CLARK FORK/PEND OREILLE SUB-BASIN ASSESSMENT

AND

TOTAL MAXIMUM DAILY LOADS

Hydrologic Unit Codes 17010213 & 17010214

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Introduction to the TMDL Process

Section 303(d) of the Clean Water Act (also called the Federal Water Pollution Control Act) directs States to identify waters for which the existing effluent limitations required by discharge permits are not stringent enough to assure protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife.

What results from this identification requirement is a list of impaired waters in the State which do not fully support the indigenous populations of shellfish, fish and wildlife. This criteria has been further elaborated on by the State of Idaho to include beneficial uses of these waters enjoyed by everyone. These include: domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics.

When these uses are impaired the Clean Water Act directs the States to develop a plan for recovery of these uses. The method to be used for this recovery action is to establish maximum amounts, also called "loads", of pollutants that can be added to the water while still supporting all of its beneficial uses. If the water is impaired it means that this load of pollutant(s) has been exceeded and needs to be reduced.

The Idaho Water Quality Standards requires that the 1996 Waterbody Assessment Guidance be used, in addition to other available information, to determine if beneficial uses are fully supported. Often times the data used for the Waterbody Assessment process is the only information available. This is the case with many of the wadable streams in this sub-basin assessment. Idaho is in the process of revising this guidance. When finalized, the streams in this sub-basin assessment will be re-evaluated to determine if their support status has changed due to the new guidance. If previously full support streams are determined to be impaired, a TMDL will be written for them.

For impaired waters, DEQ, using the best available information, determines a "total maximum daily load", TMDL for short, for each pollutant of concern in the impaired water. For example, DEQ determines that a target load for sediment pollution in stream "X" should be 0.5 tons/mile, where the existing load has been calculated at 1 ton/mile of stream. The target value, which is where we want to get to, is an estimate of the level of a pollutant that can exist in a waterbody yet still support all of its beneficial uses. In our example, if the load of sediment is reduced by half we predict at that point impaired uses will be recovered. Error of this estimate for stream "X" was 25%. To compensate for this margin of error, 25% is subtracted from the target load as the margin of safety. This gives a final target load of 0.375 tons/mile. High values for margins of error indicate that little information was available on the sub-watershed and gross assumptions had to be made in calculating existing loads and target loads.

TMDLs in this document are of the type called "phased TMDLs". This type of TMDL allows DEQ to re-adjust the values for existing and target loads based upon new more precise information obtained after the TMDL was approved.

After the TMDL has been written and approved by the U.S. Environmental Protection Agency, the Clean Water Act directs the states to develop an implementation plan. These are on-the-ground action plans which will help recover the lost beneficial use(s). Continuing the previous example of sediment pollution, some implementation plan provisions might be to stabilize cut slopes, unplug culverts, redirect stormwater, and gravel or pave road surfaces in certain critical areas of the sub-watershed. These non-point source recovery efforts are voluntary for private landowners unless they are incorporated into existing regulatory programs, such as the Forest Practices Act, County stormwater ordinances, etc. which the landowner may encounter.

Another element of a TMDL plan is to monitor on a regular basis to determine if restoration work in the watershed is helping, and to see if beneficial uses have been restored. If the use is not recovered after implementation of the TMDL, it is revised and implemented again. After the water recovers its beneficial uses it is removed from the "303(d) list" of impaired waters.

EXECUTIVE SUMMARY

The Pend Oreille portion of this sub-basin assessment examined eleven streams, one major river, and two lakes. Of the eleven streams, nine were water quality impaired and required load allocations, primarily for sediment. These streams were upper and lower Cocolalla Creeks, North Fork of Grouse Creek, Hoodoo Creek, Caribou Creek, mainstem Grouse Creek, Fish Creek, Gold Creek and the Pack River. The Pend Oreille River assessment was inconclusive. Cocolalla Lake was found to be impaired due to low dissolved oxygen levels, resulting in load allocations for phosphorus for the lake and its tributaries. The Pack River has nutrient load allocations for nutrients as well as sediment. The Pend Oreille Lake will have a near shore nutrient TMDL (anticipated completion in December 2001) and a voluntary border nutrient agreement with Montana to protect open water quality from degradation.

The Clark Fork portion of this sub-basin assessment was tabled until its scheduled due date in the year 2004. Insufficient time to complete the assessment and the prospect of more data available three years from now drove this decision.

I. OVERVIEW OF THE PEND OREILLE/CLARK FORK SUBBASIN

A. Characterization of the Subbasin

1. Physical and Biological Characteristics

The Clark Fork-Pend Oreille subbasin lies within western Montana, northern Idaho and northwestern Washington. The basin encompasses approximately 25,000 square miles (64,750 km^2) and is the source of waters that enters and leaves Pend Oreille Lake in Idaho. The Clark Fork River begins near Butte, Montana and drains an extensive area of western Montana before entering Idaho and Pend Oreille Lake. The Lake is the source of the Pend Oreille River which enters northwestern Washington from Idaho, which in turn drains into the Columbia River.

Lake Pend Oreille is the largest and deepest natural lake in Idaho. The lake is located in the panhandle region of northern Idaho and lies mostly within Bonner County (Figure 1). A small portion of the southern end extends into Kootenai County. Lake Pend Oreille covered about 83,200 acres (337 km^2) prior to impoundment and now covers 94,720 acres (383 km^2) post impoundment (USFWS 1953; Hoelscher 1993). The lake has more than 175 miles (282 km) of shoreline and has a mean and maximum depth of 538 ft (164 m) and 1,152 ft (351 m), respectively (Rieman and Falter 1976).

Most of the lake's volume (about 95%) is held in the large, southernmost basin, a glacially influenced portion of the Purcell Trench (Savage 1965) with a mean depth of 715 ft (218 m). Average hydraulic residence time in the southern basin is estimated to exceed 10 years (Falter *et al.* 1992). The lake's northern arm is shallower with a mean depth of 98 ft (30 m) and hydraulic residence time of less than one year (Falter *et al.* 1992).

Inflow and outflow of Lake Pend Oreille are regulated by hydroelectric facilities. Cabinet Gorge Dam (completed in 1952) and Noxon Rapids Dam (completed in 1959) by the Washington Water Power Company, are "power peaking" facilities (projects which use river flows to almost instantaneously meet customer demand for electricity, or "load", which fluctuates on an hourly basis) and regulates the Clark Fork River just inside the Idaho - Montana border. Cabinet Gorge operations influence riverine habitats for about seven miles (11 km) in the summer and nine miles (14 km) during the winter (Pratt 1996). WWP maintains a voluntary minimum flow of at least 3,000 cfs below the dam. Limited storage capacity in the WWP Clark Fork projects (Cabinet Gorge and Noxon Rapids) precludes these projects from influencing inflow during high flow events. The Hungry Horse (Bureau of Reclamation) storage project on the South Fork Flathead River, and irrigation practices in Montana, influence flows in the Clark Fork River.

WWP is currently engaged in the Federal Energy Regulatory Commission (FERC) relicensing process for Cabinet Gorge and Noxon Rapids Dams. WWP and relicensing participants are working actively to negotiate and draft a settlement agreement for protection, mitigation, and enhancement measures for the term of the next operating license. Mitigation measures include enhancements for bull trout.

The US Army Corps of Engineers (USACE) operates Albeni Falls Dam on the Pend Oreille River near the Washington border. This facility, constructed in 1952 also, impounds 28 miles (45 km) of the Pend Oreille River and regulates the lake's elevation between 2051 feet above sea level (msl) (winter) and 2062.5 msl (summer). Winter drawdown generally commences after Labor Day. Minimum pool (2051 msl) is normally reached between November 15 and December 1, with a target date of November 15 to facilitate kokanee salmon (*Oncorhynchus nerka*) spawning. The USACE is participating in a three-year study, initiated by IDFG in 1996, to evaluate benefits of leaving the winter lake level higher (2055 msl instead of 2051 msl) to enhance kokanee spawning on the lake shoreline.

Lake Pend Oreille supports a significant sport fishery. In 1991, anglers expended an estimated 465,000 hours fishing the lake with approximately 65% of the effort targeting trout and 35% of the effort targeting kokanee (Ned Horner, IDFG, personal communication). Bull trout comprised a relatively small percentage of the trout harvest, but provided trophy sized fish. The world record bull trout, weighing 32 pounds (14.5 kg) was taken from Lake Pend Oreille in 1949. Legal harvest of bull trout was discontinued beginning in 1996, but bull trout continue to be caught and released by anglers fishing for rainbow trout and lake trout.

Climate

Due to its relative proximity to the Pacific Ocean, climatic conditions in the Pend Oreille Lake watershed are often influenced by maritime weather patterns. Winter storms pass over the area from November through March causing a wet winter season. Summer storms, however, generally pass farther north resulting in relatively dry conditions in the summer. Winds typically prevail from the southwest across Pend Oreille Lake creating exceptionally wet conditions ("lake effect") on the Cabinet Mountains to the northeast.

Average monthly temperatures in the area range from 27°F (-3°C) to 64°F (18°C). Average annual precipitation is 33 inches (84 cm) in Sandpoint, located on the north end of the lake, and exceeds 49 inches (125 cm) in the surrounding mountains (Weisel 1982). In winter, precipitation falls mainly as snow, averaging 88 inches (224 cm) per year. Annual runoff is produced mostly by melting snow in April and May.

The main body of Pend Oreille Lake does not freeze due to considerable latent heat. Shallow areas in the northern portion of the lake do freeze over and form ice cover in some years.

Hydrology

The Clark Fork River flows into the northeast corner of Lake Pend Oreille and is the lake's largest tributary. It drains the Clark Fork River watershed in western Montana, an area of approximately 22,905 sq. mi. (59,324 km^2) (Lee and Lunetta 1990). The river contributes approximately 92% of the annual inflow to the lake (Frenzel 1991a) and most of the annual suspended sediment load. Tributaries to the Clark Fork below Cabinet Gorge Dam include Lightning Creek, Twin Creek, Mosquito Creek, and Johnson Creek. Pack River is the second largest tributary to the lake, and is in turn fed by a number of significant tributary watersheds, including Grouse Creek. Numerous other sub-basins enter Lake Pend Oreille directly, containing both perennial and intermittent streams.

The Pend Oreille River is the only surface outflow from Lake Pend Oreille. The river flows from the lake's northwest corner near Sandpoint for about 27 mi (44 km) before entering Washington. Lake Pend Oreille is hydraulically connected to the Spokane Valley-Rathdrum Prairie Aquifer at the lake's most southern end (Scenic Bay and Idlewilde Bay) and contributes about 11.6 billion gallons (44,000,000 cubic meters) of the aquifer annually (Hammond 1974; Drost and Seitz 1978).

Annual runoff in the Clark Fork River is produced mostly by melting snow, with peak flows typically occurring in May or June, but occasionally in April or July. Tributaries to the lake and lower river in Idaho may experience one or more runoff events. Midwinter rain-on-snow events can result in a rapid snow melt, and in some years the peak flow from tributary watersheds occurs during these events. Due to high precipitation results, location in relation to the lake and prevailing winds, and the tendency for warm winter storms to pick up moisture from the lake, Lightning Creek and other tributaries draining the Cabinet Mountains are particularly susceptible to rain-on-snow events.

Water Quality

Lake Pend Oreille is an oligotrophic (nutrient poor) lake. The lake's trophic status was determined in 1989 (Ryding and Rast) using euphotic zone depth, annual mean total phosphorus concentrations, mean and maximum chlorophyll-*a* concentrations, and mean and minimum Secchi disc water transparency depths. The lake was classified as oligotrophic or ultraoligotrophic ("very nutrient poor") by each parameter except minimum Secchi disc depth (Ryding and Rast 1989).

Woods (1991a) compared recent water quality data to historic data. He reported that the pelagic (open water) zone of Lake Pend Oreille showed no major temporal changes in nutrient concentrations, chlorophyll-*a* concentrations, or secchi disc water transparency depths since the early 1950's.

Nutrient concentrations in shoreline areas and in the northern basin of the lake are considerably higher due to urbanization and suspended sediments in Clark Fork River inflow. Most of the annual phosphorus and suspended sediment load enter the lake via the Clark Fork River (Hoelscher, et al. 1993).

A number of stream segments within the Pend Oreille watershed are listed (1996 303d list) as water quality limited. Caribou Creek, Cocolalla Creek, Fish Creek, Gold Creek Granite Creek, Grouse Creek, North Fork Grouse Creek, Hoodoo Creek Pack River, and Trestle Creek. These streams are listed for various "pollutants of concern" including sediment, habitat alteration, thermal modification and nutrients. Streams listed in the Clark Fork watershed are Johnson Creek, Lightning Creek, East Fork Lightning Creek, Porcupine Creek, Rattle Creek, Spring Creek, Twin Creek, and Wellington Creek. The pollutants of concern in these streams are primarily sediment, flow and habitat alteration (Map 1). The 1998 draft 303(d) list was recently released and may modify this list.

Geology/Landform

The geologic parent materials found in the Pend Oreille watershed are resultant from millions of years of sedimentation, metamorphosis, uplift, and intrusion. Belt series and Kaniksu batholith are the major underlying bedrock types. Underlying geology is an important characteristic which influences fish distribution, abundance, and growth. Streams on the northern and eastern side of Lake Pend Oreille (watersheds in the Cabinet and Bitterroot Mountains) are primarily within the Belt Series bedrock type (sedimentary), and streams draining the Selkirk Mountains are largely within the Kaniksu batholith (granitic bedrock type) (Savage 1965).

The Belt Series are metamorphic sedimentary deposits comprised partially by the Bitterroot and Cabinet mountains. These rocks were formed during the Precambrian period when shallow seas inundated northern Idaho. Sediments of clay, silt and sand settled out of brackish waters as seas retreated, subsequently metamorphosed, and began to fold and fault. The metamorphosed rocks in the basin include argillite, siltite, quartzite, and dolomite (Hoelscher et al. 1993).

The Kaniksu batholith formed about 70 to 80 million years ago when large masses of granite magma rose into the upper part of the earth's crust. As this mass of granite magma rose it caused part of the crust to shear off and move easterly, forming a part of the Cabinet Mountains. The rising magma helped form the Selkirk Mountains.

During the Pleistocene epoch, an ice lobe advanced and greatly over-deepened the lake basin. With retreat of the ice, and consequent flood of glacial melt waters, an outwash plain of poorly consolidated sand, silt, and gravel formed the morainal dam that constitutes the southwest shore of Lake Pend Oreille.

The basin was substantially altered by major glacial events in the late Pleistocene period. The present Clark Fork River valley was alternately plugged and scoured by dams of ice and deposited debris that likely served as the primary feature controlling the level and size of Glacial Lake Missoula. Lake Missoula once covered much of present day western Montana. Existing soils in the watershed are derived from the erosion of Precambrian metasediments and granitic batholith, volcanic deposition, glacial outwash, and alluvium. Most land types have 10 inches (25.4 cm) or more of surface soils composed of Mt. Mazama volcanic ash, which has very high water infiltration rates.

Watersheds in the Cabinet Mountains tend to be more prone to rapid runoff events due to the effects of scour by glacial advances. Glacial advances resulted in highly dissected watersheds (i.e. a high density of streams), shallow soils, and subsoil compaction of glacial tills. The Mt. Mazama ash layer, with its high infiltration rates, is resistant to erosion-causing overland flows. When forest conditions are undisturbed within the Pend Oreille basin, surface erosion is generally low to nonexistent on most upland land types. Mass erosion, however, plays a significant role. Since different layers of till have different water infiltration rates, watersheds draining the Cabinet Mountains tend to have a higher incidence of mass wasting than those in the Pend Oreille basin. As a result of these different till layers, groundwater seeps and springs are more prevalent in tributaries draining the Cabinet Mountains to the north of Lake Pend Oreille. Since glacial outwash makes up most of the valley bottoms in the Cabinet Mountains, and the watersheds are more flashy, in-channel erosion rates are higher than drainages on the eastern side of Pend Oreille. Activities, such as road construction, which intercept groundwater between compacted till layers and the ash layer, can increase surface flow and the potential for mass wasting.

Glaciers acted as ice dams and deposited large amounts of till. Ice in the Pack River Valley dammed most of the tributary streams upstream of their confluence with Pack River, creating a lake, which surrounded much of the valley. Fine sandy sediments deposited in the dammed water are known as glacial fluvial deposits. These sandy areas today appear on mountain side slopes, and are very erosive.

Generally streams on the northern and eastern sides tend to be more productive and have much less fine sediment than streams draining the granitic soils of the Selkirk Mountains. Belt Series streams are more likely to have bedload as a limiting habitat factor, whereas streams flowing from the granitic watersheds of the Selkirk Mountains may have fine sediment limiting habitat condition. Granitic soils tend to be nutrient-poor, and fish growth is typically slower in streams flowing from granitic watersheds. Natural waterfalls are found throughout the basin, and preclude use of several tributaries, or portions of tributaries, by migratory fish.

Topography

The Pend Oreille basin is separated from the Priest River basin to the west by a north-south running ridge (Selkirks) that varies in elevation from 7300 feet (2200 m) in the north to 3600 feet (1100 m) in the south. To the northeast and separating the Pend Oreille-Clark Fork basins from the Kootenai River basin, the southwest facing Cabinet Mountains are less than 6600 feet (2000 m) in elevation. The Purcell Trench is pitched by a gentle divide of less than 2500 feet (750 m) elevation near Elmira where Deep Creek runs north to join the Kootenai River and the southern portion drains into the Pack River.

The ridges to the southeast of the lake which separate the Pend Oreille-Clark Fork basins from the Coeur d'Alene River basin face north and west. They are generally less than 5,000 feet (1500 m) in elevation, although Packsaddle Mountain on the southeast side of the lake reaches an elevation of 6,400 feet (1951 m). The Hoodoo and Cocolalla valleys are separated from the Rathdrum Prairie and the Spokane River basin to the south by a gentle arched plain reaching an elevation of approximately 2,500 feet (760 m). Between Hoodoo Creek and Cocolalla Creek, and between Cocolalla Creek and Pend Oreille Lake are several mountains ranging in elevation from 4,100 feet (1250 m) to 5,000 feet (1500 m). On the west side of Hoodoo Creek is Hoodoo Mountain at 5,000 feet (1500 m) associated with a north-south running ridge separating the basin from Washington drainages. The northern tip of this ridge drains north into the Pend Oreille River.

Spirit Lake and Blanchard Lake drainages are also in the Pend Oreille hydrologic unit however, they are not part of the Pend Oreille/Clark Fork watersheds and will not be addressed in this document. These two watersheds are closely associated with the Rathdrum Aquifer and are separated from each other and from the Spokane River basin to the south by several east-west running ridges.

Vegetation

Historic vegetation patterns were largely influenced by wildfire. Early accounts and photographs of the Pend Oreille basin indicate that old growth stands of western red cedar (*Thuja plicates*) and other species were common in riparian zones and floodplains. Large cedar stumps can still be found in many riparian areas along Pend Oreille basin streams. Watershed uplands were more typically dominated by several species in various stages of succession, with age and composition dependent largely on fire cycles and slope aspect.

Euro-American settlement of the Clark Fork River Valley and Lake Pend Oreille has been accompanied by forest clearing, agricultural development, logging, introduction of nonnative pests, mining, railroad construction, a series of hydroelectric developments, and general urbanization. Forest products are an important commodity from timbered lands which surround the Idaho portion of the watershed. Present vegetation conditions are a product of all of these factors, as well as natural and man-caused fires.

