been observed at 900 fecal coliforms/100 ml and greater than 2600 fecal coliforms/100 ml, respectively. As a result, primary contact recreation, such as swimming, is not recommended for Paradise Creek or the SFPR.

Nonpoint Source Pollution

Unlike point sources of pollution, such as effluent from waste water treatment plants, nonpoint source pollution is extremely difficult to quantify because it originates from large undefined areas such as a clear-cut forests, city streets, and agricultural fields. Nonpoint pollution sources in the Paradise Creek watershed include agriculture, livestock, forestry, urban runoff, household hazardous waste, construction, septic system failure, mining, recreation, and chemically contaminated sites. The relative contribution of these sources to Paradise Creek is unknown.

Agriculture is the major nonpoint source of pollution to Paradise Creek. It represents the largest land-use in the watershed and occurs in all five sub-basins. Pollutants that come from agricultural practices include sediment, nutrients, organic materials, pesticides, and herbicides. These pollutants are bound up in the soil and enter surface waters when erosion occurs. The Palouse hills are very susceptible to erosion due to their topography, soil texture, and lack of vegetative cover during the period of maximum precipitation (November-March).

Urban runoff, construction, forestry, rock mining and recreational vehicles are recognized as activities within the watershed which contribute suspended solids, nutrients and other pollutants to Paradise Creek. The amount of pollutants coming from these activities remains unquantified however.

The remediated Sweet Avenue Site which borders Paradise Creek as it flows through Moscow is believed to have been an intermittent source of nitrate and several pesticides. A recent multi-phase clean-up and remediation of the Sweet Avenue Site is expected to have eliminated this site as a source of contamination to Paradise Creek. Testing continues during 1997 and 1998.

Land Use Impact on Water Quality and Habitat

Table 1.6 summarizes the impacts of land uses and their associated activities on the water quality of Paradise Creek. Different land uses may impact the water quality in a similar manner (e.g. forestry and construction) but the intensity and extent in which the land use takes place can be radically different.

Agriculture is the largest land use in the watershed, using approximately 83% of the land area. The fields are intensively farmed and barren for much of the year, making them extremely vulnerable to erosion.

8.5% of the watershed is designated as urban. Although this is much smaller than agriculture, it contains a relatively large and dense population of people, cars and pets. Because urban areas are composed largely of impervious areas such as streets, parking lots and roof tops, precipitation quickly runs off, carrying numerous pollutants into Paradise Creek.

Forestry comprises approximately 8.1% of the land use within the watershed. At present, there is very little timber harvesting or road building in the Paradise Creek watershed, and the impact of forestry on the water quality of Paradise Creek is relatively small compared to agriculture or urban land uses.

Basalt rock mining is the only heavy industry found within the watershed. This occurs along Highway 270 in the Moscow/Pullman corridor. The exact impact of rock quarries on Paradise Creek water quality is unknown.

Table 1.6 Land use impacts on the water quality and habitat of Paradise Creek and the SFPR (within the Pullman City limits).

Land use	Pollution Source	Pollutant(s)	Impact on Water Quality and Habitat
Urban	MWWTP	1. nutrients and 2. ammonia (from effluent)	1. > eutrophication; 2. > toxicity, < dissolved O_2
	PWWTP	1. ammonia (from effluent)	1. > toxicity, < dissolved O_2
	Street and parking lot runoff	1. sediment and 2. nutrients (from yard debris) 3. bacteria (from pet feces) 4. heavy metals, greases, oils (from automobiles)	1. > suspended solids, degrades fish and invertebrate habitat; 2. > eutrophication; 3. > pathogens; 4. > toxicity; > oil sheens on water
	Construction	1. sediment and 2. nutrients (from soil erosion)	see Forestry
Agriculture	Highly erodible fields; agricultural chemicals	1. sediment and 2. nutrients (from soil erosion) 3. herbicides and pesticides	1. > suspended solids, degrades fish and invertebrate habitat; 2. > eutrophicatior 3. > toxicity
	Livestock	1. bacteria and 2. nutrients (from feces)	1. > pathogens; 2. > eutrophication
Forestry	Forest roads and clear-cuts	1. sediment and 2. nutrients (from soil erosion)	1. > suspended solids, degrades fish and invertebrate habitat; 2. > eutrophication
	Wildlife	see Livestock	see Livestock
Mining	Rock quarries	see Forestry	see Forestry
Recreation	Off-road vehicles, mountain bikes	see Forestry	see Forestry
Other	Toxic sites	1. nutrients 2. ammonia, pesticides, herbicides, 3. petroleum products	1. > eutrophication; 2. > toxicity, 3. > oil sheens on water
	Failing septic systems	1. bacteria and 2. nutrients (from human waste)	see Livestock

Note: The symbols (>) and (<) = increase(s) and decrease(s), respectively.

Riparian Habitat Assessment and Bioassessment Summary

In addition to the Washington Water Research Center study, a habitat assessment and bioassessment of Paradise Creek was performed during 1992-1993 by Rabe *et al.* (1993). Seven stations along Paradise Creek and the South Fork of the Palouse River in Washington and Idaho were assessed.

Table 1.7. Habitat Assessment Scores of Paradise Creek October 1992 and February 1993 (Rabe et al., 1993).

Parameter	Mtn. View		White & Troy		6th & Deakin			Blw. WWTP		Schwartz	
	Oct	Feb	Oct	Feb	Oct	Feb	Oct[3]	Oct	Feb	Oct'91	Feb'92
Bottom Substrate	3	2	3	3	6	4	2	10	3	15	16
Embeddedness	2	2	2	2	7	4	2	12	6	11	14
Channel shape	2	2	5	5	2	2	2	12	12	13	13
Riffle/bend ratio	1	1	1	1	2	2	2	4	4	11	11
Channel alteration	2	2	2	2	2	2	1	5	5	15	15
Lower bank stability	3	3	5	5	5	5	4	6	6	8	8
Bank Vegetation protection	4	4	6	6	6	6	6	8	8	10	10
Canopy cover	2	0	7	5	7	5	7	6	4	8	6
Width of riparian	3	0	4	2	4	2	4	8	3	8	8
TOTAL SCORE	22	16	35	31	41	32	30	69	49	99	101

Based on the parameters chosen in this assessment, the qualitative habitat quality for a stream segment is rated as excellent (101-125), good (67-100), fair (33-66), or poor (0-32). The above results show that the habitat quality at Mountain View Park is poor throughout the year. The bottom substrate at this site is severely impacted with several centimeters of fines covering the gravel at all times (Rabe *et al.* 1993). This site receives a relatively low score in all parameters except bank vegetation protection. The Mountain View Park site was historically a wetland and still maintains hydrophilic plant populations such as sedges (*Carex* sp.), submergent plants, arrowheads (*Sagittaria* sp.), pondweed (*Potamogeton* sp.), and cattails (*Typha latifolia*). This station contains the highest numbers of in-stream plants, which are attractive to water quality sensitive insects such as caddisfly larvae and mayflies (Rabe *et al.* 1993). The banks are stabilized by an abundance of reed canary grass (*Phalarus arundinacea*). During low flow periods, this site consists of isolated pools covered with large mats of duckweed (*Lemna minor*).