Forest fires have had a profound impact on vegetation within the lower Clark Fork River and Lake Pend Oreille watersheds during the last century. Montana Department of Fish, Wildlife, and Parks (1984) reports that the forest fire of 1910 burned 60% of the Cabinet National Forest, part of what is now the Kootenai and Lolo National Forests. This fire burned an estimated 3,000,000 acres (121 km^2) in western Montana and northern Idaho. The most severely burned areas were reportedly on the north and south slopes of the Bitterroot Mountains (Guth and Cohen 1991; Pratt and Houston 1993) which form the west-southwest flank of the Clark Fork River Valley. One fire ecologist speculated that riparian areas along the Clark Fork River and Lake Pend Oreille might have escaped the fire (Peek 1983 as cited in MDFWP 1984). Other streams in the watershed were burned extensively by timber companies to remove understory vegetation (Humbird lands in Grouse Creek) following riparian and up-slope logging operations (USDA 1993). Following large stand replacing fires, sheep grazing occurred in several watersheds.

Low elevation riparian zones near tributary mouths include areas with and without tree canopy cover. Along stream corridors where tree overstory does not exist or is thin, vegetation includes shrubs and small trees such as thin-leaf alder (*Alnus sinuata*), willows (*Salix spp.*), snowberry (*Symphoricarpos albus*), mountain maple (*Acer glabrum*), red-osier dogwood (*Cornus stolonifera*), blue elderberry (*Sambucus cerulea*), and black hawthorn (*Crataegus douglasii).* Where tree canopy is present, tree species include black cottonwood, (*Populus trichocarpa*) or water birch (*Betula occidentalis*), quaking aspen (*Populus tremuloides*), and a mix of conifer species; including western red cedar, western hemlock (*Tsuga heterophylla*); Douglas-fir (*Psuedotsuga menziesii*), grand fir (*Abies grandis*), and western white pine (*Pinus monticola*). White pine stands have been significantly impacted by white pine blister rust, an introduced pathogen.

Conifer forests in the watershed consist of mixed stands, typified by stands of western red cedar /western hemlock; stands of co-dominant Douglas-fir and Ponderosa pine (*Pinus ponderosa*); and stands of Douglas-fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*) and western white pine. Dense stands of Douglas-fir, larch, and lodgepole are characteristic of slopes with north and east aspects. Relatively open stands of Douglas-fir and Ponderosa pine are typical on the warmer, dryer slopes with south and west aspects.

Representative species of upland shrubs include western serviceberry (*Amelachier alnifolia*), mountain maple, snowberry, mountain balm (*Ceanothus velutinus*), mallow ninebark

(*Physocarpus malvaceus*), huckleberry (*Vaccinium spp*), and others.

Vegetation can strongly influence conditions in streams. Canopy cover adjacent to streams provides shade and helps to maintain cooler water temperatures during summer months. Conifers may also provide insulation during winter months, reducing freezing and formation of anchor ice. Large trees which fall into streams and floodplains help to shape channels, create pools, provide cover and shade, introduce and store nutrients, dissipate stream energy, and contribute to overall channel stability (Murphy and Meehan 1991). Riparian vegetation also plays an important role in providing stream bank stability through binding of soils by roots. The amount, type, and stage of vegetation in a watershed can also influence stream flows. Vegetation removal by fire or timber harvest can result in increased peak flows during storm events and increased summer flows (Harr 1981; King 1989). Increased peak flows during winter months, when bull trout eggs are incubating, may reduce hatching success.

Fisheries

A wide diversity of fish species are present in Pend Oreille Lake an its tributaries. The native sport fish are westslope cutthroat trout, bull trout, and mountain whitefish. Other sport fish that have been stocked or found their way into the lake over the years include kokanee, rainbow trout, Gerrard (Kamloops) rainbow trout, lake whitefish, brook trout, brown trout, lake trout, yellow perch, black crappie, largemouth bass, brown bullhead, pumpkinseed, and northern pike. Other fishes include northern squawfish, large-scale sucker, longnose sucker, peamouth, redside shiner, slimy sculpin, torrent sculpin, longnose dace, pygmy whitefish, and tench.

In 1889, the U.S. Fish Commission introduced 1.3 million lake whitefish fry. Kokanee, which is a landlocked salmon, appeared in the lake about 1933. The original stock likely migrated into the lake via the Flathead and Clark Fork Rivers from Flathead Lake in Montana. During 1937, an unknown cause created a tremendous die-off of lake whitefish. As lake whitefish numbers declined, kokanee became very abundant. In 1941 or 1942, the presence of abundant kokanee prompted the introduction of Gerrard rainbow trout, a top level predator, from Kootanay Lake, British Columbia (Corsi *et al* 1998).

Other salmonids have been introduced into the Pend Oreille drainage including brook trout, brown trout, lake trout, and arctic grayling. The arctic grayling introduction apparently failed as there are no catch records for this species. Lake trout and brown trout have established populations in the lake and provide some harvest. Brook trout occur primarily in the tributaries. It is not known when yellow perch, black crappie, or largemouth bass were introduced into Pend Oreille Lake. These species compose an important part of the fish community in the shallow bays of the northern and western part of the lake. The westslope cutthroat trout fishery has declined more dramatically than any other Pend Oreille Lake fishery. It is now very reduced and is being supported by fingerling stocking (Hoelscher *et al* 1993).

Bull Trout

In the Pend Oreille Lake basin only adfluvial populations of bull trout are known to exist, their movements now limited by Albeni Falls Dam and Cabinet Gorge Dam. Adfluvial bull trout spawn in tributary waters where the juveniles rear from one to four years before migrating to the lake where they grow to maturity. In 1998 the U.S. Fish and Wildlife Service listed the bull trout as a threatened species under the Endangered Species Act. The Pend Oreille watershed is a high priority for efforts related to the recovery of the species. Idaho is preparing a conservation plan to restore bull trout populations in the state. This conservation plan may be incorporated into the implementation phase of applicable TMDLs (Corsi *et al* 1998).

2. Cultural Characteristics

A 1990 study by Lee *et al.* Identified twelve different land cover types in the subbasin. The largest land cover type is forested followed by the 86,018 acres (348 km²) of water of the Pend Oreille Lake (Table 1).

Table 1. Acreage of land cover types for the Pend Oreille and Clark Fork watersheds (Lee 1990).

Land Cover Type	Pend Oreille (acres)	Clark Fork (acres)	Total (acres)
Forest	276,800	21,313	298,113
Forest (thinned)	100,380	7,692	108,072
Forest (clearcut)	1,130	231	1,361
Rangeland	67,044	4,547	71,591
Agriculture (cropland/pasture)	27,859	3,579	31,438
Barren Land	11,010	28	11,038
Urban	6,655	0	6,655
Wetland	746	323	1,069
Debris (Clark Fork Delta)	0	9	9
Water (Pend Oreille Lake)	86,018	0	86,018
Water (Clark Fork River)	0	1,138	1,138
Water (other lakes, streams, rivers)			3,249
Total	580,891	38,860	619,751

The 1990 Bonner County census estimated a total population of 26,622 (U.S. Bureau of Census 1990). The population increased to an estimated 34,800 people in 1997 and a projected population of 50,500 people by the year 2020. This is double the growth rate of similar areas in Montana (NPA DATA Services 1997).

The Pend Oreille/Clark Fork subbasin contains lands under mixed ownership. Privately owned land comprises 48% of the subbasin, however, in Lee's analysis of seven 303(d) listed watersheds, roughly 81% of the land is owned by the U.S. Forest Service and privately held lands comprise 17% of the total acreage (Figure 1 and Table 2.).

Table 2. Land ownership/management in seven Pend Oreille/Clark Fork watersheds (Lee 1990).

Watershed	Total Acres	% Private	%USFS	% State	%BLM
Trestle Cr.	14,713	13.8	83.0	2.5	0.7
Gold Cr.	15,666	10.3	87.7	0	0
Granite Cr.	18,249	2.1	97.9	0	0
Johnson Cr.	15,659	19.9	79.4	0	0
Twin Cr.	18,209	24.6	75.2	0	0.2
Pack River	101,207	36.0	55.0	6.6	2.4
Lightning Cr.	73,052	11.2	86.3	0.4	0.8

Historically, Bonner County had a resource based economy, producing timber, agricultural products and mined minerals. However, this resource based sector has been replaced by a growing services, retirement, and recreation based economy (ASARCO 1998).

B. Sub-basin Pollutant Source Inventory

The major sources of pollutants in the Pend Oreille and Clark Fork watersheds are: hydropower dams, mining, timber harvest, urban development, industrial discharge, historical fires, loss of riparian habitat, agriculture, livestock and roads.

1. Summary of Past & Present Pollution Control Efforts

There is a long history of citizens and agencies working together to protect or restore water quality in the Clark Fork and Pend Oreille watersheds. Below are a few of the groups who have contributed to the effort:

Tri-State Implementation Council
Lake Pend Oreille Idaho Club
Alliance for the Wild Rockies
Public Lands Council
Trout Unlimited
Cabinet Resource Group
Idaho Rivers United
Cocolalla Homeowners Association
Pend Oreille River Homeowners Association
Sewer Districts
Stream Segments of Concern Local Working Committees
Clark Fork Superfund sites cleanup

These organizations and others have been and continue to be, very effective in the protection of water quality in the Pend Oreille and Clark Fork watersheds.

C. Subbasin Water Quality Concerns & Status

There are twenty-four (24) water body segments in the Pend Oreille and Clark Fork basins that are listed as water quality limited on the state's 1996 303(d) list. Nine (9) are in the Clark Fork hydrologic unit and fifteen (15) are in the Pend Oreille hydrologic unit (Tables 3 and 4). Most segments are listed for sediment pollution, many of which are also listed for flow, habitat or thermal problems. The exceptions being the Clark Fork River (metals), Pend Oreille Lake (threatened), and Cocolalla Lake (nutrients, dissolved oxygen). The Pack River, is listed for sediment, nutrients, dissolved oxygen, pathogens, and pesticides. The Pend Oreille River is listed for sediment, thermal modification and flow.

It is DEQ's position that habitat and flow alterations, while they may adversely affect beneficial uses, are not pollutants under Section 303(d) of the CWA, and therefore, TMDLs will not be developed to address habitat and flow alterations as pollutants.

Spirit Lake, Brickel Creek and Blanchard Lake drainages are also in the Pend Oreille hydrologic unit however, they are not part of the Pend Oreille/Clark Fork watersheds and will not be addressed in this document. These two watersheds are closely associated with the Rathdrum Aquifer and are separated from each other and from the Spokane River basin to the south by several east-west running ridges. These listed waters will be addressed in the Upper Coeur d'Alene problem assessment.

Table 3. Clark Fork Watershed Water Quality Limited (303(d) Listed) Waters

Water Body HUC #17010213	Boundaries	Pollutants	First Listed	Source
Clark Fork River	ID-MT border to PDO Lake	metals	1994	public comment
Lightning Creek	Quartz Cr. to mouth	sediment, flow, habitat alteration	1994	305(b) report
East Fork Lightning Creek	headwaters to mouth	sediment, flow, habitat alteration	1994	305(b) report
Rattle Creek	headwaters to mouth	sediment, flow, habitat alteration	1994	305(b) report
Wellington Creek	falls to mouth	sediment, flow	1994	305(b) report
Porcupine Creek	headwaters to mouth	sediment, flow, habitat alteration	1994	305(b) report
Spring Creek	headwaters to mouth	sediment	1994	305(b) report
Twin Creek	headwaters to mouth	sediment, nutrients	1994	305(b) report
Johnson Creek	headwaters to mouth	sediment, flow, habitat alteration	1994	305(b) report

The 305(b) report is a DEQ issued biannual report on the state's water quality.

Table 4. Pend Oreille Watershed Water Quality Limited (303(d) Listed) Waters

Waterbody HUC #17010214	Boundaries	Pollutants	First Listed	Source
Pend Oreille Lake	unknown	threatened (nutrients, metals)	1994	public comment
Granite Creek	headwaters to mouth	sediment	1994	SSOC-"s/t" for CWB & SS
Gold Creek	headwaters to mouth	sediment, habitat alteration	1994	SSOC-"s/t" for CWB & SS
Pack River	Hwy 95 to mouth	sediment, nutrients, DO, habitat alteration, pathogens, pesticides	1994	305(b) report SSOC-"s/t" for WWB, AWS, PCR, SCR, "p" for CWB, SS, DWS
Caribou Creek	headwaters to mouth	sediment	1994	305(b) report
Grouse Creek	unknown	sediment	1994	public comment
North Fork Grouse Creek	unknown	sediment	1994	USFS
Trestle Creek	unknown	unknown	1994	USFS
Pend Oreille River	lake to ID-WA border	sediment, flow, thermal modification	1994	305(b) report
Cocolalla Lake	unknown	nutrients, DO	1994	305(b) report SSOC-"s/t" for DWS, CWB, PCR, "p" for SS, WWB
Cocolalla Creek	headwaters to Cocolalla Lake	sediment, thermal modification	1994	305(b) report SSOC-"s/t" for WWB, "p" for CWB SS
Cocolalla Creek	Cocolalla Lake to mouth	sediment, thermal modification	1994	305(b) report SSOC-"p" for CWB
Fish Creek	headwaters to mouth	sediment, pathogens, thermal modification	1994	305(b) report
Hoodoo Creek	headwaters to Hoodoo Lake	sediment, thermal modification	1994	305(b) report
Hoodoo Creek	Hoodoo Lake to mouth	sediment, thermal modification	1994	305(b) report

DWS=domestic water supply, AWS=agricultural water supply, CWB=cold water biota, WWB=warm water biota, SS=salmonid spawning, PCR=primary contact recreation, SCR=secondary contact recreation, SSOC=stream segment of concern, "s/t"=supported but threatened, "p"=partially supported, 305(b) report=a biannual DEQ report on the status of water quality in the state.

2. Applicable Surface Water Quality Standards

Surface waters in Idaho are protected by a set of rules called the "Water Quality Standards and Wastewater Treatment Requirements" which are a part of the Administrative Rules of the Department of Health and Welfare, Volume 16, Title 01, Chapter 02. These rules protect "beneficial uses" of the surface waters of the state. The beneficial uses of surface water that Idaho protects with these rules are found under Idaho Administrative Procedures Act (IDAPA) 16.01.02.100. These uses are as follows:

Water Supply

(1) Agricultural: waters which are suitable or intended to be made suitable for the irrigation of crops or as drinking water for livestock;

(2) Domestic: waters which are suitable or intended to be made suitable for drinking water supplies;

(3) Industrial: waters which are suitable or intended to be made suitable for industrial water supplies. This use applies to all surface waters of the state.

Aquatic Life

(1) Cold water biota: waters which are suitable or intended to be made suitable for protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species which have optimal growing temperatures below eighteen (18) degrees C.

(2) Warm water biota: waters which are suitable or intended to be made suitable for protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species which have optimal growing temperatures above eighteen (18) degrees C.

(3) Salmonid spawning: waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes.

Recreation

(1) Primary contact recreation: surface waters which are suitable or intended to be made suitable for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such waters include, but are not restricted to, those used for swimming, water skiing, or skin diving.

(2) Secondary contact recreation: surface waters which are suitable or intended to be made suitable for recreational uses on or about the water and which are not included in the primary contact category. These waters may be used for fishing, boating, wading, and other activities where ingestion of raw water is not probable.

Wildlife Habitats

Waters which are suitable or intended to be suitable for wildlife habitats. This use applies to all surface waters of the state.

Aesthetics

This use applies to all surface waters of the state.

These beneficial uses are protected by a set of criteria, which include *narrative* criteria for sediment and nutrients, and *numeric* criteria for toxic substances, fecal coliform bacteria, dissolved oxygen, pH, chlorine, dissolved gas, ammonia, temperature and turbidity. Narrative criteria fall under the category of general criteria, which apply to all surface waters regardless of use classification.

Narrative criteria for excess nutrients states that: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other aquatic growths impairing designated beneficial uses."

Narrative criteria for sediment states that: "Sediment shall not exceed quantities specified in Section 250, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350.02.b. [At the present time Section 250 does not address sediment, and Section 350 describes how the nonpoint source rules are to be implemented.]

The Clean Water Act requires all states to designate which beneficial uses surface waters support. Currently, Idaho has only designated beneficial uses for a few streams, rivers and lakes in the state. If a water has designated beneficial uses, numeric criteria specific to those uses apply to the water as a minimum requirement. Undesignated waters are protected for their existing beneficial uses, cold water biota and primary and secondary contact recreation. The applicable numeric criteria then applies to those uses. Seven of the twenty-four listed waters in the Pend Oreille/Clark Fork subbasin have designated beneficial uses (Table 5). For a discussion on how beneficial uses are determined see section C.4. "Status of Beneficial Uses".

Table 5. Designated Beneficial Uses

WQS Map Code	Waters	Designated Uses
PB-10P	Clark Fork River - ID/MT border to Pend Oreille Lake	DWS, AWS, IWS, CWB, SS, PCR, SCR
PB-110P	Lightning Creek - source to mouth	DWS, AWS, IWS, CWB, SS, PCR, SCR
PB-20P	Pend Oreille Lake	DWS, AWS, IWS, CWB, SS, PCR, SCR
PB-210P	Pack River - source to mouth	DWS, AWS, IWS, CWB, SS, PCR, SCR
PB-220P	Trestle Creek - source to mouth	IWS, CWB, SS, SCR
PB-30P	Pend Oreille River - Pend Oreille Lake to ID/WA border	DWS, AWS, IWS, CWB, PCR, SCR
PB-310P	Cocolalla Lake and Outlet - to Pend Oreille River	DWS, AWS, IWS, CWB, PCR, SCR

DWS=domestic water supply, AWS=agricultural water supply, IWS=industrial water supply, CWB=cold water biota, WWB=warm water biota, SS=salmonid spawning, PCR=primary contact recreation, SCR=secondary contact recreation

3. Summary & Analysis of Existing Water Quality Data

Data used in these water quality analyses were obtained from a variety of sources such as, Idaho DEQ's Beneficial Use Reconnaissance Project, the U.S. Forest Service, Idaho Fish and Game, Idaho Department of Land's Cumulative Watershed Effects Analysis, Washington Water Power (Avista), Montana DEQ, and others. Refer to the individual sub-watershed sections of this report for site specific water quality data and analysis.

4. Status of Beneficial Uses

The Idaho Water Quality Standards under IDAPA 16.01.02.053 establishes that DEQ shall use the Waterbody Assessment Guidance (IDHW 1996) as a guide to determine the support status of beneficial uses in each waterbody. Results of the application of this guidance to wadable streams are shown in Table 6. Based upon the Waterbody Assessment Guidance results Caribou Creek and Granite Creek which were on the draft 1998 303(d) list are determined to be fully supporting their beneficial uses. The Waterbody Assessment Guidance uses Reconnaissance data to determine support status. As part of this analysis a macrobiotic invertebrate score and habitat index score are calculated. Based upon these scores, fish data and other information, the support status of the stream is determined. In each problem assessment these scores are presented under the "Existing Water Quality Data" sections.

The index scores are rated as follows:

1) For cold water biota:

MBI scores > 3.5 = full support
from 3.5. 2.5 = needs verification
and < 2.5 = not full support

HI scores ≥100 = full support

from 65-99 = needs verification
and < 64 = not full support

2) For salmonid spawning:

3 age classes = full support
2 age classes + HI score of ≥73 = full support

3) For primary contact recreation:

it exists if flow is ≥ 5 cfs
must meet bacteria water quality standard
if no bacteria data then support status defaults to CWB support call
if CWB is not full support then PCR is "not assessed"

Generally, if one index score is not full support then the entire stream is not full support. There are additional parameters and scoring criteria which aid in determining support status. I have shown only the three major ones.

Table 6.

BENEFICIAL USE SUPPORT STATUS OF 303(d) LISTED WATERS IN THE CLARK FORK WATERSHED

CLARK FORK	Full Support	Needs Verification	Not Full Support	Pollutant(s) of Concern (1996 list)
Johnson Creek Headwaters to Clark Fork		X 1995 BURP	X 1998 303(d) list	sediment, flow, habitat alteration
Lightning Creek Quartz Creek to Clark Fork	X 1998 303(d) list		X 1994 BURP	sediment, flow, habitat alteration
East Fork Lightning Creek Headwaters to Lightning Cr.			X 1994 BURP; X 1998 303(d) list	sediment, flow, habitat alteration
Porcupine Creek Headwaters to Lightning Cr.	X 1995 BURP; X 1998 303(d) list			sediment, flow, habitat alteration
Rattle Creek Headwaters to Lightning Cr.	X 1995 BURP; X 1998 303(d) list			sediment, flow, habitat alteration
Spring Creek Headwaters to Lightning Cr.	X 1998 303(d) list	X 1996 BURP		sediment
Twin Creek Headwaters to Clark Fork	X 1995 BURP; X 1998 303(d) list			nutrients, sediment
Wellington Creek Falls to Lightning Cr.		X 1995 BURP	X 1998 303(d) list	sediment, flow

Clark Fork River (from Idaho-Montana border to Pend Oreille Lake) was on the 1996 list for metals pollution. In 1998 the listing was revised to: flow alteration, habitat alteration, and total dissolved gas.

Table 6. Continued **BENEFICIAL USE SUPPORT STATUS OF 303(d) LISTED WATERS IN THE PEND OREILLE WATERSHED**

PEND OREILLE	Full Support	Needs Verification	Not Full Support	Pollutant(s) of Concern (1996 list)
Caribou Creek Headwaters to Pack River	x 1998 BURP	X 1995 BURP	X 1998 303(d) list	sediment
Cocolalla Creek Headwtrs to Cocolalla Lk.		X 1994 BURP	X 1998 303(d) list	sediment, thermal modification
Cocolalla Creek Headwaters to Pend Oreille Lake		X 1995 BURP	X 1998 303(d) list	sediment, thermal modification
Fish Creek Headwtrs to Cocolalla Cr.	X 1994 BURP, 1999 bacteria rechecked-ok		X 1998 303(d) list due to high bacteria	sediment, thermal modification
Gold Creek Headwaters to Pend Oreille Lake	X 1998 BURP	X 1994 BURP		sediment, thermal modification, pathogens
Granite Creek Headwaters to Pend Oreille Lake	X 1994 BURP		X 1998 303(d) list	sediment
Grouse Creek	X 1994 BURP			sediment
North Fork Grouse Cr.			X 1996 BURP; X 1998 303(d) list	sediment
Hoodoo Creek Headwtrs to Pend Oreille River			X 1995, □96,□98 BURP; X 1998 303(d) list	sediment, thermal modification
Pack River Hwy. 95 to Pend Oreille Lake	X 1998 303(d) list - (MISTAKE!)	X 1997 BURP (large river)	X 1994 BURP (wadable); will be on final 1998 303(d) list	nutrients, sediment, dissolved oxygen, habitat alterations, pathogens, pesticides
Trestle Creek Pend Oreille Lake and River Drainage	X 1994 BURP			threatened

Large Rivers and Lakes:

Pend Oreille Lake (threatened) on both '96 and '98 303(d) list. **Pend Oreille River** (Pend Oreille Lake to Washington border) listed for sediment, thermal modification and flow in 1996, and sediment, temperature, flow alteration and total dissolved gas in 1998. **Cocolalla Lake** listed for "pollutants", nutrients, and dissolved oxygen in 1996 and nutrients and dissolved oxygen in 1998. Note all support status calls were made using the 1996 WBAG. The 1998 303(d) list referred to is the DRAFT list.

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II. SUB-WATERSHEDS

A. Clark Fork River
(tributary to Pend Oreille Lake)

Summary:
The Clark Fork River was added to the 1994 303(d) list, and retained on the 1996 list, as a result of public comment, and listed for metals pollution. The limited data set collected by the USGS at the Whitehorse Rapids monitoring station shows that zinc and cadmium concentrations in the river over the last ten years have declined to a point where water quality standards are not exceeded. Copper was exceeded a total of four times in the last ten years: twice in '92, and once in '93 and '96. An extensive monitoring study done by the State of Montana in 1988 found no metals concentrations exceeded water quality standards at the Cabinet Gorge station. This contradicts USGS data, which used depth integrated bank to bank sampling as opposed to Montana's method of grab samples from the shore. Due to the limited data set, the variability in river flow, the presence of metals contaminated sediments, and other complicating factors the conclusion of this problem assessment is to wait until its scheduled completion date. At that time there may be more information available to base a decision.

1. Physical and Biological Characteristics

The Clark Fork River begins near Butte, Montana and drains approximately 25,000 square miles of western Montana before entering Pend Oreille Lake. It is divided into the upper, middle and lower rivers at the Milltown Reservoir and the Flathead River confluence.

A century of mining and smelting, tailings disposal, and other mine wastes have left the upper Clark Fork and its tributaries severely polluted with toxic metals and other chemicals. Four Superfund sites have been listed in the upper Clark Fork: (1) Silver Bow Creek and the upper Clark Fork from Butte to Milltown (metal residues from mining and smelting); (2) the Montana Pole plant in Butte (creosote and pentachlorophenol from wood treatment); (3) the Anaconda smelter (smelter wastes and widespread deposition of airborne contaminants), and (4) the Milltown Reservoir, which has accumulated toxic metals from upstream sources. Since 1982 EPA, Montana DEQ, industries and other agencies have worked to investigate, prescribe and implement cleanup procedures (EPA 1989).

The middle portion of the Clark Fork is less impacted from metals pollution than the upper portion because metal bearing sediments are trapped behind the Milltown Reservoir (Johns and Moore 1985). The effects of metals is also reduced due to dilution by the Blackfoot River and Rock Creek.

The lower river flows from the Flathead confluence near Dixon, Montana to its confluence with Pend Oreille Lake near Clark Fork, Idaho. This distance also includes the approximately 60 miles (97 km) of Noxon and Cabinet Gorge Reservoirs. The generally westerly flowing lower Clark Fork River is bounded by the Bitterroot Range to the south and the Cabinet Mountains to the north. Much of the drainage is located in the Kootenai, Kaniksu, and Lolo National Forests, encompassing 4,939 square miles (12,800 km^2) with 390 miles (628 km) of streams. Water quality on this part of the river tends to be better because of the volume of water flowing into it, and because the reservoirs may act as sinks for nutrients and sediment (Moore 1997).

The Clark Fork River in Idaho is approximately 11 miles (18 km) long from the Idaho-Montana border to Pend Oreille Lake. It consists of a main channel, a side channel at Foster Rapids, and a large delta at its mouth. The main channel has two riffles (Whitehorse and Foster Rapids) and several large, deep pools with a maximum depth of 76 feet (23 m). River-like conditions persist in the channel downstream to the second vehicle bridge (now closed) at the town of Clark Fork. Beyond this point varying lake levels begin to influence velocity, depth, and general hydraulic conditions in the lower river channel and the delta.

The Cabinet Gorge Dam located at the Montana-Idaho border was constructed in 1951-52 and regulates flows in the Clark Fork River. In 1973 a voluntary agreement between Washington Water Power and the State of Idaho provided for a minimum flow of 3,000 cfs except for periods of mandatory maintenance and safety inspections. This agreement is proposed to be revised in 1998 to 5,000 cfs (Federal Energy Regulatory Commission 1998). River flows are augmented by ground water inflow of at least 800 cfs below the dam (Harenburg *et al.* 1988).

The Clark Fork watershed is 76% forested, 22% grass-shrub vegetation and cropland and 2% wetlands and water (EPA 1990).

2. Pollutant Source Inventory

There are no sources of metals pollution in Idaho's stretch of the Clark Fork River. Upstream metals mining, milling and smelting plus other industrial and municipal discharges are the primary sources of pollution.

2. a. Summary of Past and Present Pollution Control Efforts

No watershed improvement projects in Idaho for reducing metals loading to the river were found in the literature cited.

3. Water Quality Concerns and Status

The Clark Fork River was added to the 1994 303(d) list (and retained on the 1996 list) as a result of public comment, and is listed for metals pollution. Most of the metals pollution in the Clark Fork system resulted from decades of past mining activities within the basin, an issue that is currently being addressed by federal and state agencies in Montana. Metals of concern in the Clark Fork are copper, zinc, arsenic, cadmium, and lead (Ingman and Kerr, 1989).

Bottom sediments have been examined for metals contamination (Moore, 1997) primarily in the Cabinet Gorge and Noxon reservoirs. Copper and zinc are the metals of greatest concern because they are found in elevated concentrations in bottom sediments. No toxicity or bioaccumulation data exist to determine if these elevated levels are affecting aquatic biota. A catastrophic event may remobilize these bottom sediments and affect beneficial uses in downstream waters, however, at this point it is highly speculative without further study.

Very little fish tissue analyses have been conducted in the lower reach of the Clark Fork River. In 1986, Barnard and Vashro determined that bioaccumulation of copper and mercury was comparable to other noncontaminated waters elsewhere in the region. They found elevated levels of zinc (55 to 166 ppm) in the 68 fish sampled. In 1993 a limited study of fish tissue indicated that mercury levels were high in squawfish and that further research was necessary.

3. a. Applicable Water Quality Standards

The Clark Fork River in Idaho is listed for metals pollution. IDAPA 16.01.02.250.07. Numeric Criteria for Toxic Substances, protects cold water biota and human health from certain toxic substances. Metals which have been of historical concern in the river are copper, zinc, arsenic, cadmium, and lead. The maximum allowable concentrations of these metals in Idaho waters are found in Table 1.

Table 1.

Metal	Dissolved Concentration (mg/l)*
copper	0.0085
zinc	0.0791
arsenic	0.0062 (total recoverable concentrations)
cadmium	0.00085
lead	0.00065

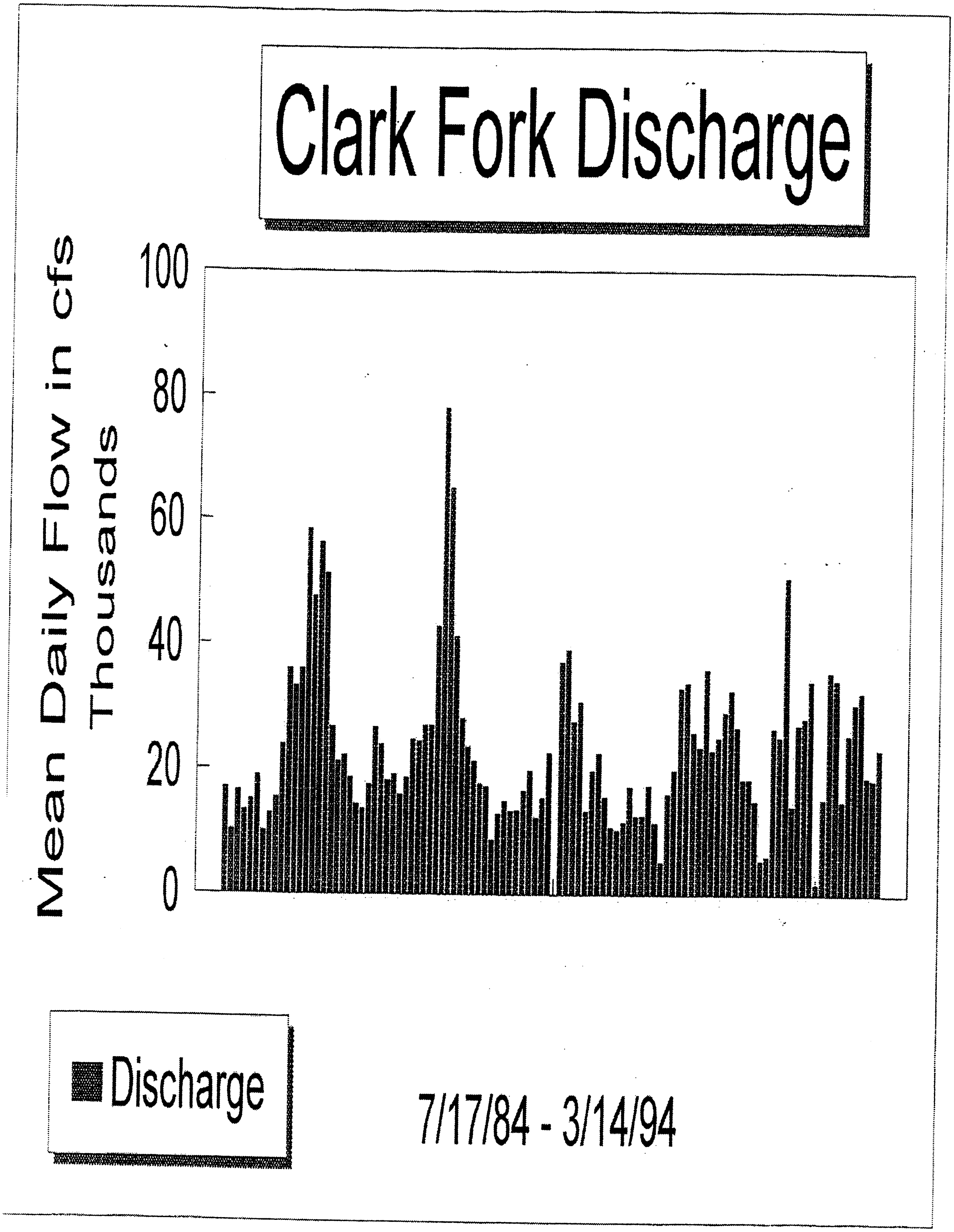
*Using a hardness of 85.7mg/l (ASARCO 1998).

3. b. Summary and Analysis of Existing Water Quality Data

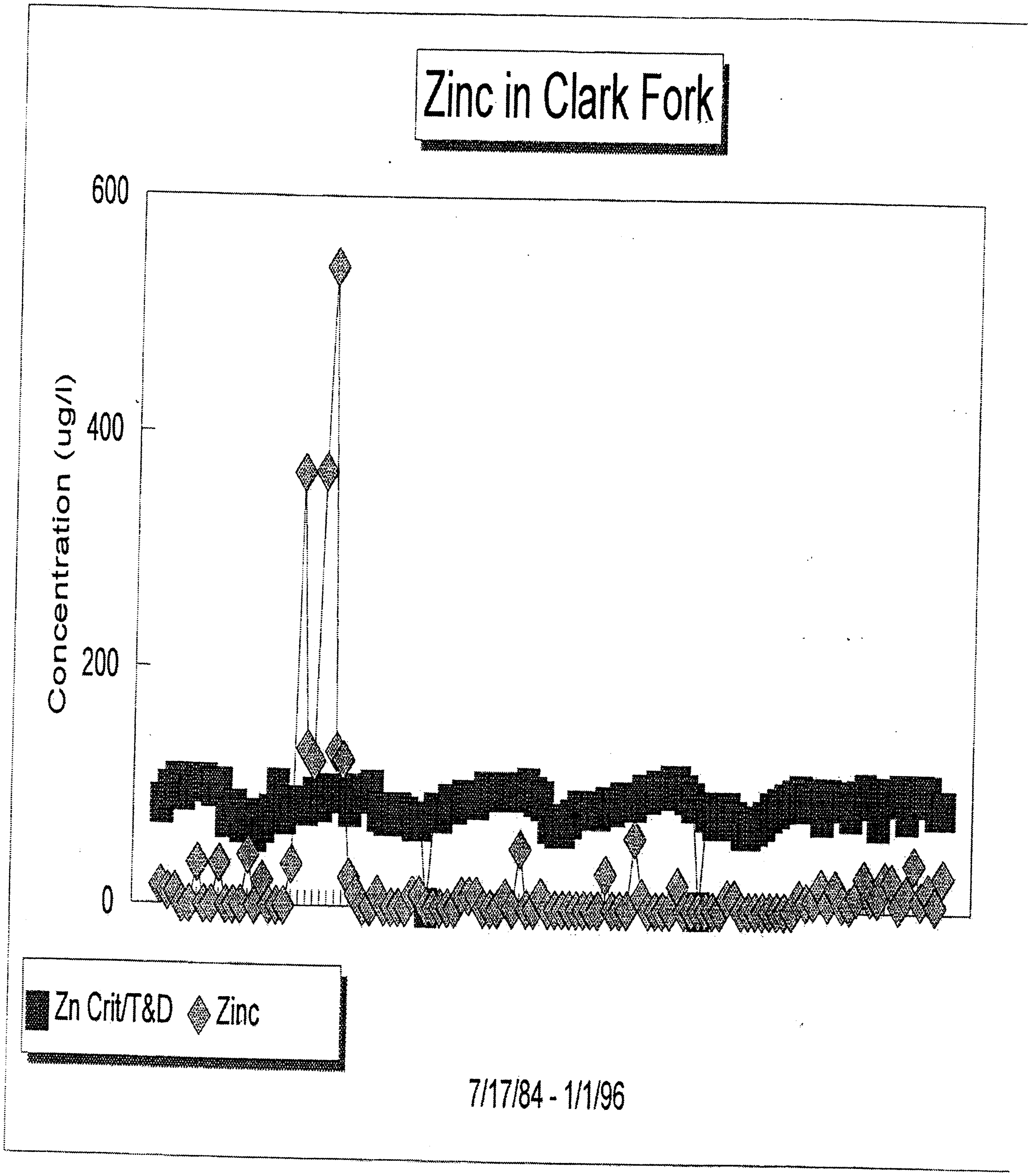
Examination of the USGS monitoring data at the Cabinet Gorge station shows that zinc has not exceeded standards since 1985, cadmium last exceeded standards in 1991, and copper exceeded standards four times in the last ten years (Tables 2, 3 and 4). Sampling frequency ranged from six to twenty times per year from 1984-1988, quarterly from 1990 -1993, and once yearly from 1994-1997. Improving water quality in the Clark Fork may be attributed to cleanup efforts in the headwaters and reductions of pollutants from industrial and municipal facilities in Montana.

Monitoring data presented in Tables 2, 3, and 4 should be examined with the following information in mind. Beginning in 1992, the USGS at the Cabinet Gorge station began using clean sampling techniques to improve data accuracy down to 1ppb. This was necessary due to the discovery of inaccurate sampling results for zinc, copper and lead concentrations, and the increasing scientific interest in more accurate monitoring data. Error in metals concentrations before this date were over-estimated by approximately ≤50% for zinc, ≤10% for copper, ≤4% for lead, and no estimated error for cadmium (M. Hardy personal communication 1998).