The habitat quality rating at the White Avenue & Troy Highway stations is fair. At this site, water depth and velocity increases. Rip-rap has been placed in a short section of the channel which creates a riffle. Fairly extensive gravel beds also exist.

[3] October 1993

Both maples (*Acer* sp.) and willows (*Salix* sp.) grow along the bank and contribute coarse particulate organic matter (CPOM) in the form of leaf fall. The lower reach of the channel contains a fairly dense concentration of macrophytes including pondweed, arrowheads, and duckweed. The banks are more steeply sloped and are stabilized by reed canary grass. Some undercut banks exist in the upper reaches of the channel.

The Sixth Street & Deakin station also received a fair habitat quality rating. Dr. Rabe characterizes this site as an elongated, deep pool containing an accumulation of fines. Below this pool is a riffle area with the bottom substrate comprised of gravel bars alternating with fines. Although the upper bank is eroded in several places, the lower bank is stabilized by reed canary grass. Little submerged vegetation exists at this site. This section of the creek has been channelized. Large mature elm (*Ulnus* sp.) trees parallel the creek on both sides and are a source of CPOM. This site is in the middle of Moscow. Oil slicks have been seen on the water surface, and a hydrogen sulfide smell has been noted. This site was impacted adversely by the construction of sewer and water pipes across the stream channel and was re-evaluated in October 1993, when it received a much lower score for bottom substrate and embeddedness (Table 1.7).

In contrast to having the poorest water quality, the station below the Moscow WWTP was given the highest habitat quality score, though it was still scored as fair. The WWTP discharges approximately two million gallons a day into Paradise Creek nearly doubling its flow. This section of the creek is characterized by slight meanders and steep stable banks, some of which are undercut. A large riffle exists where boulders were placed to support a railroad trestle. Reed canary grass grows on the bank and no submergent plants exist. The substrate is largely gravel and is covered with fines after large runoff events.

Schwartz Creek, the reference stream, exhibits optimal habitat conditions and received a rating of good. Substrate consists of gravel and small cobble interspersed with submergent and emergent aquatic plants, tree roots, and logs. Undercut banks are also frequent. Embeddedness is highest in the pools where the gradient is reduced. Velocity-depth conditions are diverse with slow deep, slow shallow, and fast shallow habitats present. The dominant vegetation is alder (*Alnus incana*) which provides bank stabilization, shading, and a source of CPOM.

Macroinvertebrates

Benthic macroinvertebrates are used as environmental indicators because they are relatively stationary and represent the biological integrity of a particular location. Information regarding changes in the community structure and function enable investigators to determine water quality conditions (Klemm *et al.* 1990). Dr. Fred Rabe *et al.* (1993) have monitored the macroinvertebrate communities of Paradise Creek since 1991. The data used in this study was collected in October 1992 and February, April, June 1993 (Table 1.8). Samples were collected along the entire

length of Paradise Creek and portions of the South Fork of the Palouse River, but only those stations in Idaho are presented below. Schwartz Creek was used as a reference site.

In most of the samples, chironomidae (midges) were the dominant insects in Paradise Creek and are therefore ecologically important because of their high density and diversity. Total midge abundance in excess of 30% probably indicates depressed habitat/water quality (Wisseman 1993). In contrast, midge populations in samples from Schwartz Creek were well below 30% of the total abundance. Other dominant insects included Odonata, the dragonflies and damselflies. In the October samples, high numbers of damselflies were found at White & Troy and Sixth & Deakin. Damselflies are extremely tolerant of impaired water conditions and sediment, their ability to climb onto the reed canary grass enables them to partially avoid the water (Rabe *et al.* 1993). Oligoehaeta (aquatic earthworms) had the highest density of the non-insects at the three lower sites. In October, over a thousand individuals per square meter were recorded below the MWWTP. This is a common occurrence below sewage effluent. Other non-insect dominants were Gastropoda (snails) and Hirudinea (leeches).

Table 1.8. Macroinvertebrate Results in Paradise Creek

Metric Evaluated	Mt. View Park Oct	Feb	Apr	Jun	White & Troy Oct	Feb	Apr	Jun	6th & Deakin Oct	Feb	Apr	Jun	Below WWTP Oct	Feb	Apr	Jun	Schwartz Oct	Feb	Apr	Jun
Total Abundance	213	219	398	380	645	133	131	195	847	77	200	194	1412	478	427	803	146	-	-	56
Species Richness	31	16	31	38	28	19	24	26	23	14	23	14	5	7	6	12	36	34	29	33
EPT-Taxa Richn.	2	2	3	4	0	1	0	2	0	0	0	0	0	0	0	0	21	20	18	18
Hilsenhoff B.I.	7.0	4.2	6.7	7.4	7.6	7.9	7.8	8.2	8.9	8.0	8.1	8.4	9.0	9.0	9.0	8.7	3.2	-	-	4.5
%Donimant Taxa	15	41	24	18	32	19	27	21	35	41	16	19	73	87	80	50	7	-	-	-

Perhaps the most important indicator of overall stream health is the EPT Taxa Richness, which includes the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisworms). Many of these species are very pollution sensitive; stations having high EPT numbers are associated with clean water and unimpacted habitat. Table 3.2 indicates that EPT Taxa Richness was highest at Mountain View Park with values ranging between 2 and 4, although it should be noted that no Plecoptera were found in the creek. This suggests that the water quality is highest at this site and that the large amount of in-stream vegetation supports the macroinvertebrate populations. EPT Taxa Richness decreases slightly at the White Avenue & Troy highway site with values ranging between 0 and 2. This indicates that water quality has begun to decrease. By the Sixth Street & Deakin site the water quality has significantly decreased so that EPT populations are no longer supported. On a relative basis, EPT values at the upper sites appears to be fair but when the EPT Taxa Richness values are compared to those of Schwartz Creek, it becomes apparent that Paradise Creek is highly degraded.

The Hilsenhoff Biotic Index (HBI) summarizes the overall pollution tolerances of the taxa collected. Tolerance values for taxa range from 0-10, with taxa assigned higher values to indicate an increased tolerance to organic and sediment pollution. This index can detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. The lowest HBI value (4.2) was recorded at Mountain View Park in April, the highest (9.0) was recorded below the WWTP. The yearly average for all the sites is as follows: Mountain View Park (6.3), White & Troy (7.9), Sixth & Deakin (8.4), and Below WWTP (8.9). It should be noted that the Chironomidae data was not included in the HBI scores. If it was, the average values for all four stations would have been higher since Chironomids were numerous and are highly tolerant to poor water quality. The HBI results coincide with the EPT Taxa Richness results, indicating that water quality decreases downstream.

The Moscow WWTP has a significant impact on the composition of the macroinvertebrate community at Station 4. The total species richness is less than half of the other sites. Although total abundance is higher than the other sites, these numbers are represented only by a few species. In October, 96% of the individuals were aquatic earthworms and midges, both of which are highly tolerant to poor water quality (Rabe *et al.* 1993). The habitat at this site is fair, possibly because poor water quality limits the biological integrity or structural and functional components of the macoinvertebrate community.

Fish Monitoring

Results from fish shocking in Paradise Creek can be found in Table 1.9.

Table 1.9. Electroshocking Results in Paradise Creek

Species	Amount	Size	Location
Speckled dace (*Rhinichthys osculus*)	>50	1-3"	Mountain View Park[4], White & Troy Hwy., Gus Wicks Field
Bridgelip sucker (*Catostomus columbianus*)	11	3-6"	White Avenue & Troy Highway
Longnose sucker (*Catostomus catostomus*)	1	6"	White Avenue & Troy Highway

(Wertz, 1993)

Speckled dace is typically classified a cold water fish. All of the fish that were recovered appear to be healthy and two or three different age classes were represented. Two speckled dace were found at Guy Wick's Field where the habitat is similar to that below the MWWTP; this suggests that the water quality is the limiting factor in supporting the fish. The speckled dace will live in a variety of habitats, but normally prefers shallow, cool, and quiet waters. This fish serves as an important forage fish for trout when both are present in the same stream. The Bridgelip sucker prefers the colder water of small, fast flowing rivers with gravel to rocky bottoms. However, it may also live in waters with a more moderate current with the bottom composed of sand and silt. It may be assumed that habitat requirements are similar for the Longnose sucker. The major food items for the Longnose sucker are algae, midge larvae, and most other bottom-dwelling aquatic invertebrates (Simpson and Wallace 1982).

[4] Shocking recovery estimated at 20% due to large amounts of duckweed on water surface.

Part II. The Paradise Creek Watershed Project

A. The Paradise Creek Watershed Project and the Paradise Creek Management Committee

Paradise Creek is an extremely visible and culturally important stream. The Paradise Creek corridor is traveled by workers, students, and faculty in their commute between Washington State University, the city of Pullman, the University of Idaho, and the city of Moscow. As a result, the state of the stream is a matter of public interest. Various groups have sought to implement a coordinated project to improve the habitat and water quality of the creek and make it an asset to the communities.

A group of concerned citizens, agencies, and civic groups convened to sponsor a project leading to the development of a water quality management plan for Paradise Creek. As a result of this effort, Palouse Conservation District (PCD) submitted a grant application to fund this planning effort and now serves as lead agency for the project. The Paradise Creek Watershed Water Quality Management Plan (hereafter PC Plan) is the outcome of these efforts.

The Paradise Creek Management Committee

As the next step in the project the group formed the Paradise Creek Management Committee. The Paradise Creek Management Committee (PCMC) was formed after notifying all known landowners by mail of the project's basic objectives, the envisioned function of the PCMC, and of a proposed work plan for the project. Those groups known to be interested were asked to designate a representative. The initial group then identified possible interested parties and individuals not present. Their representation was recruited. The resulting committee is a broad-based, grassroots body representative of the watershed community.

The PCMC also recruited persons of sufficient technical knowledge to assess the current status of the stream and to evaluate the steps needed to begin restoring the stream. They formed a technical sub-committee to collect and analyze data and to make recommendations to the Paradise Creek Management Committee. The technical sub-committee is composed of agency, university, city, and other individuals who have or have access to expertise needed to make informed decisions. Typically, agency personnel serve in an advisory mode to the Committee.

Participants in the Paradise Creek Project

The Paradise Creek Management Committee includes representatives from the following groups:

Palouse Conservation District,
Whitman County,
City of Pullman,
Washington State University,
Pullman Business District,
Washington Agriculture,
Pullman Civic Trust,

Latah Soil and Water Conservation District,
Latah County,
City of Moscow,
University of Idaho,
Moscow Business District,
Idaho Agriculture,
Palouse-Clearwater Environmental Institute.

Technical Subcommittee members who provide information and advice to the Paradise Creek Management Committee include representatives from the following organizations:

Washington Department of Ecology,
Washington Water Research Center,
WSU Environmental Health and Safety,
Pullman Public Works Department,
U.S. Environmental Protection Agency,
UI Facilities Management Department.

Idaho Division of Environmental Quality,
Idaho Water Resources Research Institute,
U.S. Fish and Wildlife Service,
Moscow Public Works Department,
WSU Civil and Environmental Engineering,

Other invited agencies and entities include:

Washington Department of Transportation,
Idaho Department of Transportation,
Burlington Northern Railroad,
Palouse River Railroad.

Paradise Creek Watershed Project Procedures

To develop the PC Plan, the Paradise Creek Management Committee divided the process into several steps. As a first step, the committee defined its mode of operation and guiding principles. The committee agreed to operate on the basis of consensus decision making. Consensus decision making requires that each member support a decision before it is considered as a committee decision or recommendation. A PCD staff coordinator, assisted by committee members, facilitates the meetings in a manner consistent with the consensus process adopted by the committee. The PCMC adopted the following guiding principles for the project:

- Foster respect for the value of Paradise Creek's historic and potential contribution to the quality of life on the Palouse
- Balance expectations of land owners and other habitat users with sensitivity to costs of implementing and maintaining improvements.
- Facilitate conditions which encourage natural regenerative processes to enable Paradise Creek to support beneficial aquatic and riparian plants and animals.
- Maintain sustainable uses by promoting equilibrium between urban, agricultural, recreational, and environmental interests.

The next step in the process was to acquire a thorough knowledge of the watershed and the factors affecting water quality within the watershed. Through reviewing all available information, the committee gained a common understanding of the factors affecting the watershed and the needs of each of the watershed's land users. After becoming familiar with the watershed, the committee defined goals for each of the sub-basins in terms of supported uses, water quality, physical characteristics, and aesthetics. This discussion focused on desired characteristics without the constraints of identified problems or other limitations. By envisioning a desired state of the watershed, the committee expanded their vision of the watershed.