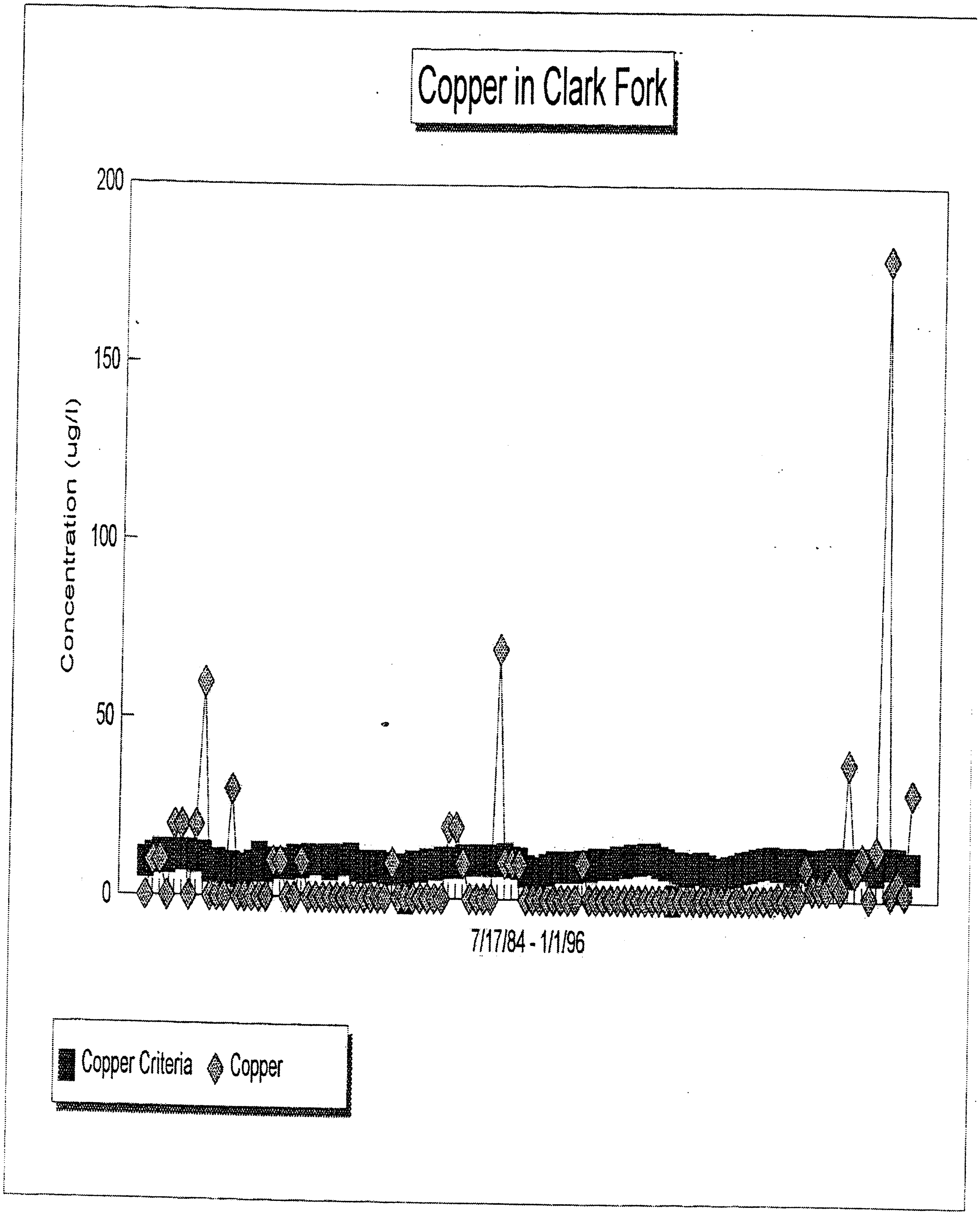
In 1986, Barnard and Vashro determined that bioaccumulation of copper and mercury was comparable to other noncontaminated waters elsewhere in the region. They found elevated levels

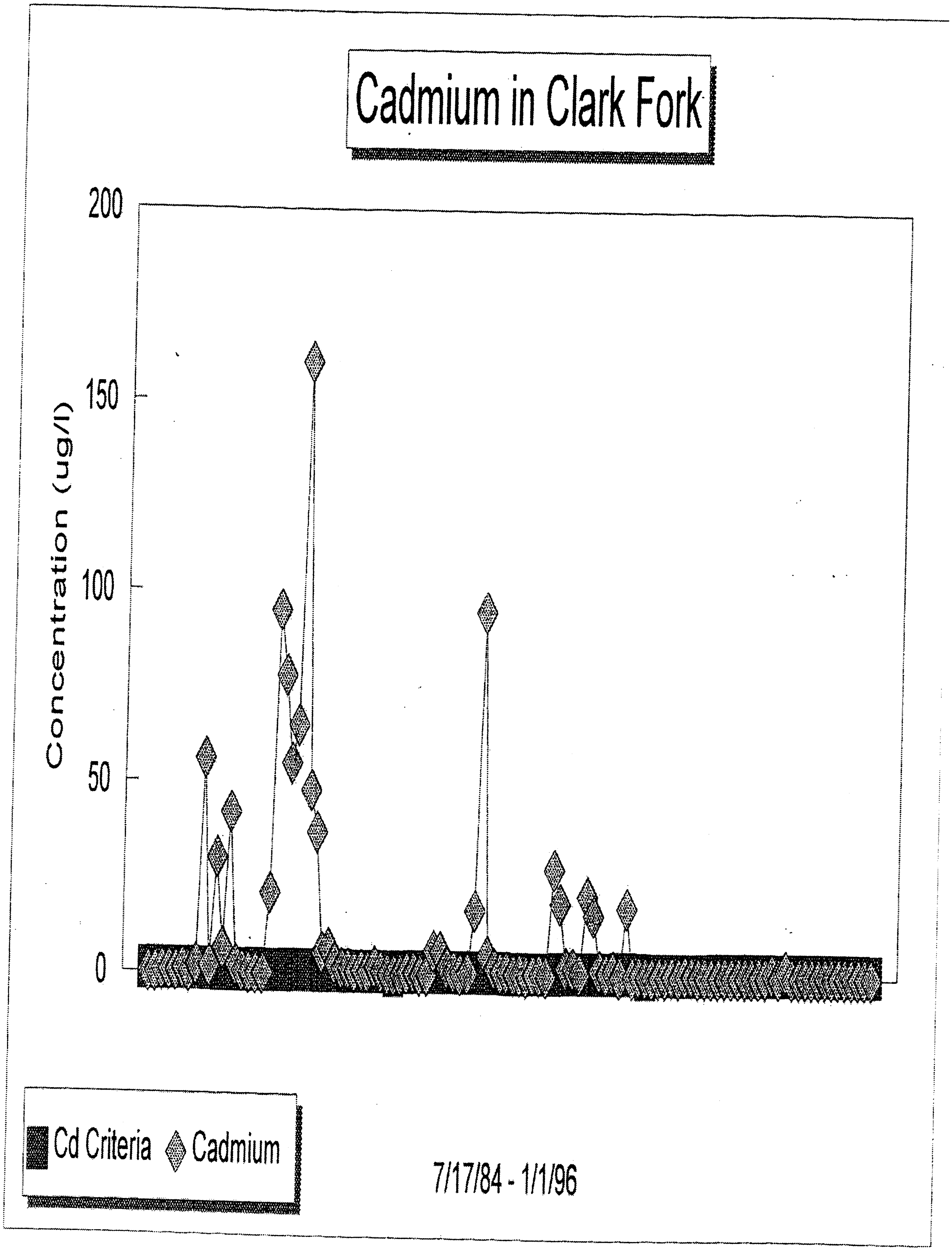


Clark Fork Discharge
100
80
60
40
20
0
Mean Daily Flow in cfs
Thousands
Discharge
7/17/84 - 3/14/94



Zinc in Clark Fork
600
400
200
0
Concentration (ug/l)
Zn Crit/T&D
Zinc
7/17/84 - 1/1/96


Copper in Clark Fork
200
150
100
50
0
Concentration (ug/l)
7/17/84 - 1/1/96
Copper Criteria
Copper



Cadmium in Clark Fork
200
150
100
50
0
Concentration (ug/l)
Cd Criteria
Cadmium
7/17/84 - 1/1/96

of zinc (55 to 166 ppm) in the 68 fish sampled. There is no human health criteria for zinc

concentration in fish tissue in the Idaho standards or EPA's Quality Criteria for Water -1986 (Gold Book).

Another major source of metals monitoring data was a study conducted in 1988 which measured copper, zinc, arsenic, cadmium and lead seventeen times throughout the year at thirty stations along the Clark Fork River. Data shows that standards were not exceeded for these metals at the Cabinet Gorge monitoring location (Ingman and Kerr 1989). This data is included with the USGS data in Tables 2, 3, and 4, however the sampling method used may not have accurately assessed metals concentration.

In 1993, Hoelscher sampled fish for arsenic, cadmium, chromium, copper, lead and mercury. This study was intended to provide a gross indication of potential human health risks. Results indicated that regular consumption of the northern squawfish could pose a risk of mercury intoxication. His conclusion was a recommendation that mercury bioaccumulation requires further study.

In the future, considerably more information will be available on metal bearing sediments and their effect on aquatic life. As part of their relicensing agreement, Washington Water Power will be conducting analyses of sediments in the river and reservoirs to determine if fish tissue sampling is necessary. If indicated, fish tissue analyses will be conducted and the appropriate human health advisories will be determined (Federal Energy Regulatory Commission 1998).

USGS also monitors for barium, a metal used in metallurgy, paint, glass, and electronics industries. It is present in the river, however concentrations are far below the limits for drinking water and cold water biota.

3. c. Data Gaps For Determination of Support Status

A more intensive monitoring of river metals concentrations began in 1998 in conjunction with the Washington Water Power dam relicensing process and the Tri-State Council's Clark Fork - Pend Oreille Watershed Monitoring Program. These efforts, if sampling methodology is equivalent to USGS protocols, should provide more frequent sampling for long term trend monitoring of metals in the river and also serve to establish baseline levels prior to the Rock Creek mine discharge, if the mine is permitted.

Bioaccumulation of metals in the Clark Fork River requires further investigation. The WWP investigation of metals present in bottom sediments and the follow up study on fish tissue analyses should fill this need.

4. Problem Assessment Conclusions

In summary, due to the very small sample size and the limited number of metals examined, it is very difficult to correctly assess if a TMDL is required for metals pollution on the Clark Fork River. The data indicates that prior to the late 1980's the Clark Fork River routinely exceeded standards for certain metals at the Cabinet Gorge station. Data since that time was taken on an infrequent basis and conflicts with other sampling results conducted using a different sampling technique. Due to this conflicting data and an inadequate data base, the conclusion of this problem assessment will be deferred until 2003. At this time, we anticipate more information will be available from several different monitoring efforts currently underway.

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B. **JOHNSON CREEK**

(tributary to the Clark Fork River)

Summary

The problem assessment for Johnson Creek will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Johnson Creek flows into the south channel of the Clark Fork River delta. Fish habitat surveys conducted in July, 1992 indicate that Johnson Creek consists of 59% riffles, 17% pools, 14% runs/glides, 6% pocket water, and 4% dry channel based on the total length of the surveyed habitat. Johnson Falls, a migration barrier to adfluvial bull trout and westslope cutthroat trout, is located approximately one mile upstream from the mouth of Johnson Creek. Excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in an unstable channel and are believed to be the major limiting factor to bull trout production in Johnson Creek. The backwater effect of Pend Oreille Lake also contributes to bedload aggradation without development of riparian vegetation on the lowermost reaches. Johnson Creek is considered a condition yellow watershed by the U.S. Forest Service, meaning activities in the watershed must proceed with caution.

2. Pollutant Source Inventory

Point Source Discharges

Nonpoint Source Discharges

Nonpoint sources of pollution contributing to the impairment of beneficial uses in the Johnson Creek watershed include:

Roads - A road parallels Johnson Creek for almost its entire length upstream to the falls. This road limits recruitment of large woody debris to the system. Roads upstream in the watershed have shown evidence of failures, including a stream crossing on private land. Failures are likely contributing to bedload aggradation within the streambed.

Timber Harvests - Several small timber sales have been planned and/or sold in the Johnson Creek drainage on Forest Service lands. Timber harvest has also occurred on private lands, and recruitment of large woody debris to the stream channel appears to be lacking.

Diversions - There are no known diversions at this time, but as recently as 1992 there was a proposal to divert water from Johnson Creek for power generation. Depending on the size and location of the bypass, a power diversion could significantly impact the water quality of Johnson Creek.

2.a. Summary of Past and Present Pollution Control Efforts

3. Water Quality Concerns and Status

The US Environmental Protection Agency determined that sediment, flow, and habitat alterations threaten Johnson Creek's beneficial uses. Based on an evaluation of Beneficial Use Reconnaissance Project data for Johnson Creek using the 1996 Water Body Assessment Guidance, the IDEQ categorized Johnson Creek as not having full support of beneficial uses.

3.a. Applicable Water Quality Standards

3.b. Summary and Analysis of Existing Water Quality Data

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

C. **LIGHTNING CREEK WATERSHED**
(tributary to Clark Fork River)

Summary
The Lightning Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

<u>Lightning Creek mainstem</u>

The Lightning Creek sub-watershed, as assessed by Cacek (1989), includes over 89 square miles (230 km$^{2)}$ of land area. The creek is approximately 22 miles (35 km) long and drains into the Clark Fork River 2.5 miles (4 km) upstream from Lake Pend Oreille. This sub-watershed has five major tributary streams: Rattle, Wellington, Porcupine, East Fork, and Spring Creeks. Most of the major streams below Quartz Creek, located above these major tributaries, were listed in 1996 as water quality-limited including the five major tributaries. The geomorphology of the sub-watershed is the product of mosaic block faulting with subsequent glaciation and mass wasting. The valley side slopes are often steep (>70%) with a preference for northerly or east to southeasterly aspects. Elevations range from 2,100 feet (640 m) near the mouth of Lightning Creek to 7,000 feet (2,134 m) at Scotchman Peak. Glacial features dominate the landscape and the steep valley walls are marked by several large, ancient debris avalanches. Valley slopes show straight to concave cross sections in long profile. Areas above 5,000 feet (1,524 m) elevation are dominated by steep rock outcrops and talus-scree slopes with little if any residual soil mantle.

The Lightning Creek basin receives significantly greater precipitation, snowpack, and intense storm events than adjacent areas in northern Idaho. During the most intense storm periods, Lightning Creek can receive twice as much precipitation as nearby areas to the south and west (Cacek 1989). Bear Mountain, in the Lightning Creek watershed, averages 81 inches of precipitation annually, the highest annual precipitation anywhere in north Idaho. The watershed has shown a history of floods associated with spring melt and rain-on-snow events. Floods affecting the town of Clark Fork, the highway and the railway have occurred in 1894, 1913, 1918, 1921, 1922, and 1932. To curtail flooding of the town, a large dike was built on the east side of the creek in 1922. Between 1932 and 1964 information on flood activity is scarce. From 1964 to 1989, six major flood events have occurred at the approximate rate of one every five years. The last four events were rain-on-snow events.

Intense storm runoff, soil thickness, snowpack, temperature, and prior soil moisture are all important aspects of the triggering mechanism of landslide initiation in these shallow, erodible soils. The Lightning Creek drainage experiences debris slides, debris avalanches, earthflows, and channelized debris flow/torrents. Slides occur on all slope positions, however, an overwhelming 83% of the slides occur on lower slopes. The remaining 17% of slides, which originate on middle or upper slopes, contribute larger amounts of debris, slightly under one half the total slide volume. Seventy five percent of the total slide volume came from road and road/clearcut related slides.

Lightning Creek is considered to be unstable, and aerial photos from the 1930's suggest that lower Lightning Creek has shifted from a primarily single channel stream to a highly braided stream with an increased width to depth ratio (Corsi et al. 1998) A barrier falls is present on Lightning Creek near Quartz Creek preventing fish passage beyond that point.

Certain Landtypes appear quite susceptible to sliding when impacted. These are Landtypes 29/57+, 24/29g and 29 (Cacek 1989). Map ___ shows the various Landtypes found in northern Idaho.

The Lightning Creek watershed has an extensive forest road system. Road erosion, road failure (slides), and culvert blockage have been large contributors of bedload and sediment to Lightning Creek (Cacek 1989). Poor road location and design (built on wood slash fill) in many areas have resulted in slides, slumps, and increased peak run-off flows; the potential for road failure is compounded by the fact that geologically, this watershed is already conducive to natural mass wasting.

Road construction has also resulted in loss of riparian forest canopy recruitment of large organic debris to the stream. The main channel is highly impacted and unstable in most reaches. Lower reaches of this stream exhibit severe bedload deposition. Bedload deposition creates fish migration barriers (intermittency) in many locations. Near its mouth, the channel is overly widened and extensively braided. The channel in this area continues to carve a new course during high spring flows each year. The railroad and highway bridges on lower Lightning Creek may be contributing to the bedload aggradation problem by constricting flows and creating a deposition area. Past road repair/maintenance in Lightning Creek has been troublesome and costly. Repair costs for the 1980 road failure/slide event alone were in excess of $875,000.

Lightning Creek, in comparison with other Pend Oreille watersheds, has been logged extensively. Over 35% of the entire watershed has had timber harvest activity (Corsi, et al. 1998). Poor harvest practices in the past have led to severe bank, bed, and channel instability along most of the mainstem. Bedload deposition, peak flows, stream temperature, and intermittency are exacerbated problems in the Lightning Creek drainage. Lightning Creek (from Quartz Creek to its confluence with the Clark Fork River) is on the 1996 303d list of water quality impaired waters as not fully supporting beneficial uses. Pollutants of concern are sediment, flow, and habitat alteration (DEQ, 1996).

2. Pollutant Source Inventory

Point Source Discharges

Nonpoint Source Discharges

2.a. Summary of Past and Present Pollution Control Efforts

3. Water Quality Concerns and Status

3.a. Applicable Water Quality Standards

3.b. Summary and Analysis of Existing Water Quality Data

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

Cacek, C. C. 1989. The relationship of mass wasting to timber harvest activities in the Lightning Creek Basin, Idaho and Montana. Eastern Washington University, Masters Thesis.

D. **RATTLE CREEK**

(tributary to Lightning Creek)

Summary
The Rattle Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Existing information on watershed conditions in Rattle Creek indicates the system is in fair condition, with impacts to habitat a result of flooding, road construction and subsequent failures, and logging activity. A logging road parallels Rattle Creek over much of its length, and there are several stream crossings within the drainage. Rattle Creek has been significantly impacted by landslide activity (Cacek 1989).

In summary, excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in unstable channels. The road that parallels Rattle Creek for most of its length, reduces recruitment of large woody debris to the stream channel. Portions of the road encroach upon the floodplain and reduce floodplain capacity and function. Timber harvest has occurred in several locations in the watershed. Rattle Creek has been significantly impacted by clearcut related landslide activity (Cacek 1989).

2. Pollutant Source Inventory

Point Source Discharges

There are no established point sources in the Rattle Creek watershed.

Nonpoint Source Discharges

Excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in unstable channels and are believed to be major limiting factors to water quality and beneficial uses in Rattle Creek. Sources of this pollution include:

Roads - A road parallels Rattle Creek for most of its length, reducing recruitment of large woody debris and increasing the sediment load to the stream. Portions of the road encroach upon the floodplain and reduce floodplain capacity and function (Corsi, et al. 1998).

Timber Harvest - Timber harvest has occurred in several locations in the watershed. Rattle Creek has been significantly impacted by clearcut related landslide activity (Cacek 1989).

2.a. Summary of Past and Present Pollution Control Efforts

Stream habitat surveys were conducted in the Rattle Creek drainage in 1997 by Cascades Environmental, Inc. as part of WWP's hydropower relicensing process. Results of these surveys were>>>>>>>>

Last fall the Rocky Mountain Research Station (USFS) began a longer term investigation of the relationship between stream hydrology and bull trout redd site selection and spawning success.

3. Water Quality Concerns and Status

Rattle Creek was included on the 1994 303(d) list for these pollutants of concern: sediment, flow, and habitat alteration. These pollutants were determined to be limiting beneficial uses of the stream according to the 305(b) list criteria in the State of Idaho.