Finally, the Paradise Creek Management Committee considered many possible actions to improve identified water quality problems in the Paradise Creek Sub-basins. After thoroughly discussing the alternatives, those actions that were consistent with the PCMC's guiding principles were adopted as recommendations. From these recommendations, action steps, timelines, and strategies were developed.

B. PCMC Identified Land Uses and Associated Problems

The problems in the Paradise Creek watershed occur in several forms. Degrading factors include sedimentation from urban and rural sources, nutrients, toxics, fecal coliform concentrations, loss of habitat, and storm water effects from urban influences. Other associated factors of concern include dissolved oxygen levels and elevated water temperatures.

Paradise Creek watershed: All Sub-basins

Several land uses affect each of the sub-basins in the watershed.

Agriculture: Agriculturally related erosion results in increased sediment levels. Increased nutrient levels occur through the movement of soluble nitrates and from phosphorus attached to sediments.

Livestock: Livestock production degrades the stream's water quality through increased fecal coliform populations, increased nutrient concentrations, and through contributing to increased sediment loads. Also, livestock grazing degrades riparian habitat and can increase stream erosion.

Other land uses do not occur as widely and are presented by sub-basin. The headwaters sub-basin has been further divided into forested and agricultural uplands.

Headwaters Sub-basin: Forested Upland

Water quality in the forested uplands remains good despite occasional fecal coliform episodes. Potential water quality degradation from expanded land use may occur in the following four major areas.

Rural Residential Development: Rural residential development in the forested uplands creates potentially degrading influences by increasing sediment and its associated attached nutrients as a result of construction activities, road maintenance and construction, and other uses that remove vegetative cover from the land. The potential for denuding forest fires in the area increases dramatically as housing is located in the forested area. Another potentially degrading influence includes the potential for nutrients, ammonia, and bacteria from poorly located, constructed, and maintained septic systems. Increased use of household fertilizers, herbicides, and other pesticides can degrade the stream if not use in an appropriate manner.

Recreation: Off road vehicles when operated during critical periods cause severe erosion both on dirt roads and open areas. This erosion leads to increased sediments in the stream. Attached nutrients are carried with sediments and also degrade water quality.

Forestry: Improper logging activities can create additional sedimentation and associated nutrient problems. Road construction and timber handling techniques can leave areas exposed to severe erosion during the winter and other rainfall events.

Headwaters Sub-basin: Agricultural Uplands

Water quality in the agricultural uplands is impacted by dryland farming, by livestock production and by residential development. Agriculture and livestock were covered as watershed-wide uses.

Residential: Rural residential development in the agricultural uplands creates potential degrading influences through increased sedimentation and the associated attached nutrients due to construction activities, road maintenance and construction, and other uses that remove stabilizing vegetative cover from the land. Septic tanks produce potentially degrading factors which include nutrients, ammonia, and bacteria from poorly located, constructed, and or maintained systems. Increased use of household fertilizers, herbicides, and other pesticides can degrade the stream if not used in an appropriate manner.

Moscow Sub-basin

The Moscow Sub-basin exhibits the common point and nonpoint problems associated with urban and agricultural lands. Identified problem areas include:

Waste Water Treatment: The major factor impacting Paradise Creek in the Moscow Sub-basin is Moscow's waste water treatment plant. Problems include excessive phosphorus, nitrate, and ammonia. The high level of nutrients provides a basis for excessive algae growth which further degrades water quality.

Industrial Site: A site previously used for farm chemicals, fertilizer and oil distribution is located near the intersection of Sweet Avenue and South Main in Moscow. This site has been remediated.

Pavement Runoff: Storm water runoff from street and parking lots contributes degrading materials including sediments, nutrients, bacteria, heavy metals, and greases and oils.

Construction: Erosion from construction sites contributes significantly to sedimentation in the Moscow reach. This loading also contributes to nutrient problems in the stream.

Residential: Nutrients from yard debris, household and commercial fertilizers and pesticides, and other degrading materials from commercial wastes degrade the water quality of Paradise Creek.

Middle Reach Sub-basin

The Middle Reach Sub-basin includes land-uses and their associated problems common to other sub-basins in the watershed, as well as the following land-uses:

Highway Runoff: Storm water runoff from the Pullman-Moscow Highway contributes degrading materials including sediments, nutrients, bacteria, heavy metals, and greases and oils.

Construction: Future commercial and residential construction in the Middle Reach has the potential to impact water quality. Erosion from construction sites can contribute significant sediment to the stream, with associated nutrient problems.

Heavy Commercial: These uses have the potential to impact water quality in the Middle Reach.

Mining: Erosion of exposed areas contributes sediment and associated nutrient degradation to Paradise Creek.

Septic Systems: Septic systems in the Middle Reach may contribute to fecal and ammonia problems.

Airport Creek Sub-basin

The Airport Creek Sub-basin includes the Moscow-Pullman Airport, agriculture, WSU research livestock and wildlife, and other university land uses. The Airport Creek Sub-basin has an inactive chemical disposal site which at present is not known to be degrading Airport or Paradise Creek. Land uses and their associated problems are listed below:

Wildlife Research Animals: Livestock and wildlife research animals are kept in the sub-basin. WSU's Airport Road Creek Water Quality Study shows that wildlife currently are not a source of pollution, but livestock maybe a source of pollution.

WSU Maintenance Facility: WSU has a maintenance facility in the Airport Creek watershed which contributes to storm water runoff into the creek. WSU's Airport Road Creek Water Quality Study has not found any contamination problems in this runoff.

Pavement Runoff: Storm water runoff from roads and the airport contributes degrading materials including sediments, nutrients, bacteria, heavy metals, and greases and oils. Sampling below the airport showed little degradation due to the airport land use.

Demolition Waste Disposal Site: Impact unknown.

Pullman Sub-basin

The Pullman Sub-basin has been included to assist in monitoring and planning. The Pullman Sub-basin consists of the urban area which drains into the remainder of Paradise Creek and the South Fork of the Palouse River (SFPR) within the city limits of Pullman. In addition to urban land uses, the Pullman Sub-basin is impacted by Washington State University through its staff, faculty, student population, and other research and maintenance facilities.

Waste Water Treatment: A major factor impacting the SFPR in the Pullman Sub-basin is Pullman's waste water treatment plant (PWWTP). The PWWTP currently meets nutrient and ammonia standards while contributing nitrates and phosphorus to the SFPR.

Urban Highway Runoff: Storm water runoff from street and parking lots contributes degrading materials including sediments, nutrients, bacteria, heavy metals, and greases and oils to Paradise Creek and the SFPR.

Construction: Erosion from construction sites contributes sediment in the Pullman Sub-basin. This also contributes sediment associated nutrients to Paradise Creek and the SFPR.