Water quality data collected in 1995 near the mouth of Rattle Creek as part of the IDEQ beneficial use reconnaissance project was analyzed and the stream reach was determined to be fully supporting all established beneficial uses according to the waterbody assessment guidance and was subsequently taken off the 1996 and 1998 lists.

Rattle Creek is currently under scrutiny as a high priority watershed for bull trout recovery in the Lake Pend Oreille Key Watershed, as assessed by the Panhandle Bull Trout Technical Advisory Team. (Corsi, 1998)

3.a. Applicable Water Quality Standards

The 303(d) list is composed of streams found to be not supporting beneficial uses designated for that stream. Beneficial uses that have been designated for Rattle Creek include: Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Industrial Water Supply, Wildlife Habitat, and Aesthetics. These have all been determined according to the Waterbody Assessment Guide established by Clean Water Act revisions.

Additionally, Rattle Creek is under scrutiny as a high priority under the Lake Pend Oreille Key Watershed Bull Trout Problem Assessment for sustainable persistence of bull trout, a federally protected species under the Endangered Species Act.

3.b. Summary and Analysis of Existing Water Quality Data

Beneficial use data was collected on Rattle Creek approximately 1.3 miles from its mouth (confluence with Lightning Creek) on July 6,1995. The temperature recorded was 11°C and discharge (flow) was recorded at 32.41 cubic feet per second. The macrobiotic index (MBI - measure of macroinvertebrate community quality) was recorded at 4.92 (fully supporting Cold Water Biota), sediment was found to be 13.33% of the total substrate, and the habitat index (HI), which measures habitat quality for salmonids and other aquatic biota was 80 (determined to be needing verification. Fish data was not included, so determination of salmonid spawning cannot be confirmed. This data confirms full support for all designated uses except salmonid spawning.

There has been additional water quality data collected as part of bull trout protection efforts in the Rattle Creek watershed. Continuous temperature data collected from 7/11/98 through 10/12/98 recorded consistent ($\geq$10 days) temperatures as high as 13°C in July and August to approximately 9°C in October. Bull trout redds (spawning beds) have been recorded in Rattle Creek as high as 51 in 1983 (first year recorded) to as low as none (0) in 1994. There were 10 bull trout redds counted in 1996. This data would seem to support the salmonid spawning beneficial use, however marginally.

3.c. Data Gaps For Determination of Support Status

Primarily, fish community composition data would be valuable to officially confirm salmonid spawning as a beneficial use in accordance with protocols established by the Waterbody Assessment Guide. Additional monitoring in the form of collecting data from different reaches (to account for differences in land use and geography) within the watershed and to establish changes over time would also be useful.

4. Problem Assessment Conclusions

Based upon currently available IDEQ assessments, designated beneficial uses are being fully supported in Rattle Creek. Therefore, it is recommended that this waterbody be removed from the 303(d) list pending further information.

References

Cacek, C. C. 1989. The relationship of mass wasting to timber harvest activities in the Lightning Creek Basin, Idaho and Montana. Eastern Washington University, Masters Thesis.

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

E. **WELLINGTON CREEK**

(tributary to Lightning Creek)

Summary

The Wellington Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Existing information on watershed conditions in Wellington Creek indicates the system is in fair condition as a result of flooding, road construction and subsequent failures, and logging activity. A logging road parallels Wellington Creek over much of its length, and there are several stream crossings within the drainage. Several significant landslides associated with road failures have occurred in the Wellington Creek drainage, and Wellington Creek is generally considered to be unstable (Corsi, et al. 1998).

Excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in unstable channels. There are over 12 miles?????? of roads in the Wellington Creek watershed, and average road density is between one and two miles per square mile. Cacek (1989) found that gentler slopes have contributed to less slide activity resulting from land management activity than in other portions of the Lightning Creek basin, and that landslides were not contributing to sediment to the stream. Roads may alter drainage patterns and increase peak flows (Corsi, et al.1998). Approximately 19% of the Wellington Creek watershed has been logged. Removal of trees may contribute to increased peak flows.

2. Pollutant Source Inventory

<u>Point Source Discharges</u>

There are currently no point sources discharging into Wellington Creek.

<u>Nonpoint Source Discharges</u>

Excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in unstable channels and are believed to be the major limiting factors to water quality and beneficial uses in Wellington Creek.

Roads - There are over 12 miles of roads in the Wellington Creek watershed, and average road density is between one and two miles per square . Cacek (1989) found that gentler slopes have contributed to less slide activity resulting form land management activity than in other portions of the Lightning Creek basin, and that landslides were not contributing to sediment to the stream. Roads may alter drainage patterns and increase peak flows.

Timber Harvest - Approximately 19% of the Wellington creek watershed has been logged. Removal of trees may contribute to increased peak flows.

2.a. Summary of Past and Present Pollution Control Efforts

Wellington Creek was evaluated in 1998 as part of the Idaho Department of Lands Cumulative Watersheds Effects Assessment project to determine the effects of forest practices upon water quality in this watershed.

Stream habitat surveys were conducted in the rattle Creek drainage in 1997 by Cascades Environmental, Inc. as part of Washington Water Power's (Avista Corp.) hydro relicensing process. Last fall, the Rocky Mountain Research Station (USFS) began a longer term investigation of the relationship between stream hydrology and bull trout redd site selection and spawning success. (Corsi, et al. 1998)

Beneficial Use Attainability and Status Reconnaissance surveys were completed by the IDEQ in 1995, 1996, and 1997. These surveys were completed as required by a status 303(d) listing in 1994.

3. Water Quality Concerns and Status

3.a. Applicable Water Quality Standards

3.b. Summary and Analysis of Existing Water Quality Data

Stream habitat surveys were conducted in Wellington Creek in 1997 by Cascade Environmental, Inc. As part of WWP's hydropower relicensing process. Results of these surveys were>>>>>>>>>

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

Cacek, C. C. 1989. The relationship of mass wasting to timber harvest activities in the Lightning Creek Basin, Idaho and Montana. Eastern Washington University, Masters Thesis.

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

F. **PORCUPINE CREEK**

(tributary to Lightning Creek)

Summary
The Porcupine Creek problem assessment will be completed in 2003 along with the Clark Fork River.

2.1.1. Physical and Biological Characteristics

Porcupine Creek drains into Lightning Creek from the west, and provides about four miles of accessible fish habitat. A barrier falls exists a short distance down stream from the outlet of Porcupine Lake, which is at the head of the drainage.

Existing information on watershed conditions in Porcupine Creek indicates the system is in poor condition as a result of flooding, road construction and subsequent failures, and logging activity. A logging/recreation road parallels Porcupine Creek over much of its length, and there are several stream crossings within the drainage. Evidence of fill slope failures is evident at most headwater stream crossings on the main Porcupine Creek road. The channel is unstable in the lower reaches as a result of bedload deposition.

A road parallels Porcupine Creek for most of its length, crossing several headwater channels. Evidence of fill slope failures at headwater stream crossings is common, and failed culverts can be seen at the bottom of slides, in the Porcupine Creek channel. Landslides from road failures probably occurred recently (within the last 10 years) as Cacek (1989) did not report slide activity impacting the stream.

Hybridization between brook trout in Porcupine Lake and the upper reaches of Porcupine Creek indicate that brook trout pose a significant threat to bull trout, a federally threatened species, in Porcupine Creek. Relatively recent declines in spawning activity, despite the long term presence of brook trout in the system, suggest poor stream conditions may be favoring brook trout and the potential for hybridization (Corsi, et al. 1998).

2. Pollutant Source Inventory

Point Source Discharges

There are currently no known point source discharges in the Porcupine Creek watershed.

Nonpoint Source Discharges

Excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in unstable channels and may impair beneficial uses in this watershed. Sources of this pollution in the Porcupine Creek watershed are primarily roads and timber harvest, as identified below:

Roads - A road parallels Porcupine Creek for most of its length, crossing several headwater channels. Evidence of fill slope failures at headwater stream crossings is common, and failed culverts can be seen at the bottom of slides, in the Porcupine Creek channel. Landslides from road failures probably occurred recently (within the last 10 years) as Cacek (1989) did not report activity impacting streams.

Timber Harvest - timber harvest has occurred in several locations in the watershed. Approximately 20% of the watershed has been logged, including several large clearcuts. Timber removal at this scale may increase water yield and peak flows.

2.a. Summary of Past and Present Pollution Control Efforts

Stream habitat surveys were conducted in the Porcupine Creek drainage during 1997 by Cascades Environmental, Inc. as part of WWP's hydropower relicensing process. Results of these surveys were.>>>>>>>>>>>>>>>>>>>>

Porcupine Creek was listed as a water quality and beneficial use impaired stream in 1994 as part of the Clean Water Act mandated section 303(d) legislation. This listing prompted the IDEQ to survey this stream for information relative to beneficial use support status.

The 1998 Lake Pend Oreille Key Watershed - Bull Trout Problem Assessment listed Recommended Approaches to Address Limiting Factors of bull trout propagation and persistence in this stream and also established Recommended Actions to promote water quality and bull trout habitat in the Porcupine Creek watershed.

3. Water Quality Concerns and Status

Existing information on watershed conditions in Porcupine Creek indicates the system is in poor condition as a result of flooding, road construction and subsequent failures, and logging activity (Corsi et al., 1998).

Porcupine Creek was included on the 1994 303(d) list for not supporting beneficial uses due to watershed pollution. The listed pollutants of concern were sediment, flow, and habitat alteration. Porcupine Creek has since been evaluated by the IDEQ and determined to be fully supporting designated beneficial uses according to Waterbody Assessment Guidance and the Beneficial Use Assessment and Status Reconnaissance.

Porcupine Creek is also under scrutiny as a high priority watershed for bull trout recovery in the Lake Pend Oreille Key Watershed, as assessed by the Panhandle Bull Trout Technical Advisory Team.

3.a. Applicable Water Quality Standards

The 303(d) list is composed of streams found to be not supporting beneficial uses designated for that stream. Beneficial uses that have been designated for Porcupine Creek include: Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Industrial Water Supply, Wildlife Habitat, and Aesthetics.

Additionally, Porcupine Creek is under scrutiny as a high priority under the Lake Pend Oreille Key Watershed Bull Trout Problem Assessment for sustainable persistence of bull trout, a federally protected species under the Endangered Species Act.

3.b. Summary and Analysis of Existing Water Quality Data

A Beneficial Use Assessment and Status Reconnaissance survey was conducted on Porcupine Creek on July 6, 1995. This survey produced results which were found to be fully supporting designated beneficial uses within this watershed. The macrobiotic index (MBI), which evaluates the aquatic macroinvertebrate community, was determined to be 5.42, a value that demonstrates a healthy community with high species diversity. The habitat index (HI) scores a combination of habitat parameters and produced a result of 104 (not impaired) for Porcupine Creek. The substrate was found to be composed of only 3.17% of fines (particles <6 mm. diameter).

Continuous temperature data was found to be slightly in exceedance of criteria for salmonid spawning but well within Cold Water Biota criteria with a high average daily temperature (>10 days continuous) of approximately 14°C for late July and early August. Average daily temperatures consistently dropped from this high to approximately 9°C in early October.

No IDEQ fish data was acquired as part of the Beneficial Use Reconnaissance Project, so determinations of support status of Salmonid Spawning could not be assessed according to this protocol.

Idaho Fish and Game has conducted bull trout redd counts in Porcupine Creek in 11 of the past 15 years. Redd numbers have declined noticeably since the 1980's with a high of 52 in 1984 to a low of zero in 1996 and 1997. Based on the low numbers of redds, the apparent declining trend, and substantial variability in counts, bull trout in Porcupine Creek are expected to have a fairly low probability of persistence.

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

Cacek, C. C. 1989. The relationship of mass wasting to timber harvest activities in the Lightning Creek Basin, Idaho and Montana. Eastern Washington University, Masters Thesis.

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

G. EAST FORK LIGHTNING CREEK

(tributary to Lightning Creek)

Summary

The East Fork Lightning Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Existing information on watershed conditions in the East Fork indicate the system is in poor condition as a result of flooding, road construction and subsequent failures, and logging activity. A logging road parallels the East Fork for much of the lower two miles, and there are several stream crossings within the drainage. Currently, portions of the road have been captured by the creek, and the East Fork is generally considered to be highly unstable with impaired fish habitat conditions (Pend Oreille Bull Trout Problem Assessment 1998). Cacek (1989) reported that the East Fork received significant volumes of landslide debris into the stream channel, due to road locations in relation to the stream channel.

In summary, excess bedload, loss of large woody debris, and altered water delivery and flow patterns have resulted in unstable channels. Riparian roads reduce recruitment of large woody debris to stream channels, reduce flood plain capacity, result in increased erosion, and contribute large amounts of bedload material to streams. Improperly constructed or maintained hill slope roads increase the drainage density and can influence the rate of water delivery to the stream channel from the basin. Road wash outs are common along portions of the East Fork road, and the East Fork crossing of the main Lightning Creek road contributes significant amounts of bedload material to the lower reach of the East Fork.

Approximately 12% of the drainage has been harvested. Past timber harvest included clearcuts, which can contribute to mass wasting in the East Fork area (Cacek 1998).

2. Pollutant Source Inventory

<u>Point Source Discharges</u>

<u>Nonpoint Source Discharges</u>

2.a. Summary of Past and Present Pollution Control Efforts

3. Water Quality Concerns and Status

3.a. Applicable Water Quality Standards

3.b. Summary and Analysis of Existing Water Quality Data

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

Cacek, C. C. 1989. The relationship of mass wasting to timber harvest activities in the Lightning Creek Basin, Idaho and Montana. Eastern Washington University, Masters Thesis.

H. **QUARTZ CREEK**

(tributary to Lightning Creek)

Summary

The Quartz Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Quartz Creek, a tributary to Lightning Creek, was assessed in 1992 by BIO/WEST, Inc. Quartz Creek was dominated by pocket water and pool habitat formed by boulders and rock outcrops. Average maximum pool depth was 29 inches (74 cm) which is within the range of optimal pool depths for rainbow, cutthroat and bull trout. Residual pool depth was low, about 7 inches (18 cm), indicating marginal habitat during extreme low flow conditions. Pool riffle ratio was high at approximately 2:1, but pool abundance is low (11% of total stream habitat area). Cover availability was considered only slightly sub-optimal for adult trout (<25%), whereas pool cover was considered adequate for juvenile trout (>15%). The dominant cover type was boulders which is considered high quality.

Cobble constituted more than 25% of the substrate, and embeddedness was moderate at 35%. Despite the relative high levels of embeddedness, fines and sands made up less than 10% of the embedded material. Gravel substrate suitable for trout spawning was abundant in pools, but relatively uncommon in runs. Fines overall were rare (<5%), and sands and fines together were low enough to provide optimal trout spawning and emergence success.

Stream shade in Quartz Creek was less than the 50% considered ideal for trout streams, however, stream temperatures measured in October were well below state water quality standards levels for cold water biota, salmonid spawning and bull trout spawning.

2. Pollutant Source Inventory

Point Source Discharges

Nonpoint Source Discharges

2.a. Summary of Past and Present Pollution Control Efforts

3. Water Quality Concerns and Status

3.a. Applicable Water Quality Standards

3.b. Summary and Analysis of Existing Water Quality Data

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

I. **SPRING CREEK**
(tributary to Lightning Creek)

Summary
The Spring Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Spring Creek is located immediately to the northwest of the town of Clark Fork, Idaho, and approximately 30 miles east of Sandpoint, Idaho. The spring Creek drainage contains 6,480 acres used primarily for forestry with small areas of rural residential. Land ownership is distributed among the Panhandle National Forest, industrial timber companies, and small private owners (Dechert 1999).

The Spring Creek watershed is underlain by Precambrian metasedimentary rocks. The landforms in Spring Creek are strongly influenced by Pleistocene glacial activity. The watershed is bisected by the northwest trending Hope Fault, with significantly different landforms on either side. Higher elevation areas to the north of the fault have been glacially scoured and are very steep and angular. Lower elevations to he south of the fault exhibit deposits of varying depths of glacial debris. Some of the lower elevation hills in the south end of the watershed were scoured by the Lake Missoula floods. The lowest elevation floodplains and terraces are Quaternary deposits (Dechert 1999).

Spring Creek is a large, spring fed tributary to lower Lightning Creek. It is the primary source of water for the Clark Fork state fish hatchery, and the community of Clark Fork has a water diversion facility further upstream. Downstream from the hatchery, Spring Creek has a low gradient channel which meanders through a modified riparian zone comprised largely of hardwoods and young conifers. Water temperatures appear to be suitable for salmonids. Juvenile bull trout have been reported from Spring Creek, but no bull trout spawning activity has been documented in recent years. Rainbow trout, westslope cutthroat trout, and brook trout have all been documented in Spring Creek. Brook trout are known to occur in high densities in the upper reaches of Spring Creek, but are uncommon in the lower reaches (Corsi 1998).

The drainage is oriented in a southerly direction with Spring Creek generally flowing from the north to the south southeast. Elevation ranges from 2120 ft at the mouth to near 6210 ft on the divide above Porcupine Lake. The drainage pattern is modified trellis with steep gradients in the bedrock-controlled portions of the watershed. In the portions of the watershed dominated by glacial and alluvial deposits, drainage patterns are irregular and poorly defined. Stream profiles here are relatively low gradient, and with the abundance of unconsolidated material, streams may go subsurface during drier portions of the year (Dechert 1999).

Spring Creek is a tributary to Lightning Creek and was also assessed by BIO/WEST, Inc. In 1992. Spring Creek was about equally dominated by pool, riffle and run habitats. Most pools were created by large organic debris. Average maximum pool depth was 14 inches (36 cm) which was considered sub-optimal for rainbow, cutthroat, and bull trout. Residual pool depth was 6 inches (16 cm) and mean residual pool volume were also low.

2. Pollutant Source Inventory

Sources potentially limiting water quality in Spring Creek are not well understood at this time. While diversions, roads, agriculture, and timber land uses exist in this watershed, they have not been adequately studied to or evaluated to determine potential effects on Spring Creek.

2.a. Summary of Past and Present Pollution Control Efforts

Spring Creek was designated a Stream Segment of Concern (SSOC) on May 11, 1993, pursuant to Idaho's Antidegradation Agreement. No Local Working Committee (LWC) was required; however, on June 2, 1994 revisions pertaining to site specific best management practices (SSBMPs) were reached after consultation with other agency resource management personnel. The Director of the Idaho Department of Lands approved these SSBMPs on December 14, 1994 (Dechert 1999).

The U.S. Environmental Protection Agency determined that sediment threatens Spring Creek's beneficial uses. Based on an evaluation performed in 1996 by the IDEQ (as described below), Spring Creek was categorized as having full support of beneficial uses.

3. Water Quality Concerns and Status

Spring Creek (headwaters to mouth) was listed in 1994 as a waterbody not fully supporting all of its designated beneficial uses due to sediment pollution. The source of this listing was the 305(b) report. Since then, IDEQ beneficial use reconnaissance data collected on Spring Creek was analyzed for evidence of beneficial use support. Data collected in 1995 and 1996 was first determined to be needing verification for support status. Further analysis and review has determined that, based on available data, Spring Creek is currently supporting all designated beneficial uses.

3.a. Applicable Water Quality Standards

Beneficial uses that have been designated for Spring Creek include: Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Industrial Water Supply, Wildlife Habitat, and Aesthetics. Data currently available indicates that Spring Creek is fully supporting all of these beneficial uses.

3.b. Summary and Analysis of Existing Water Quality Data

Spring Creek has been evaluated by the Idaho Division of Environmental Quality under auspices of the 1996 Water Body Assessment Guide. This evaluation was based upon water quality data collected as part of the Beneficial Use Reconnaissance Project. One site inspection was completed in 1995 and one in 1996 for the purpose of establishing data on beneficial use support status. These surveys were analyzed and determined to provide full support for all designated beneficial uses.

A Cumulative Watershed Effects (CWE) assessment of the forested portions of Spring Creek was conducted by the Idaho Department of Lands to: 1.) develop an understanding of the inherent hazards of the landscape within the Spring Creek watershed, 2) document the current conditions within the watershed relevant to hydrologic processes and the disturbance history, and 3) develop a control process that will ensure that the watershed is managed to protect water quality so that beneficial uses are supported (Dechert 1999).

The results of this analyses, coupled with the results of the DEQ surveys, show that water quality and beneficial uses are being maintained in the forested portions of the watershed using current forest management practices as specified by the Site Specific Best Management Practices adopted in 1994 by the Idaho Department of Lands pursuant to the Idaho Antidegradation Agreement (Dechert 1999).

3.c. Data Gaps For Determination of Support Status

An assessment of factors (pollution sources) which may be effecting or may potentially effect the water quality and aquatic habitat is desired for reference now and in the future. Continued surveying should be done to monitor support status and to identify stream segments which may be impaired.

4. Problem Assessment Conclusions

References

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

Dechert, Tom; Raiha, Dan; and Saunders, Vincent. Idaho Department of Lands. *Spring Creek Cumulativ*

J. **TWIN CREEK**
(tributary to Clark Fork River)

Summary
The Twin Creek problem assessment will be completed in 2003 along with the Clark Fork River.

1. Physical and Biological Characteristics

Twin Creek is a third order tributary to the lower Clark Fork River, and flows from the northern tip of the Bitterroot Range. Existing information on watershed conditions in Twin Creek indicates the system is in poor condition as a result of stream channelization, road construction and livestock grazing. Lower Twin Creek, downstream from the county road, was relocated and channelized in the early 1960's to improve agricultural production. Much of the lower reach consists of a wide shallow channel with riffle habitat being the primary feature. Riparian vegetation is limited due to livestock grazing and the modified floodplain, and consists primarily of grasses, sedges, and sparse alders. Considerable bedload moved and deposited in the lower reaches of Twin Creek during 1997.

Immediately upstream from the county road the stream has been modified to allow it to pass under the road and into the channelized reach. Further upstream the channel shows signs of recent activity and instability .

2. Pollutant Source Inventory

Point Source Discharges

There are no known point source discharges within the Twin Creek watershed.

Nonpoint Source Discharge

Bedload transported from upstream sources and livestock grazing appears to be potentially limiting water quality in Twin Creek.

Agriculture/Livestock Grazing - Affects of livestock grazing in the Twin Creek watershed represent a potential threat to water quality. In the early 1960's, the lower reach of Twin creek was channelized, significantly reducing stream length and creating a reach with high width/depth ratios and poor salmonid habitat. The channel has not recovered and grazing continues to negatively impact the stream and riparian area.

Roads - A portion of North Twin Creek is paralleled by a road, and there is a road which follows the valley corridor up the mainstem of Twin Creek. At this time we do not have information on the condition of these roads. The County road crosses Twin Creek just upstream from the channelized reach, and the grade of the stream has been adjusted to place the creek under the road. The sudden change in grade results in a deposition zone immediately downstream, and limits creek restoration options.

Timber Harvest - Approximately 11% of the Twin Creek watershed has been harvested. Riparian harvest has reduced recruitment of large woody debris in lower reaches of the stream.

2.a. Summary of Past and Present Pollution Control Efforts

Stream habitat surveys were conducted in the Twin Creek drainage by Cascades Environmental, Inc. As part of WWP's hydro relicensing process.

3. Water Quality Concerns and Status

Twin Creek (headwaters to mouth) was listed in 1994 as a waterbody not fully supporting all of its designated beneficial uses due to sediment and nutrient pollution. The source of this listing was the 305(b) report. Since then, IDEQ beneficial use reconnaissance data collected on Twin Creek was analyzed for evidence of beneficial use support. Data collected in 1995 and 1996 was first determined to be needing verification for support status. Further analysis and review has determined that, based on available data, Spring Creek is currently supporting all designated beneficial uses.

3.a. Applicable Water Quality Standards

Beneficial uses that have been designated for Twin Creek include: Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Industrial Water Supply, Wildlife Habitat, and Aesthetics.

Additionally, Twin Creek is under scrutiny as a high priority under the Lake Pend Oreille Key Watershed Bull Trout Problem Assessment for sustainable persistence of bull trout, a federally protected species under the Endangered Species Act.

3.b. Summary and Analysis of Existing Water Quality Data

3.c. Data Gaps For Determination of Support Status

4. Problem Assessment Conclusions

References

Corsi, C., DuPont J., Mosier, D., Peters, R., and Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

K.

PEND OREILLE LAKE

(tributary to Pend Oreille River)

Summary

Pend Oreille Lake was added to the 1994 303(d) list, and retained on the 1996 list, as a water quality "threatened" waterbody, due to the increasing amount of nutrients in the lake and the threat of metals pollution from the Clark Fork River. This problem assessment concludes that the lake is not expected to exceed any water quality standard due to declining water quality within the next two years. Because no violation is expected within this time frame, EPA, Region 10 does not consider the lake a "threatened" water body and no TMDL for nutrients or metals will be written for it at this time. It is recommended that the Tri-State Implementation Council be supported in their efforts to develop a voluntary nutrient reduction plan for this waterbody.

1. Physical and Biological Characteristics

Pend Oreille Lake is the 21st largest natural freshwater lake and the 5th deepest in the United States. Surface area of the lake is 91,180 acres (369 km^2). Lake levels are controlled by Albani Falls dam operated by the U.S. Army Corps of Engineers. Normal full-pool elevation is 2,062 feet (628 m) mean sea level (USGS 1996) and normal drawdown around the first of December is 2,051feet (625.1 m). Due to the water level fluctuations and shoreline development, bank erosion is severe in some areas.

The nearest U.S. Geological Survey water quality monitoring station is located below the Cabinet Gorge dam on the Clark Fork River near the Idaho-Montana border. No annual water quality monitoring is being conducted on the lake other than the occasional volunteer monitoring effort.

The lake is characterized by two distinct morphometric basins. The large deep southern basin has a surface area of 57,377 acres (232 km^2) and a mean depth of 721 feet (220 m) and contains about 95% of the lake's volume (Woods 1991b). The mean hydraulic residence time of the deep basin is likely in excess of ten years (Falter et al. 1992). The northern basin is characterized by a relatively shallow mean depth of 95 feet (29 m) and a mean hydraulic residence time of much less than one year (Falter et al. 1992). It is heavily influenced by the inflow of the Clark Fork River which provides 92% of the lake's water (Frenzel 1991).

Pend Oreille Lake is used extensively for recreation. Over one million visitors used public recreational facilities in 1985, and 30,000 angler days were recorded for that year also. The lake is also used as a supplemental water supply for the City of Sandpoint and as a main water source for many individual homes along the lake.

2. Pollutant Source Inventory

<u>Point Source Discharges</u>

There are ten point source discharge permits with effluent limitations along the Clark Fork River in Montana. There are seven dischargers in Idaho's portion of the Pend Oreille watershed, six of which have National Pollution Discharge Elimination System (NPDES) permits. Only four Idaho discharges enter above or into the lake. These dischargers are:

1. Cabinet Gorge Dam - Clark Fork River (unpermitted)
2. Cabinet Gorge Hatchery - Clark Fork River
3. Clark Fork Hatchery - Spring Creek
4. Kootenay-Ponderay Sewer District - Boyer Slough

1. The Cabinet Gorge Dam treats their domestic wastewater using a package treatment plant (aeration chamber, clarifier, chlorine contact chamber) and discharges it to the Clark Fork River. The EPA in a letter dated January 9, 1991, indicated that they were unable to prepare an NPDES permit at that time for the discharge, and recommended that Washington Water Power meet state water quality standards until the time that EPA can issue a permit for it. Idaho DEQ set effluent limits for the discharge and established a monitoring plan. Compliance with this agreement has been sporadic both in monitoring frequency and meeting effluent limits. The EPA has not yet issued a permit for this discharge.

2. The Cabinet Gorge Hatchery, operated by the Idaho Department of Fish and Game, is a kokanee trout hatchery with 64 raceways, 3 production ponds, a fish ladder and a settling pond. Maximum production is 45,000 pounds of kokanee per year. Their NPDES permit was effective May 23, 1989 and expired June 21, 1994 (permit #ID-002661-1). The permit has not been re-issued. Reporting by Idaho Fish and Game is current and the discharge appears to be within the allowed effluent limits.

3. The Clark Fork Fish Hatchery is also operated by the Idaho Fish and Game and has 10 raceways, two production ponds and a settling pond. Maximum production was 50,000 lbs of cutthroat, 300 lbs of rainbow, 2,000 lbs of kokanee, 20 lbs of brook trout and 100 lbs of brown trout per year. Their NPDES permit was effective on October 22, 1990 and expired on October 23, 1995. An application for re-issuance of this permit was made to EPA on April 26, 1995 which indicated a change of production to rainbow, cutthroat and brook trout only, and an increase in production by 27,580 lbs/yr and an increase of feed by 10,000 lbs/yr. The permit has not been re-issued by EPA. Reporting by Idaho Fish and Game is current and the discharge appears to be within the allowed effluent limits.

The Clark Fork Hatchery and the Cabinet Gorge Hatchery permits have identical effluent limits for their settling ponds, however, there is an additional discharge allowed for the cleaning of the waste treatment system at the Cabinet Gorge facility. This addition allows approximately twenty times the amount of total suspended solids and ten times more settleable solids to be discharged during cleaning than the settling pond effluent limits. The Cabinet Gorge permit does not allow discharge of this wastewater, indicating that it should be disposed of on an upland site. In reviewing the discharge monitoring reports for the Clark Fork Hatchery, it appears that this additional effluent allowance is (1) not necessary and (2) not consistent with similar NPDES permits.

4. The Kootenai-Ponderay Sewer District each year discharges 1,432 kg total phosphorus and 9,929 kg total nitrogen into Boyer Slough which flows into Pend Oreille Lake. This discharge accounts for 0.4% of the phosphorus and 0.2% of the nitrogen load entering Pend Oreille Lake and River. For comparison purposes, the City of Sandpoint discharges

4,250 kg total phosphorus and 29,470 kg total nitrogen annually to the mouth of the Pend Oreille River. The treatment plant was originally permitted in 1975, the permit was revised in 1984 and expired in 1989. For fourteen years ('69 – '83) the treatment plant provided only primary treatment of sewage before discharging to Boyer Slough. In 1984 a sand filter system was added to meet secondary treatment rules.

In summary, this system has a troubled history, ranging from severe infiltration and inflow, noncompliance with monitoring requirements, exceeding effluent limits and an emergency discharge of wastewater in 1996 of 1.04 million gallons. The District has continually responded to problems with equipment upgrades and increasing maintenance. Due to the rapid growth of these two communities the system is currently undergoing expansion plans with the addition of a land application site. This will not reduce the amount of nutrients discharged to the lake.

A proposed discharge into the Clark Fork River from the ASARCO Rock Creek mine would introduce metals and nutrient pollution to the river and Pend Oreille Lake. However, as stated by the USEPA in a letter to Montana DEQ dated April 8, 1998, "Our calculations, based upon low flow conditions in the Clark Fork River, as outlined in the draft permit, indicated that proposed effluent limitations will not cause a violation of water quality standards in the Clark Fork River, nor cause a measurable increase in the concentration of any parameter at the Montana-Idaho border.". The project has not yet obtained an operating or discharge permit.

Nonpoint Source Discharges

The Clark Fork-Pend Oreille Basin Water Quality Study, (EPA, 1993) identifies the near shore littoral zone as the primary location for water quality problems in the lake. The areas of highest algae growth, which correlates with areas of higher phosphorous loadings, were found along shorelines with significant residential development. Phosphorous loadings from local tributaries also reflected the near shore findings, that the higher degree of urban development the higher the phosphorous loading. Factoring in the land area drained by tributaries, the Pack River and Sand Creek contribute the largest loads of phosphorus to the lake. Lightning Creek, Pack River and Sand Creek contribute the largest loads of nitrogen. The Clark Fork River contributes the least amount of nutrients per unit of land drained, however, due to the huge volume of water entering the lake, the Clark Fork River contributes approximately 80% of the phosphorus and 81% of the nitrogen load (Hoelscher et al. 1993).

Other nonpoint sources which contribute nutrients to the lake are the result of land disturbing activities such as silviculture, agriculture, grazing, septic tanks, and urban runoff. Eighty three percent (83%) of the Pend Oreille watershed is forested. Forest practices play a large role in determining the water quality of many of the tributaries which flow into the lake (Figure 1). Currently, nineteen (19) tributaries are listed as water quality impaired due to excess sediment, temperature, nutrients, and flow and habitat alterations. These water quality limited streams are addressed separately from the lake.

Other sources which introduce nutrients to the lake are agriculture, grazing, septic systems, and urban runoff. Agriculture accounts for 4% of the land use in the watershed, and occurs primarily in flat valley bottoms around Cocolalla Lake. Grazing comprises about 3% of the watershed. Failed septic systems along the lake contribute to near shore eutrophication. Stormwater from urban areas flows into the lake, most with minimal or no treatment. Contribution of pollutants to the lake from this source has not been quantified.

2. a. Summary of Past and Present Pollution Control Efforts

As a result of citizen concerns about increased aquatic weed and algae growth in the Clark Fork River, Pend Oreille Lake and Pend Oreille River, the U.S. Congress added language to the 1987 Clean Water Act Amendments (P.L. 100-4, Feb. 4, 1987) that directed EPA to study the sources of nutrient pollution in the basin. A comprehensive three year study led to the development of the Clark Fork-Pend Oreille Basin Water Quality Study, A Summary of Findings and a Management Plan (EPA 1993), designed to protect and restore water quality in the watersheds from nutrient pollution. The Tri-State Implementation Council (later changed to Tri-State Water Quality Council) was established in October 1993, to oversee implementation of the Plan. The Council consists of representatives from counties, cities, tribes, citizen groups, businesses, industries and state and federal agencies. The Council provides oversight to eleven (11) ad hoc subcommittees who are working at the local level to put into effect the specific action items from the management plan. Accomplishments of the Council to date are:

1. A basin wide phosphate detergent ban.
2. A Voluntary Nutrient Reduction Plan, approved by Montana DEQ and EPA and developed cooperatively with major point source dischargers establishes a target nutrient load for the middle Clark Fork River.
3. Created a "Watershed Trunk" game for grade school use.
4. Initiated the Missoula and Sandpoint Water Festivals.
5. Offered educators tours of the watershed; Arranged for a continuing education college course about watersheds.
6. Coordinates with Washington DOE on milfoil control.
7. Promote and facilitate regional sewer planning. Ellisport Bay sewering is currently underway.
8. Instituted major improvements to the City of Missoula, Deer Lodge and Butte wastewater treatment systems.
9. Established and currently maintaining a water quality monitoring network throughout the basin.
10. Assisted Bonner County in developing an effective stormwater and erosion control ordinance.

Washington Water Power, as part of their relicensing process for the Noxon and Cabinet Gorge hydro-power projects, agreed to the following protection, mitigation and enhancement measures (PM&Es) (Federal Energy Regulatory Commission 1998)*:

1.	Idaho Tributary and Fishery Enhancement Program	$400,000/yr for 45 years
2.	Fish Passage/Native Salmonid Restoration Plan	$400,000/yr for 45 years
3.	Bull Trout Protection and Public Education	$125,000/yr for 45 years
4.	Watershed Council Program	$ 10,000/yr for 45 years

5.	Support of Tri-State Implementation Council	$ 15,000/yr for 45 years
6.	Monitoring of Noxon Reservoir Stratification and Mobilization of Sediment, Nutrients/Metals	$ 4,000/yr for 45 years
7.	Implementation of Land Use Management Plan	$ 75,000/yr for 45 years
8.	Wildlife Habitat Acquisition and Enhancement Fund	$ 192,000/yr for 45 years
9.	Wetlands on WWP Property	$ 50,000/yr for 45 years
10.	Clark Fork Delta Habitat	undetermined yrly amt.
11.	Erosion Fund and Shoreline Stabilization Guidelines Program	$ 50,000/yr for 5 years+ $ 40,000/yr for 40 years

*The above list is not inclusive. Some PM&Es have been excluded and funding amounts shown are only the annual contributions.

Many of these relicensing projects will benefit the water quality of Pend Oreille Lake also. Stream improvement projects, fish passage projects, habitat restoration, bank stabilization and similar types of activities will benefit both the lake fishery and lake water quality. Funding over the next 45 years should result in a substantial number of improvement projects being achieved.

In 2001, the federal stormwater permit program will be extended to communities of 10,000 or more in population. This program requires that communities work towards improving the water quality of their stormwater discharges to surface or groundwater through the use of best management practices. The City of Sandpoint is presently coordinating with the State to insure that they meet EPA's permitting requirements (T. Maguire personal communication 1998).

The Idaho Forest Practices Act may soon have the addition of the Cumulative Watershed Effects Process for Idaho (Idaho Cumulative Effects Task Force 1995) added to it as a tool to evaluate problem watersheds. This process enables the forest practices advisor to recommend additional protection measures to address cumulative effects of timber harvest. In areas which have been heavily roaded, over harvested, or with unstable geology, site specific Best Management Practices developed from this process should significantly reduce sedimentation of streams. This will benefit the lake since tributaries contribute significant amounts of nutrients to the lake, often transported by adhesion to sediment particles.

Improvements

1. The Clark Fork River contributes 80-85% of the total phosphorus loading to the lake. With the announcement of the Voluntary Nutrient Reduction Plan agreement for the middle Clark Fork and its nutrient reduction schedule, the threat to the lake has decreased. It should continue to decrease with the work of the Tri-State Implementation Council as they focus next on the lower Clark Fork.

2. Pack River, Sand Creek and Lightning Creek discharge the highest level of nutrients per unit of land to the lake. Many of the major tributaries to the lake require TMDL development and implementation. A large percentage of these watersheds are federally owned, and therefore, full compliance with the TMDLs is expected.

3. The listing of the bull trout as federally threatened will also indirectly aid in the

maintenance and improvement of lake water quality through implementation of the recovery plan.

4. The Washington Water Power relicensing settlement includes substantial amounts of money for stream enhancement projects, public education, habitat acquisition, gas supersaturation studies, water quality monitoring and bank stabilization. They will also fund an aquatic organism tissue analysis study to determine if past metals contamination from the Clark Fork superfund sites require human health related fish consumption advisories. These projects will provide direct long term benefits to the water quality of the lake.

5. Until this time, the Special Resource Water designation (IDAPA 16.01.02.056) has been strictly interpreted by DEQ to be very protective of water quality. Although this policy could change, thus far it has protected Pend Oreille Lake and the Clark Fork River from the authorization of additional point source discharges.

6. In 1993 Bonner County adopted a stormwater ordinance which, if enforced, would provide for adequate protection of the lake and its tributaries from sedimentation as a result of various land disturbing activities.

7. The City of Sandpoint is involved in early coordination with DEQ to be prepared to meet the new federal stormwater regulations which become effective in 2001. These rules will address stormwater discharges to surface water and groundwater and require a uniform level of pre-treatment. Involvement and concern for clean water in a community is a positive indication that water quality improvements will be a high priority.