Residential: Nutrients from yard debris, household fertilizers and pesticides, and other materials degrade the water quality of Paradise Creek and the SFPR.

Summary

Agriculture represents the largest land use in the watershed and is a major nonpoint source pollutant contributor to Paradise Creek. Degrading materials include sediments and their associated nutrients. While urban land uses represented by the cities of Moscow and Pullman are relatively small in acreage, the Moscow sub-basin contributed a higher level on a per acre basis of sediments than did the upstream agriculture and forestry lands. While the waste water treatment plant effluent beneficially provides the majority of Paradise Creek's flow during low flow periods it also contributes high levels of ammonia, nitrates, and phosphorus to Paradise Creek. Additional land uses including recreation, livestock, mining, and forestry impact the water quality of Paradise Creek (Table 4.1). Addressing the issues of sedimentation, temperature and nonpoint nutrients (phosphorus) in each sub-basin will lead to significant improvements in the water quality of Paradise Creek.

C. Paradise Creek Project Goals and Objectives

An Overview of the Desired Appearance for Paradise Creek

The PCMC envisioned a future Paradise Creek with improved riparian buffers to reduce sedimentation, improve fish and wildlife habitat, and visually improve Paradise Creek. The Committee recognized that increasing riparian areas would provide an improved food source for resident wildlife, while providing channel structure and shade for fish habitat. Toxics and other pollutants would be reduced through uptake, allowing for overall cleaner water.

In the future, the Committee envisioned more park-like settings and recreational uses along Paradise Creek. Local residents commuting between Moscow and Pullman would experience a more interesting environment with more trees and greenery. Communities will have greater access to secondary contact recreational activities, such as walking along the stream, observing wildlife, and bird watching. In addition, improved conditions along Paradise Creek will provide a greater opportunity for recreational fishing while maintaining agricultural water supplies.

Paradise Creek Management Committee Goal Statement

The PCMC carefully developed a goal statement that personified the views and values essential in developing a water quality plan for Paradise Creek:

> The goal of the Paradise Creek Watershed Water Quality Management Plan is to identify water quality problems and provide a framework for implementing practical and economical practices which promote the natural restoration and continuing viability of Paradise Creek.

Specific Goals and Objectives

Based on the findings of the *Paradise Creek Use Attainability Assessment*, the PCMC will combine it's efforts with Idaho's DEQ to establish attainable goals for Paradise Creek. The goals of the PC Plan are to improve the water quality in Paradise Creek so that it will support the beneficial uses of: (1) secondary contact recreation, (2) agriculture water supply, (3) cold water biota, and (4) salmonid spawning. The objectives identified for each beneficial use were chosen on the basis that they were either existing water quality parameters being used by Idaho's DEQ or an objective considered to directly support a specific beneficial use. Each beneficial use and it's objectives are addressed separately.

Secondary Contact Recreation. Secondary contact recreation, an existing use, includes activities with less intimate contact with water, such as fishing, boating, and wading. These activities present a minimal possibility of ingesting raw water. In contrast, primary contact recreation includes activities such as swimming, skiing, and diving. Fecal coliform reduction is a principal objective for both primary and secondary contact recreation. Achieving the following objectives will act to support the beneficial use of secondary contact recreation:

- Reduce Sedimentation
- Reduce Toxicity
- Reduce Nutrient Loading
- Reduce Fecal Coliform
- Improve Aesthetics
- Improve Aquatic Habitat Quality
- Improve Wildlife Habitat Quality
- Improve Stream Bank Stability

Agricultural Water Supply. As a existing beneficial use, agricultural water supply refers to waters suitable or potentially suitable for the irrigation of crops or as drinking water for livestock. Achieving the following objectives will support the beneficial use of an agricultural water supply:

- Reduce Nutrient Loading
- Reduce Sedimentation
- Reduce Toxicity

Cold Water Biota. As an existing beneficial use, cold water biota refers to the waters suitable or intended to be made suitable for the protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species that have an optimal growing temperature below 18 degrees C. Habitat improvement for aquatic life in Paradise Creek will include improving habitat structure as well as improving water quality. Upgrading water quality in Paradise Creek by achieving the following objectives will act to support the beneficial use of cold water biota:

Reduce Water Temperatures
Reduce Nutrient Loading
Reduce Sedimentation
Reduce Toxicity
Increase Dissolved Oxygen
Improve Stream Habitat Quality
Improve Stream Bank Stability
Improve Riparian Quality

Salmonid Spawning. Salmonid spawning, an identified attainable use, refers to waters which provide suitable or potentially suitable habitat for active self-propagating populations of salmonid fish during the spawning and incubation periods of the year. Water temperature, dissolved oxygen and sedimentation act as the primary limiting factors for such activities. Upgrading water quality in Paradise Creek by achieving the following objectives will act to support the beneficial use of salmonid spawning:

Improve Stream Habitat Quality
Improve Stream Bank Stability
Reduce Water Temperatures
Reduce Sedimentation
Reduce Toxicity
Increase Dissolved Oxygen

D. Committee Recommendations

The Committee recognizes that human activities will occur in the watershed. PCMC envisions active management to be an essential component of the watershed planning process. Recommendations for Paradise Creek are divided into the following five separate areas of the watershed.

Forested Uplands

The PCMC endorses Idaho's State Forest Practices Act as a comprehensive guide for forestry practices. The Committee recommends forest practices that reduce

sedimentation and enhance water quality. The Committee focused on recommending practices and activities that would reduce impacts from unpaved roads of rural residential areas and road construction. The PCMC recommends the following practices:

- Continued implementation of Idaho's State Forest Practices Act and associated BMPs.
- Develop specifications that minimize sedimentation and turbidity for upland dirt roads.
- When feasible, utilize road closures during highly erodible periods of the year.
- Prohibit off road vehicles in areas sensitive to severe erosion.
- Encourage all jurisdictions to work with local fire departments and planning/zoning agencies to develop criteria for road development and road accessibility.

Agriculture Uplands

The PCMC recommends the following conservation practices:

- Establish buffer areas along stream banks with diverse vegetation for channel stabilization, wildlife habitat, and shading to lower stream temperatures.
- Continue uphill plowing practices to maintain residue content.
- Establish grass waterways where appropriate.
- Utilize shank and seed practices to minimize the effects of tillage, when appropriate.
- Install sediment retention structures such as gully plugs and sediment basins.
- Manage grazing practices along riparian areas to minimize impact.