3. Water Quality Concerns and Status

In 1994 the lake was added to the 303(d) list as a water quality "threatened" waterbody, due to the increasing amount of nutrients in the lake and the threat of metals pollution from the Clark Fork River (EPA 1994). Although water quality standards had not been violated, the Clean Water Act, as interpreted by the U.S. Environmental Protection Agency (EPA), allows a waterbody to be listed as "threatened" to avoid an impending impaired status. This provision is found in 40 CFR130.07.(b)(5) and stated below:

> [As part of the state's Continuing Planning Process:] "Each State shall assemble and evaluate all existing and readily available water quality-related data and information... about the following categories of waters: (I) Waters identified by the State in its most recent section 305(b) report as "partially meeting" or "not meeting" designated uses or as "threatened";"

The EPA, Region 10 has interpreted the meaning of a "threatened" water to be a declining trend in water quality which will not meet water quality standards within the next listing period, i.e. two years (EPA 1995).

The primary water quality concerns for the Pend Oreille Lake are as follows:

Nutrients

Since the listing in 1994, there have been numerous successful efforts to reduce nutrients in the watershed, most notably in the upper and middle Clark Fork River. Lagging behind is the effort to reduce nonpoint sources of nutrient pollution related to near shore development around the lake and pollutants entering the lake from tributary streams, most notably the Pack River, Lightning Creek and Sand Creek. Of these three streams, two are on the 1996 303(d) list and will require load reductions. The third, Sand Creek, may be listed in the future. The most effective means of addressing this issue is through local land use ordinances, which must not only be enacted, but vigorously enforced and supported by the public.

The Tri-State Water Quality Council has been very successful in its development of a voluntary nutrient reduction plan for the middle Clark Fork River. They have recently developed a Voluntary Border Nutrient Load Agreement for the Lower Clark Fork River to protect open waters of Pend Oreille Lake from degradation. It is expected that both Idaho and Montana will sign this agreement (see Appendix D).

In February 2001 the EPA and Idaho DEQ decided to proceed with a near shore TMDL for Pend Oreille Lake in light of public comment expressed after DEQ proposed that the lake be de-listed. A considerable number of people indicated that near shore water quality has been declining. Attached and suspended algae and the odor of decaying vegetation were noted by the public. The 2000 census results showed population growth far above those projected by Hoelscher *et al.* (1993) in his lake response model. Hoelscher determined that with the projected population growth rate (35,081 by 2010) the difference between oligotrophic and mesotrophic conditions would be reduced by one half in twenty years. The twenty year population figure Hoelscher used was actually reached in 1998. Without controls to prevent increasing amounts of nutrients from entering the lake, near shore areas will decline and become increasingly dominated by algae and other aquatic plants. The absence of near shore data and the changes observed in the phytoplankton community composition over the past twenty years (EPA 1993), compelled Idaho DEQ and EPA to reconsider the de-listing proposal. In March 2001, the Tri-State Council was awarded a grant from EPA to develop the near shore TMDL and implementation plan. It is scheduled to be completed by December 2001.

Metals

Metals reduction has been achieved by the partial clean up of the Clark Fork River superfund sites and other point source reductions. However, there remains public concern about the potential metals pollution from a proposed hard rock mine (Rock Creek) which would discharge to the Clark Fork in Montana. As part of the process to determine the downstream effects of a discharge in a different state, Region 8 of the EPA, in a letter to Montana DEQ and the U.S. Forest Service dated April 8, 1998 analyzed the project and concluded that the mine's discharge will not violate Idaho water quality standards.

Gas Saturation

It was discovered in 1998 that water quality standards for gas saturation have been exceeded in the Clark Fork River and Pend Oreille Lake due to nitrogen gas supersaturation from the Cabinet Gorge and Noxon Rapids hydroelectric dams. This problem is being addressed by Washington

Water Power as part of their relicensing agreement. DEQ will address the gas supersaturation problem once it has fulfilled its obligations outlined in the April 1997 TMDL Development Schedule.

Fisheries
It is presently unknown if the lake is fully supportive of two native fish species, the federally threatened bull trout and the westslope cutthroat trout (presently under review for listing under the Endangered Species Act). The lake is critical habitat for completion of the bull trout life cycle. Impairment of bull trout habitat due to water quality may be from water level fluctuations (flow), gas supersaturation, and near-shore nutrient enrichment (Corsi et al.1998).

Eurasian Milfoil
Eurasian milfoil was discovered for the first time upstream of the Albani Falls dam. Shallow bays and near shore areas of the lake are now threatened by the invasion of this nuisance exotic plant. The County's response to battling the spread of Eurasian milfoil has been aggressive and timely. Cooperation with Idaho Fish and Game, U.S. Army Corps of Engineers, and Idaho Department of Agriculture has aided in the effort to prevent the further spread of the weed. The Washington Department of Ecology has listed their portion of the Pend Oreille River as water quality impaired due to exotic weeds. Their exists a possibility for a similar listing for the lake in the future.

NPDES Permits
None of the point source dischargers have current NPDES permits. Re-issued permits should reflect public concerns for water quality of the lake, be consistent, and require particular attention to nutrient reduction.

Idaho Water Quality Standards
The mixing zone rules for lakes and reservoirs allows a mixing zone size not to exceed ten percent (10%) of the surface area of the lake (IDAPA 16.01.02.060.01.f.). This amounts to a little less than thirteen square miles in Pend Oreille Lake before the discharge must meet standards (which is no reduction of ambient water quality for special resource waters). If the intent is to protect existing water quality of the lake, then consideration should be given to strengthening the rules for special resource waters or increasing the protection of the lake to an "outstanding resource water" level. (See section 3.a. for a more detailed discussion of this issue.)

3. a. Applicable Water Quality Standards

The state water quality standards under IDAPA 16.01.02.200.06 has a narrative description of what comprises unacceptable levels of nutrients in state surface waters. It states, "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." Public concern about water clarity and algae growths played a large role in listing the lake as threatened. A secondary reason for the listing was concern over metals pollution entering the lake from the Clark Fork River. The state water quality standards protect against metals pollution through the adoption of the National Toxics Rule (57CFR 60848, Dec. 22, 1992). This rule establishes maximum concentrations for various toxic substances, including metals, which are protective of human and aquatic life. Criteria are provided for both acute and chronic concentrations.

The lake has some additional protection by being designated as a Special Resource Water (IDAPA 16.01.02.110). This designation protects the lake from discharges which would cause a measurable reduction in ambient water quality below the *applicable mixing zone*. The pollutant must also be significant to a designated beneficial use. An *applicable mixing zone* is defined as an area where water quality standards can be exceeded in not more than 10% of the surface area of the lake. This would allow for a mixing zone in Pend Oreille Lake of a little less than thirteen (13) square miles. At the edge of this mixing zone the diluted wastewater must be the same as, or better, than the surrounding water quality of the lake, but inside this mixing zone the lake can exceed chronic water quality criteria. Without the Special Resource Water designation water outside the mixing zone would have to support all designated beneficial uses but could be reduced in quality. An example of this would be the Pend Oreille River.

The Pend Oreille Lake and Clark Fork River are protected for all beneficial uses except warm water biota. The Special Resource Water designation also limits existing dischargers to their current permit capacities.

3. b. Summary and Analysis of Existing Water Quality Data

The three-year Clark Fork-Pend Oreille Basin Water Quality Study, A Summary of Findings and a Management Plan (EPA 1993) yielded the following major research findings and conclusions about the Pend Oreille Lake:

- Open lake water quality has not changed statistically since the mid-1950s.

- There is a high correlation between total phosphorus loading from near shore and local tributaries and the degree of urban development. [Note discussion concerning this study found on page 57.]

- Ninety percent (90%) of the water entering the lake comes from the Clark Fork River inflow, as does 85% [this percentage differs depending on the document referenced, the range is 80 - 85%] of the total loading of phosphorus, the nutrient that limits algae growth in the lake.

- Maintenance of open lake water quality is largely dependent upon maintaining nutrient loadings from the Clark Fork River at or below present [1993] levels.

- Pack River, followed by Sand Creek, are the tributaries discharging the highest phosphorus loads per unit of land area to the lake. Lightning Creek, Pack River, and Sand Creek have the highest nitrogen levels.

*Recommended management objectives of the plan include:

- Protect Pend Oreille Lake water quality by maintaining or reducing current rates of nutrient loading from the Clark Fork River.

- Reduce nearshore eutrophication in Pend Oreille Lake by reducing nutrient loading from local sources.

* These recommended management objectives have been partially achieved, largely due to the efforts of the Tri-State Implementation Council (section 2.a.).

Based upon the Phase I Diagnostic and Feasibility Analysis: A Strategy for Managing the Water Quality of Pend Oreille Lake (Hoelscher, *et al.* 1993) the physical and biological environment of the lake is as follows:

1. Average water transparency for the southern end of the lake averaged about 29.5 feet (9m) and 18 feet (5.5 m) for the north portion of Pend Oreille Lake. The lower readings for the northern end were attributed to the Clark Fork inflows and wind induced re-suspended sediment from the lake bottom and littoral areas.

2. Water temperature ranged from 66° F to 73°F (2.2°C to 22.5°C). The shallower northern end of the lake was generally two degrees centigrade warmer. Below 164 ft (50 m) water was a uniform 39°F to 41°F (4°to 5°C).

3. Dissolved oxygen concentrations ranged from 7.8 mg/l to 14.0 mg/l.

4. Nutrient concentrations in the euphotic zone [sun lit depths] were, mean total phosphorus 7.6 μg/l with a range from 3 to 16 μg/l; and mean total nitrogen was 137 μg/l. Several studies (Woods 1991b, Greene *et al.* 1984, Gangmark and Cummins 1987) concluded that the limiting nutrient for algae growth was phosphorus, however, one study (Gangmark and Cummins 1987) reported some evidence of phosphorus and nitrogen co-limiting algae growth.

5. Mean chlorophyll *a* concentration was 0.8 μg/l and varied little within the euphotic zone. The range was 0.1 to 1.9 μg/l.

6. Trophic status of the lake was determined to be oligotrophic. The Clark Fork River caused increased turbidity in the northern part of the lake indicative of mesotrophic or eutrophic conditions. However, this lack of transparency was not due to biological production and disregarded in developing the classification.

7. The highest bacteria count found in near shore waters was 50 colonies/100ml.

8. Distribution of nutrient loads into Pend Oreille Lake was also determined by this study. Table 1. lists the source of nutrient and percentage contribution.

   Table 1. Distribution of Nutrient Loads Into Pend Oreille Lake and River for water year 1990 (Hoelscher *et al.* 1993).

Source	Nitrogen	Phosphorus
Clark Fork River	81.8%	71.8%
Priest River	6.5%	9.4%
Ungaged runoff	3.5%	5.1%
Atmospheric	3.4%	4.6%
Pack River	2.2%	5.0%
Sand Creek	0.4%	0.5%
Lightning Creek	1.3%	0.9%
Wastewater	0.9%	2.7%

9. A nutrient model developed by Woods (1991a) concluded that small to moderate alterations in the nutrient load would not cause changes in the lake trophic status, however, increases of one-quarter the present nutrient load would move the lake closer to a more productive state (Figure 2).

10. The report also examined the potential for future changes to generate increased nutrients, esp. phosphorus, in the watershed in sufficient quantity to noticeably degrade the lake. Conclusions were that in 20 years the margin of safety between existing conditions (oligotrophic) and impaired (mesotrophic) conditions would be reduced by approximately one half. This assumes a projected County population growth of 8,500 residents for1990-2010 [actual value from 1990 - 1998 was 8,604], and the existing level of County standards for development and stormwater management. The accelerated growth pattern around Pend Oreille Lake is a very real threat to water quality if looked at along a greater than ten year time line. In 1997 Bonner County disbanded their Building Department. As a consequence, building permits were issued and construction was undertaken with little to no regulatory oversight. Therefore both population and county involvement in resource protection were grossly underestimated when the model was developed.

A study attempting to correlate shoreline development with increased near shore eutrophication (Falter et al., 1992) was of particular interest to this investigation to determine if a near shore TMDL for nutrients was warranted. Studies conducted previous to 1989 found little difference in indicators of trophic status over the years, despite intensive development of the area around the lake, however, these studies focused on deep water locations.

Falter's hypothesis was that the near shore areas in the rapidly developing lake area would be the first to show accelerated eutrophication (aging) as a result of increased nutrient inputs (Falter, 1989). Sixteen sites were selected around the lake which represented undeveloped, moderately developed and developed near shore areas. Data collected were bacteria, total phosphorus, chlorophyll a and attached algae, both oven dry weight and ash free oven dry weight.

Conclusions of the two year study were that there was no statistically significant difference between productivity on developed and undeveloped sites of attached algae and filamentous green algae in all cases, even with eight replicates per site. Orthophosphorus levels were similarly not significantly different between sites. Water was more turbid at the north lake sites than at the mid or south lake sites. There was a difference in total phosphorus between developed and undeveloped sites and a possible shift from diatoms in the 1970's to green and bluegreen algae found in the 1989-90 study. Typical total phosphorus concentrations were 8 to 10 μg/l. These results do not indicate a statistically significant cause and effect relation between developed areas and near-shore cultural eutrophication of Pend Oreille Lake, however, the trend of some of the data did indicate such a relationship. Falter's periphyton sampling was resumed by the Tri-State Water Quality Council in 1998 to establish a statistically valid set of trend data.

Other information in Falter's study closely correlate Lake Tahoe with Pend Oreille Lake as they are morphometrically very similar. It was shown in Lake Tahoe that from the time higher fertility was evident in the nearshore areas, sixteen years later the earliest stages of eutrophication had spread to the pelagic (deep water) zone of the lake. During that same time period urban growth within the watershed has paralleled increases in primary productivity.

During the first comment period for this problem assessment, numerous members of the public responded that nearshore eutrophication was a problem. Attached algae on nearshore rocks and floating algae were cited the most as significantly impairing their use of the lake. The U.S. EPA's "Water Quality Criteria 1972" (blue book) states, "most relatively uncontaminated lake districts are known to have surface waters that contain 10 to 30 μg/l total phosphorus as P; in some waters that are not obviously polluted, higher values may occur."(EPA, 1972). Falter, et al. (1992) reported that the mean total phosphorus level of developed near shore sites in 1989 and 1990 were 10 μg/l and 7 μg/l, respectively.

In a more in-depth investigation, Rothrock studied nearshore periphyton growth in Priest Lake. Rothrock found that Priest had approximately five times the algal biomass of Pend Oreille Lake, even though Priest Lake shows a high quality oligotrophic status (Figures 1 and 2) (Rothrock, 1997). Similar to Falter's findings, Rothrock found that the differences between indicators of pheriphytic algae on developed versus undeveloped shorelines were not statistically significant. In summary, Rothrock pointed out that a number of factors can affect periphytic algal density and productivity within regions of a lake. Some of these factors include ambient nutrient concentrations, tributary enrichment, interstitial phosphorus and nitrogen (seepage of water moving laterally or upward from the lake bottom), abundant fine particulate and colloidal material with attached phosphorus, wave action and grazing by benthic invertebrates. Rothrock recommended further study concerning nearshore algae and its causes, focusing on specific topics of investigation.

Recent studies completed for the hydroelectric dam relicensing effort discovered that dissolved gas, presumably as a result of the spillways at the Cabinet Gorge and Noxon Rapids dam, exceeds Idaho's 110 percent gas saturation standard in the river and lake during periods of high river flow (WWP 1995; Parametrix 1996, 1997). Washington Water Power is studying this phenomenon in more detail.

c. Data Gaps For Determination of Support Status

General

Yearly trend data for nutrient concentrations in the lake is not available. Monitoring stations should be located in the different limnological zones of the lake and monitored regularly to detect changes in nutrient levels. An active volunteer monitoring program would also be useful for data collection.

Point Sources

The *Rules Governing Point Source Discharges* section (IDAPA 16.01.02.400.) of the Idaho water quality standards does not address the effects of loading to a waterbody, or cumulative effects of multiple point source discharges until a beneficial use is threatened.

Nonpoint Sources

Need to establish what amounts of nutrients and other pollutants are being contributed to the lake by urban stormwater runoff.

Further investigation to determine the degree that periphyton growth is related to human induced nonpoint source nutrients.

4. Problem Assessment Conclusions

Water quality data of the open lake shows little change in trophic conditions from earlier investigations conducted in 1923, 1954, 1975 and 1981 (Falter, 1989). Although threatened over the long term the pelagic zone is slow to change due to the enormous size and depth of the lake. The Tri-State Water Quality Council's "Montana and Idaho Border Nutrient Load Agreement for Pend Oreille Lake Open Water" was created as a cooperative effort between the two states and the Council (Appendix D). If signed, it will provide the best protection possible to maintain the lake's current open water quality. Therefore, at this time a pelagic nutrient TMDL for Pend Oreille Lake is not warranted.

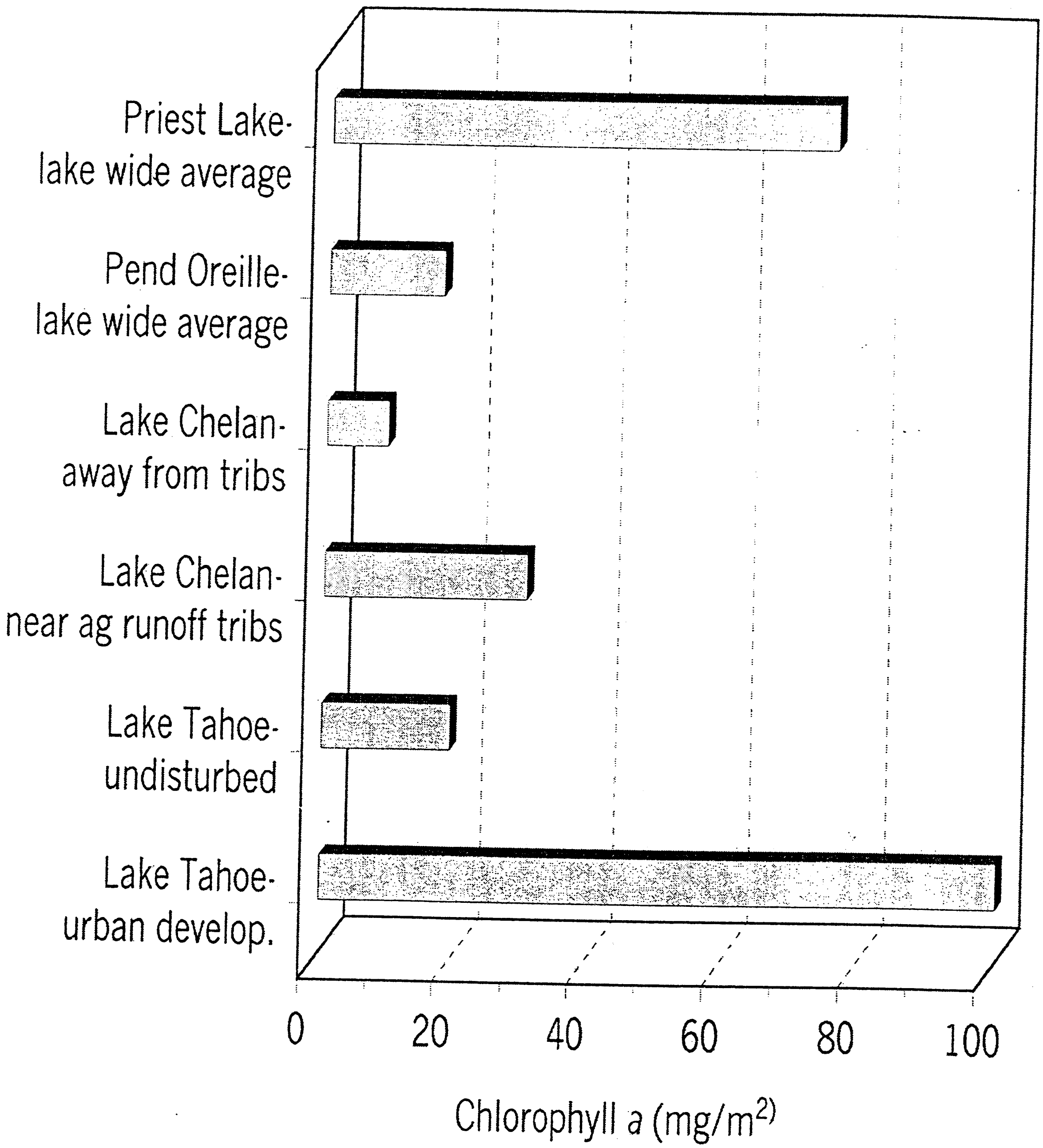
The nearshore areas of Pend Oreille Lake were initially proposed for de-listing. However, due to public input on this issue, comments from EPA and additional information collected in the two years since the de-listing proposal, DEQ now agrees that a nutrient nearshore TMDL should be developed. Factors which were considered in this decision are:

1. Numerous comments from citizens using the near shore areas of the lake indicate that excess nutrients are causing impairment of nearshore uses and that nearshore areas have become increasingly algae rich. These comments were received after it was proposed to de-list the nearshore areas.