Moscow Sub-basin

The Committee encourages the various jurisdictions to coordinate their efforts in water quality management so as to achieve the desired goals and objectives as described in this plan. The PCMC recommends the following practices:

- Establish environmental educational programs for water quality.
- Develop guidelines for proper lawn fertilization.
- Develop a household hazardous waste program.
- Install catch or sediment retention basins for large parking lots.
- Identify the damage caused by improper dumping into storm drains.
- Develop sediment control programs for construction sites.
- Where appropriate construct greenbelts along Paradise Creek.
- Establish a method for allocating the responsibility of land owners in sediment control.

- Initiate proactive street sweeping programs.
- Develop snow and ice management guidelines.
- Provide economic incentives for installing storm sewer systems.
- Upgrade Moscow's Waste Water Treatment Plant.
- Develop a comprehensive stormwater runoff ordinance.

Middle Reach Sub-basin

The PCMC recommends the following practices for the Middle Reach Sub-basin:

- Establish diverse riparian buffers that will reduce sedimentation and be visually pleasing.
- Design riparian buffers to stabilize stream banks and channels.
- Provide shade to reduce stream temperatures.
- Encourage the use of grassy swales, ditches, and catch basins for storm drainage.
- Encourage the use of sediment retention structures and other agricultural conservation practices.
- Establish weed control guidelines or a weed control program.
- Manage grazing within riparian areas.

Airport Creek

The PCMC recommends the following practices for the Airport Creek Sub-basin:

- Continue uphill plowing practices to maintain residue content.
- Utilize shank and seed practices to minimize the effects of tillage, where appropriate.
- Install sediment retention structures such as gully plugs and sediment basins.
- Encourage the use of sediment retention structures and other agricultural practices.
- Encourage the use of grassy swales, ditches, and catch basins for storm drainage.
- Establish weed control guidelines or a weed control program.
- Manage grazing within riparian areas.
- Manage animal wastes.
- Monitor airport runoff and manage when necessary.

Pullman Sub-basin

The PCMC recommends the following practices for the Pullman Sub-basin:

- Establish environmental educational programs for water quality.
- Develop guidelines for proper lawn fertilization.
- Develop a household hazardous waste program.

- Install grassy swales, sediment retention or catch basins for large parking lots.
- Identify the damage caused by improper dumping into storm drains.
- Develop sediment control programs for construction sites.
- Construct greenbelts along Paradise Creek where appropriate.
- Establish a method for allocating the responsibility of land owners in sediment control.
- Initiate proactive street sweeping programs.
- Develop snow and ice management guidelines for roads.
- Provide economic incentives for the installation of storm sewer systems.
- Develop a comprehensive stormwater runoff ordinance.

Committee Recommendations Affecting the Entire Watershed

The Committee recommends that Washington's Department of Ecology (DOE) conduct a Use Attainability Study to re-evaluate the Class A stream designation in Washington for Paradise Creek to develop a classification consistent with Idaho DEQ's classification.

The Committee recommends that the Washington Department of Ecology revise its current management policy that disallows the allocation of Centennial Clean Water Funds for projects on private lands.

Part Three: The Paradise Creek Watershed Water Quality Management Plan

Overview

The Paradise Creek Watershed Water Quality Management Plan (PC Plan) identifies and prioritizes specific activities which reflect the goals and recommendations of the Paradise Creek Management Committee for addressing problems identified during the Paradise Creek Project. The Committee members discussed the planned solutions with their respective entities and wrote letters of commitment indicating the activities they were willing to initiate. A method of assessment based upon the concept of adaptive management was designed to monitor the progress of plan implementation. Implementation of many activities in the plan has already begun.

A. The Phased TMDL Concept

The PC Plan incorporates a phased TMDL concept for water quality management. The key steps of phased TMDLs are as follows:

1. Define the beneficial uses affected
2. Determine the factors/causes
3. Determine the priorities
4. Develop pollutions control activities and identify resources
5. Monitor results to assess the status of beneficial uses
6. Adjust the controls
7. Involve the public at all steps

The PCMC advocates that most future resources be devoted to implementing water quality improvement activities and then to monitoring the cumulative effect of these activities. The continuous monitoring of project activities will allow for participating entities to proceed to improve water quality while some uncertainties remain. The feedback provided by monitoring will enable all entities to adjust their efforts to maximize beneficial impacts. The PCMC decided on this approach to developing a management plan for several reasons. The committee believes that specific problems have been adequately identified by previous and project monitoring projects. The Paradise Creek Project brings together entities who can directly address many of these most pressing problems. Many of the necessary activities, such as tree planting, phasing in BMPs, and building buffer strips along riparian areas require years before full benefits are realized for water quality. Resources for improving water quality are scarce, and the extensive monitoring projects necessary for developing a TMDL based plan would use existing scarce resources and reduce resources for implementation. With these reasons in mind, the PCMC decided that the best approach in the Paradise Creek watershed is to proceed directly to implement identified activities, to monitor all activities for impact on improving water quality, and to adjust future activities based upon results.

Steps 1, 2, and 7 have been described in Parts I and II of this report. The remain steps will be described in this part of the report.

B. The PC Plan Activity List

Participants in the Paradise Creek Management Committee identified water quality activities which their groups were willing to implement. These activities fell into three categories: "Implementation Activities" includes activities which would directly impact Paradise Creek water quality through physical changes to enhance water quality; "Planning and Policy Development Activities" includes planning, regulatory, and policy development activities; "Organizational Activities" includes activities such as education, networking, communication, and coordination. Organizational activities are critical to implementing the PC Plan, but their impacts are indirect. The PCMC prioritized each proposed project within the categories according to importance to improving the water quality of the Paradise Creek watershed.

Implementation Activities

1. *Plant Trees along Paradise Creek. - PCT/WSU/UI/PCD/PCEI*
   Cost: $400,000
   Funding Source: DOE/NRCS/Private donations/Whitman County
   Implementation Date: Ongoing

2. *Implement BMP's on agricultural lands to enhance water quality--PCD/UI*
   Cost: $2,500,000
   Fund Source: DOE/WCC/Private Foundations/WSU/UI/PCD
   Implementation Date: 1995-2003

3. *Construct bioengineering structures to stabilize stream banks and slopes*
   Cost: $600,000
   Funding Source: DOE/WSU/PCD
   Implementation Date: $300,000 project currently being implemented; $300,000 not yet funded.

4. *Plant upland areas with shrubs and trees to reduce erosion and provide habitat*
   Cost: $200,000
   Funding Source: WSU/UI/PCD/PCEI/other agency and private sources
   Implementation Date: Ongoing

5. *Enhance and restore wetlands to filter runoff, improve water quality and provide habitat*

Cost: $500,000
Funding Source: DOE/EPA/WSU/other agency and private source
Implementation Date: Ongoing

6. *Plan and upgrade storm drainage system--UI.*
Cost: Normal Operations
Implementation Date: 1995-2005

7. *Address Ammonia, BOD, and Suspended Solids at the MWWTP--Moscow*
Cost: $12,000,000-18,000,000
Funding Source: Rate payers of City Sewer Service
Implementation Date: 1999

8. *Organize Annual Paradise Creek Headwaters Cleanup--PCEI*
Cost: $9,800
Fund Source: Normal Operations
Implementation Date: Annual

9. *Remove All Non-compliant Underground Storage Tanks/Monitoring--UI/WSU (DEQ/DOE/EPA provide oversight)*
Cost: UI--$180,000; DEQ--Normal Operations
Implementation Date: December 1998

10. *Utilize BMPs to prevent soil erosion and prevent surface water pollution on construction projects of less than 5 acres --WSU*
Cost: Normal Operations
Implementation Date: Ongoing with all projects

11. *Conduct ongoing replacement of sanitary sewer systems. Problems will be corrected as capital improvement program allows--Pullman/WSU*
Cost: Normal Operations
Implementation Date: Ongoing

12. *Construct an additional wastewater holding pond along Airport Road or construct roofs over cattle holding pens contingent upon the data generated from WSU's Airport Road Creek Water Quality Study--WSU*
Cost: $1,300,000
Implementation Date: Funding Dependent

13. *Monitor and Cleanup Model Toxics Control Act (MoTCA) site --WSU*
Cost: Safety Minor Capital Renewal Funds
Implementation Date: Ongoing

14. *Construct deicing fluid collection system--Pullman Moscow Regional Airport*
Cost: $120,000

Fund Source: Normal Operations
Implementation Date: 1996-2005

15. *Repipe water softener backwash and boiler blowdown to sanitary sewer, adjusting pH and temperature--UI*
Cost: Normal Operations
Implementation Date: Current

16. *Fence research livestock from Creek on West Campus--UI/DEQ*
Cost of Operations: $15,000
Implementation Date: Ongoing

Planning and Policy Development Activities

1. *Completed Initial Assessment of Paradise Creek watershed. When completed will apply for and implement a planning grant through the Idaho State Agriculture Water Quality Program--LSWCD/DEQ*
Cost: $750,000
Funding Source: Idaho State Agriculture Water Quality Grant
Implementation Date: Current - 2005

2. *Develop Paradise Creek watershed riparian policy and seek legislation to provide tax relief for riparian policy (private)--Latah County/LSWCD*
Cost: $6,500
Funding Source: Normal Operations
Implementation Date: 1995--2005

3. *Develop storm water management plan and erosion control ordinance for the City of Moscow--Moscow/PCEI/LSWCD*
Cost: Normal Operations
Implementation Date: 1996

4. *Monitor discharge from aquaculture lagoon when active--UI*
Cost: Normal Operations
Implementation Date: Current

5. *Monitor Moscow WWTP discharge--DEQ*
Cost: Normal Operations
Implementation Date: Ongoing

6. *Assist in transferring city construction/development specifications for erosion control to county. Development of planning policies for construction related erosion problems through BMP's--LSWCD/Latah County*
Cost: Normal Operations
Implementation Date: Current

7. *Investigate routing normal surface drainage to grassy areas prior to discharge to storm water system--Pullman/Moscow Regional Airport*

8. *Apply for EQUIP funds through NRCS/FSA for Paradise Creek watershed--LSWCD/PCD*
Cost: Normal Operations
Funding Source: USDA-FSA ACP
Implementation Date: Ongoing

9. *Develop linear park concept for buffer and recreation--Moscow, UI*
Funding Source: Normal Operations
Implementation Date: Current

10. *Propose improved erosion control practices and management in Pullman--Pullman*
Funding Source: Normal Operations
Implementation Date: Current

11. *Establish a standard construction project plan to manage construction site runoff--UI*
Funding Source: Normal Operations
Implementation Date:

12. *City engineer to develop requirements for reducing run-off from new construction--Moscow*
Funding Source: Normal Operations
Implementation Date: Current

13. *Promote erosion control guidelines and BMP's to address water quality in Middle Reach. Work to develop and adopt an ordinance to manage storm water run-off from developments in the Middle Reach--PCD*
Funding Source: Normal Operations
Implementation Date: Current

14. *Establish bike path through Middle Reach to provide buffer--PCT/Whitman County/PCEI/Pullman/Moscow/UI/WSU*
Cost: $1,400,000
Implementation Date: 1997

15. *Design and implement WWTP plans for ammonia and nutrients-Moscow*
Cost: $11,000,000
Implementation Date: 2005

16. *Implement Animal Waste Management Plan--WSU*
Funding Source: Normal Operations

Implementation Date: reviewed annually, updated as necessary

17. *Promote erosion control guidelines and BMP's to address water quality in the Pullman sub-basin--PCD*
Funding Source: Normal Operations
Implementation Date: Current

18. *Develop and implement more rigid regulations on urban erosion control for new developments--Pullman*
Funding Source: Normal Operations
Implementation Date: 1995

19. *Document water quality improvements through ongoing monitoring*
Cost: $75,000
Funding Source: DOE/WCC/Private Foundations
Implementation Date: 1997-2005

Organization/Education Activities

1. *Provide a representative for PCMC--All Groups*

2. *Plan and conduct BMP tours/demonstrations within watershed--LSWCD/PCD*

3. *Update farmers with an information and education program--LSWCD/PCD*

4. *Develop and distribute a brochure to the Moscow urban community, about Paradise Creek and water quality--LSWCD/PCEI*
Cost: $10,000

5. *Research effectiveness of wetland demonstration pilot project in conjunction with City of Moscow to enhance water quality--UI/Moscow/PCEI*

6. *Operate WWTP to meet all requirements of NPDES discharge permit--Pullman*

7. *Conduct educational programs to transfer latest information, including tours, newsletters, slide shows and personal contact--PCD/PCEI/WDOE/WSU/UI*
Cost: $ 25,000
Funding Source: DOE/WCC/Private Foundations
Implementation Date: 1995-2003

8. *Stencil signs next to storm drains--PCEI/DEQ/EPA/WDOE/WSU*

9. *Develop Paradise Creek Stream Care Guide--PCD/PCEI/WDOE/DEQ/EPA*

10. *Coordinate Environmental Restoration Service Learning Projects--PCEI/WSU*

Completed Activities

1. *Paradise Creek Watershed Restoration - Phase II 319 Grant - demonstration wetland treatment facility near Moscow Waste Water Treatment Plant. - PCEI/UI/Moscow/DEQ/EPA/Moscow*
   Cost: $186,800
   Funding Source: EPA/Private Foundations/DEQ/EPA
   Implementation Date: 1996

2. *Paradise Creek Watershed Restoration Phase III 319 Grant--Stream Channel realignment, revetted banks, restored flood plains, pocket wetlands and other stormwater treatment facilities at the Sweet Avenue site at University of Idaho--PCEI/UI/ IWRRI)/DEQ/EPA/Moscow.*
   Cost: $199,980
   Funding Source: EPA/DEQ
   Implementation Date: Completed

3. *Install rain gutters on facilities to divert uncontaminated runoff from animal areas--WSU*
   Cost: Normal operations; $5,000
   Implementation Date: Completed

4. *Paradise Creek Watershed Restoration Phase I 319 Grant - Flood plain and stream banks restored in demonstration/education project. - PCEI/DEQ/EPA*
   Cost: $199,980
   Funding Source: EPA/DEQ
   Implementation Date: Completed

5. *Construct de-chlorination and sludge de-watering facilities at MWWTP--Moscow*
   Cost: $1,700,000
   Fund Source: Rate payers of City Sewer Service
   Implementation Date: Completed

6. *Clean up Sweet Avenue site reclamation project--DEQ/UI/Former Tenants*
   Cost: $3,650,000
   Implementation Date: Completed/Monitoring continues through 1998

7. *Construct animal wastewater pond along Airport Road--WSU*
   Cost: $320,000
   Implementation Date: Completed

8. *Construct a compost facility--WSU*

   Cost: $500,000
   Implementation Date: Completed

9. *Manage Paradise Creek monitoring project to generate data for planning and policy development--DEQ*
   Funding Source: Nutrient Management Act Grant
   Implementation Date: Completed

10. *Power Plant storm water pollution prevention plan and NPDES permit--WSU*
    Funding Source: Normal Operations
    Implementation Date: Completed

11. *Develop critical areas ordinances under the Growth Management Act in Whitman County including wetlands, fish and wildlife habitat conservation areas, frequently flooded areas, aquifer recharge areas, and geologically hazardous areas--Whitman County*
    Cost: Normal Operations
    Implementation Date: Completed

C. Funding and Timeline

The Committee considers finding funding for the PC Plan to be a major goal to successfully improve Paradise Creek water quality. Palouse Conservation District and other committee members will pursue long-term stable funding to support watershed and water quality restoration. Committee members will also seek funding to carry out activity assessment and to develop an ongoing program of water quality monitoring.

The PCMC anticipates that the PC Plan will take ten years to implement. Many projects already have been completed from the time between identifying activities and completing this report . Other projects are currently underway. Many projects will be carried out as part of the normal operations of the participating groups. Others will be made possible by grassroots or other local funding efforts. Other projects need outside funding and will take longer to complete. For this reason the PC Plan will be implemented in phases, some of which will depend upon funding.

In agricultural lands, the conventional crop rotation of three years also will affect this schedule on a farm by farm basis. In both upland and lowland implementation, projects can only be initiated at the appropriate point in the rotation cycle.

D. Paradise Creek Project Evaluation and Monitoring

Project Evaluation

In order to determine if the PC Plan is working or needs to be refined, the PCMC will conduct an annual evaluation of progress in implementing the plan. As part of this evaluation the PCMC will consider the following:

- completion of activities
- effectiveness of implemented activities in impacting parameters as reflected by water quality monitoring data and other indicators
- new knowledge impacting PC Plan implementation
- problems in implementation
- newly identified activities that should be prioritized in the implementation process
- beneficial uses are supported or improved by project activities.

Based upon this evaluation, the PCD will submit an annual report to cooperating groups describing the status of the project and any revisions that are deemed necessary by the PCMC.

Water Quality Monitoring

Water quality monitoring is an important means of measuring the success of both individual activities and the success of the overall effort.

Unfortunately, to adequately measure the impact of the PC Plan several decades of monitoring will be necessary. No single long-term funding source is available for such a monitoring effort. In response to this situation, the PCMC will encourage that all current and future projects include a water quality monitoring component as part of implementation, when appropriate. The data generated from any project specific monitoring program will be coordinated into the overall watershed monitoring program. In addition, the PCMC will use data generated by other projects in the area, whether related to the PC Plan or not. Through this means the PC Project will generate a continuous stream of water quality data which will serve as the basis for ongoing monitoring to assess both activity and PC Plan success. If no projects occur for a several year period, then the PCD will take responsibility for locating funding for a monitoring project to continue the ongoing monitoring effort.

Other Indicators Used in Evaluation

It will be difficult to evaluate success solely on the results of the water quality monitoring. In fact, many activities may not have dramatic quantifiable results for years after implementation. Therefore the PCMC will also include, but not be limited to, the following items in its annual evaluation:

- that activities are working as they have been designed to and are being properly maintained;

- that educational programs are reaching their desired audiences and are resulting in changes in how people are doing things;
- that changes in practices, such as implementation of BMPs, are occurring;
- that public support for and activity in implementing the PC Plan continues.

This combination of water quality monitoring and commonsense indicators of success will provide evidence of success or need for refinement to the PCMC, and provide an annual basis for evaluating and revising the PC Plan. Throughout the life of the PC Plan, it will be necessary to encourage public involvement. This may mean that new members will need to be added to the PCMC to reflect changes in the local communities. Through this process, the PCMC will continue to involve the public in the decision making processes involved in the implementation of activities designed to improve the overall health of the Paradise Creek watershed.

E. Final Committee Recommendations for Implementing the PC Plan

Process Recommendations
The Paradise Creek Watershed Management Committee recommends several process considerations to guide the implementation and evaluation of the PC Plan. All partners in the project should do the following:

- Take a holistic approach to water resource management, prioritizing activity implementation according to impacts on overall watershed water quality.
- Balance short-term economic needs and long-term gains.
- Consider the needs of everyone with an interest in the watershed in the design of solutions.
- Be flexible and innovative in implementing activities.
- Recognize that the key to success in implementing the PC Plan in a timely manner involves securing funding for the major components of implementation.

Funding Recommendations
The Paradise Creek Management Committee requests that the Department of Ecology fund research to develop an index of total watershed health rather than relying on chemical parameters. The PCMC also requests that the Department of Ecology fund interim sediment monitoring and monitoring at the end of the project to evaluate changes in water quality using both biotic and chemical parameters.

Support for the PC Plan

After PCMC participants had identified activities to solve PC water quality problems, they presented the proposed activities to their respective constituents. Each group wrote a formal letter of support, identifying activities which they were willing to initiate subject to funding, personnel, and time constraints. These letters of commitment are included in Appendix B.

Additional letters of concurrence for the PC Plan have been drafted by the committee partners and included in Appendix B.

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