2. The 2000 census indicates that the Bonner County has experienced a very high growth rate since 1990. A model developed in 1990 predicted a twenty year window where the margin of safety between an oligotrophic and mesotrophic state would be reduced by one half due to urbanization of the watershed. This prediction was, in theory, met in 1998 based on actual growth rate. If the Lake Tahoe experience is any indication of what could happen in Pend Oreille Lake, it is critical that we control nearshore nutrient enrichment to protect open water quality.

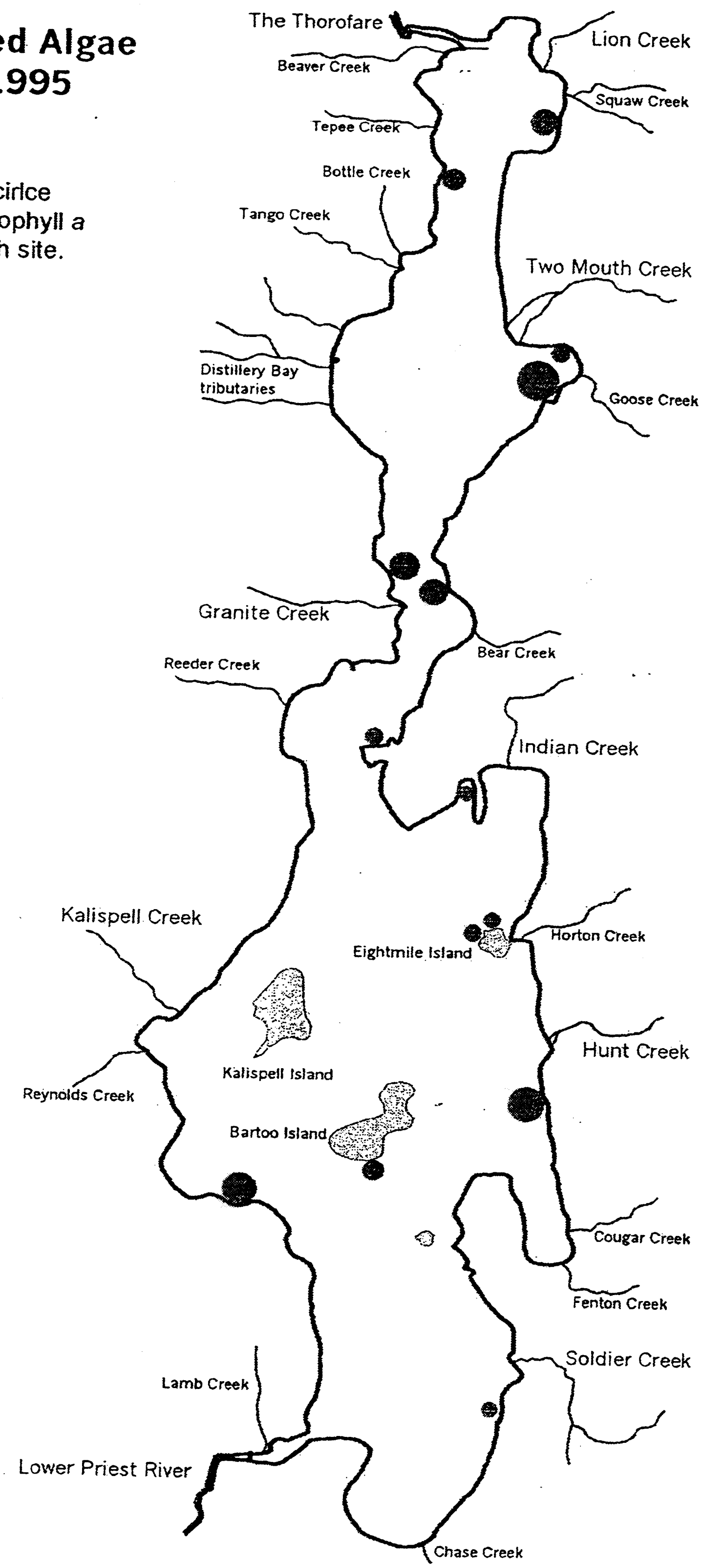
3. Although Bonner County has a good stormwater ordinance, the disbanding of the Building Department from 1997-2001 has greatly reduced enforcement of the ordinance. If stormwater

Algal Biomass Measured on Nearshore Rocks in Various Oligotrophic Lakes



Priest Lake Attached Algae Sampling Sites in 1995

Sampling Sites: size of cirlce represents relative chlorophyll *a* per square meter at each site.



ordinances are not enforced it is likely that in many cases water quality protection measures have not been implemented.

4. The EPA commenting in a December 21, 1999 letter stated that, "...observed changes in phytoplankton community composition from diatoms and chrysophytes to green and bluegreen algae over the past twenty years should be a cause for concern (EPA 1993)." Another comment was, " Particularly given its Special Resource Water status, EPA believes that a natural resource such as Lake Pend Oreille should be managed conservatively to assure protection." EPA also does not believe enough information has been presented to justify de-listing.

The near shore TMDL will be developed and is scheduled to be completed by December 2001. It will have a thirty day comment period for public and agency input prior to its finalization.

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TRIBUTARIES TO PEND OREILLE LAKE

L. TRESTLE CREEK

(tributary to north Pend Oreille Lake)

Summary: Trestle Creek was placed on the 1996 303(d) water quality impaired list as "Threatened". Since the USFS's 1995 Trestle Creek Watershed Improvement Project, concerns about the water quality of Trestle Creek have been greatly reduced. DEQ's assessment of the support status of the creek indicates it fully supports all of its beneficial uses. The Bull Trout Technical Advisory Team believes that Trestle Creek fish habitat and watershed conditions are good. Recommendation is to remove the stream from the 303(d) list.

1. Physical and Biological Characteristics

[The following information was summarized from the USFS's "Trestle Creek Watershed Improvement Environmental Assessment", Sandpoint Ranger District, 1995.]

Trestle Creek is an important bull trout stream and has been studied extensively. Trestle Creek epitomizes a number of high gradient forested watersheds on the northeast side of Pend Oreille Lake. Trestle Creek is a linear sub-watershed that drops 3300 feet (1000 m) in elevation from the divide across from Quartz Creek (Lightning Creek sub-watershed) to Pend Oreille Lake. The entire sub-watershed is in the Kaniksu National Forest, however, there are numerous private in-holdings along Trestle Creek at lower reaches. The sub-watershed is accessed by USFS roads #275 and #1082.

The portion of Cabinet Mountains where Trestle Creek is located has a rounded smooth topography due to scouring by the continental ice sheet movement in the past. These smooth mountain side slopes have some areas of weak to moderately incised draws. Areas of talus and avalanche chutes are also found. A few alpine glaciers were once present at higher elevations as evidenced by the cirque basins on northerly aspects.

The sub-watershed landscape is dominated by glacial scour and glacial deposition areas. In the scour areas soils tend to range from rock outcrops and predominantly shallow soils to areas of deep soils. Deposition areas have deep to very deep soils. The glacial till materials which make up the subsoil and substratum layers of the soil are weakly weathered with a high component of fragmented rock. The surface soil consists of volcanic ash 6 inches (15 cm) to 18 inches (45 cm) thick, mostly originating from Mt. Mazama in Oregon about 6,700 years ago. The underlying bedrock geology consists of hard, metasedimentary rocks of the pre-Cambrian (Belt Series). Some till layers can be very dense and, if close enough to the ash soil layer, may restrict the flow of water.

The drainage pattern of Trestle Creek is pinnate with palmate patterns in the headwaters of many tributaries. This pattern is typical of steep mountain terrain susceptible to rapid flood response. The drainage density is 0.97m of stream per km^2 of watershed. Areas of high drainage density are associated with high flood peaks, high sediment production, and steep hill slopes.

Annual precipitation ranges from 59 inches (1.5 m) per year at Lunch Peak, at the head of Trestle Creek, to 42 inches (1.06 m) per year near the mouth. Annual precipitation is thought to be higher along the southeast side of the valley because of higher elevations on that side and because of lake effects.

The lower portions of Trestle Creek were homesteaded at the turn of the century which involved clearing of the riparian corridor of large trees and some irrigation ditch development. Portions of the sub-watershed also burned in the 1910 fire. The stream bottom began to head cut and become entrenched as a result. This down cut in the lower two miles of Trestle Creek is still evident today. Also during this time period, 21 mining claims were patented on the ridges approximately one or two miles above Trestle Creek. Their effects are considered insignificant. Between 1910 and 1940 logging continued in the privately owned lower riparian sections of the drainage and the USFS did some logging at mid slope areas that had not been burned in 1910. This resulted in increased spring flows, reduced late season base flows, and more bedload being moved out of the tributaries and into the main Trestle Creek. After 1940 logging progressed into the upper half of the drainage. Large trees were removed from the riparian areas and slash was left to accumulate into debris dams. The stream tended to braid around these debris dams in fairly steep terrain. Due to stream bank cutting in these braided sections, bedload deposition in lower portions increased. These braids and debris dams persist today although only larger pieces of slash remain, slightly increasing stream stability.

Construction of the main road (#275) up the valley occurred throughout this period and skid roads prevalent in several sections were, and still are, sources of bedload to Trestle Creek. Because of road washouts, sometime around 1950, the main access road up the valley to the divide was moved from the south side of the creek to the north side, and the original route was abandoned. Since the road□s construction on the north side, steep fill material in places has slid dozens of time adding material to the creek. Repairs were performed on the road in 1952, 1956, 1961, 1968, and 1975. This second access route to the divide was abandoned in 1982 and a third location for road #275 was constructed higher up the side slopes to avoid the unstable problem areas. Despite water bars and seeding of the abandoned second road, sediment production and water quality problems have continued to occur from plugged culverts and fill slope failures. The third road was built to access timber sales of over-mature timber in headwater areas that had been missed by the 1910 fire. Road #275 was reconstructed in 1982 for a timber sale. Reconstruction included additional culverts, a gabion wall and a treated timber wall on the fill slope at 7 miles (10.8 km).

These timbered areas led to the construction of another road (#1082) from Cochran Draw to the Round Top Mountain area. The first one half mile (1.3 km) of road #1082 is considered stable and not a threat to stream channels. However, from the half mile (1.3 km) to 5 miles (7.9 km), the road crosses many steep stream draws which have proven to be some of the most erosive landtypes found on the Idaho Panhandle National Forest. The cut bank at these crossings exposed a contact layer between permeable surface glacial tills and relatively non-permeable, highly compacted glacial tills. The contact between these two till layers is where large quantities of water move laterally underneath the soil. Many of these draws have had problems with landslides. Snow avalanches are common in the upper reaches of these draws. Bedload and debris have been filling culverts. The impermeable till layers are highly susceptible to landslides and cut bank failures. Many of these problems still exist. Beyond 5 miles (7.9 km), road #1082 was built on slash without drainage control structures. There has been sporadic fill slope failures and at least two known stream crossing failures. Because of the lack of drainage measures, risk to stream channels is higher. Also, as the slash begins to decay, the risk of mass wasting increases. The risk of future failures of road fill and stream crossings remains extremely high.

Timber harvest between 1960 and 1985 in the Trestle Creek drainage probably would not have had an effect on water quality except for three confounding factors: 1) tributary channels had not recovered from the 1910 fire and the pre-1940 riparian logging, 2) clearcut harvests of the past did not use riparian buffers in the headwater channels, and 3) above each of the incised draws crossed by road #1082 lies clearcut harvest units adding more water yield. Most of the timber harvesting during this time period has been confined to private lands, firewood gathering and timber theft.

In 1974, a rain-on-snow event caused formation of several debris dams in the Trestle Creek sub-watershed. The IDFG and USFS removed wood from three of these dams in lower reaches in an effort to remove suspected barriers to kokanee spawners. These debris dams probably should have been left in place to control down cutting. Today, the lower reaches continue to down cut until they reach a bedrock control point. The creek then adjusts its floodplain to match its channel location. The channel attempts to carve a new floodplain for itself during high flows by eroding banks of its old floodplain. This increases bedload even further and results in a degraded channel condition that could effectively decrease late season base flows as more water flows through sorted cobbles and infiltrates instead of flowing over an armored channel bottom.

After 1985, timber harvests on National Forest lands have been salvage, commercial thinning, or shelter wood harvest of the 80 year old timber grown since the 1910 fire. Watershed monitoring has not revealed any problems associated with these activities. Roads on the other hand continue to add increased rates of bedload at various locations. There are documented problems on both the abandoned road segments of road #275 and on road #1082 as indicated previously. These problems are well documented in the Trestle Creek Watershed Improvement Environmental Assessment.

2. Pollutant Source Inventory

Point Source Discharges

No point source discharge permits have been issued for Trestle Creek.

Nonpoint Source Discharges

In 1995, the primary factor potentially affecting cold water biota and salmonid spawning is bedload. Far more bedload is being delivered to the lower reaches than can be effectively moved through the system. The watershed has always had to deal with a certain amount of bedload delivered after wildfires and periodic landslides. However, since 1900 the watershed has had additional bedload generating events including homestead clearing, riparian logging, early methods of slash disposal and road building, poor road locations, undersized culverts, clearcuts up slope of unstable road cuts, clearcuts in headwaters without buffers, rain-on-snow flood events, and private home construction within the floodplain. Most of these events occurred before 1970. A related second factor potentially affecting aquatic life uses is a reduction in late season base flow. Stream flow timing shifts have lead to greater spring runoff and less late summer flows in reaches that are down cut.

2.a. Summary of Past and Present Pollution Control Efforts

The Trestle Creek Watershed Improvement Project was begun in 1995 by the USFS to correct watershed problems identified in the Trestle Creek Environmental Assessment. The extensive corrective measures were completed in 1996, which included road obliteration and re-contouring, culvert and bridge removal and bank stabilization.

3. Water Quality Concerns and Status

Trestle Creek was listed in the 1996 303(d) list of water quality impaired waters as "threatened". In 1994 a beneficial use reconnaissance survey was conducted in the Trestle Creek drainage by DEQ. This data was used to determine the support status of Trestle Creek using the 1996 Water Body Assessment Guidance. Results of this assessment concluded that Trestle Creek was fully supporting all of its beneficial uses. Beneficial uses of Trestle Creek include domestic and agricultural water supply, primary and secondary contact recreation, cold water biota and salmonid spawning.

In the *Lake Pend Oreille Key Watershed Bull Trout Problem Assessment*, Corsi states, "Overall, the TAT [Technical Advisory Team] believes that habitat and watershed conditions in Trestle Creek are good." He goes on to say that, "Threats to bull trout in Trestle Creek have been significantly reduced by the USFS watershed restoration project completed in 1995."(Corsi et al., 1998).

3a. Applicable Water Quality Standards

N/A

3b. Summary and Analysis of Existing Water Quality Data

The macroinvertebrate index score for Trestle Creek was 5.31 and the habitat index score was 93. Fish data indicates that salmonid spawning is fully supported.

3c. Data Gaps for Determination of Support Status

N/A

4. Problem Assessment Conclusions

There is no indication that a water quality standards violation exists or will exist in the next two years on Trestle Creek. The watershed restoration work completed by the USFS significantly reduced water quality concerns for this stream. Recommendation of this problem assessment is to remove Trestle Creek from the 303(d) list as water quality threatened.

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Caribou Creek: Land Use Information

Land Use		*Explanation/Comments*
Sub-watershed	Caribou	
Pasture (ac)	**19**	
Forest Land (ac)	**9,154**	
Unstocked Forest (ac)	**1,081**	Includes once burned areas
Highway (ac)		State or County Paved Highways
Double Fires (ac)		Areas which have been burned over twice
Road Data		
Sub-Watershed	Caribou	
1. Forest roads (total miles)	**45**	
CWE road score (av)	35.4	
*Sediment export coefficient (tons/mi/yr)	**16.1**	
#Total Forest Rd Failures (cubic yds delivered)	**981**	*Cumulative Watershed Effects Data*
##2. Unpaved Co.& priv. roads (total miles)	2	
Paved Co.&priv. roads (total miles)	0	
Total C&P Rd Failures (cubic yds delivered)	43.6	*Based on weighted average of forest road failures.*
###Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**2.72**	*95 tons/yr/mi*
good condition	**ND**	*47.5 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1999. Good Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1ton/2000lbs = 47.5 tons/yr/mi
Poor Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1ton/2000lbs = 95 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##County and private road erosion derived from using the same method as forest roads. Since the method used for foest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.
###Source of data:1995 Beneficial Use R. data.
ND=no data

Caribou Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments	
Watershed:	Caribou	*Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr*	
		Yield Coeff. (tons/ac/yr)	
Pasture (tons/yr)	2.6	*0.14*	
Forest Land (tons/yr)	347.9	*0.038*	
Unstocked Forest (tons/yr)	18.4	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0	*0.034*	
Double Fires (tons/yr)	0	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**368.9**	*(Values taken from WATSED and RUSLE models see below explanation [#])*	

*Sediment Yield From Roads		
Watershed:	Caribou	
Forest Roads (tons/yr)	**724.5**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**1403.8**	***Assumes soil density of 1.7 g/cc and a conversion factor of 1.431.*
County and Private Roads (tons/yr)	32.2	
Co. and Private Road Failure (tons/yr)	62.4	

*Percent fines and percent cobble of the Pend Oreille - Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.14) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.034) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Caribou Creek: Sediment Exported To Stream

	Caribou Creek
Land use export (tons/yr)	368.9
Road export (tons/yr)	756.7
Road failure (tons/yr)	1466.2
Bank export (tons/yr)	
poor condition	258.4
good condition	ND
Total export (tons/yr)	**2850.2**
*Natural Background Mass Failure (tons/yr)	315

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure associated with roads.

Caribou Creek

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	9,173			
Presently Forested	9,154			
*Estimated Historically Forested	9,173	0.038		348.6
Estimated Historically Pasture	0	0.14		0
Natural Mass Failure (tons/yr)	315			315
Background Load = Target Load			**Target Load**	**663.4**
			Existing Load	**2850.2**
			Load Reduction	**2186.6**

M. CARIBOU CREEK

(tributary to the upper Pack River)

Summary Caribou Creek was placed on the 1996 303(d) water quality impaired list for sediment pollution based upon information provided in the 1995 305(b) report. The 1996 Waterbody Assessment Guidance methodology concluded that Caribou Creek, utilizing the 1995 Beneficial Use Reconnaissance Data, was not fully supporting beneficial uses, but another survey conducted in 1998 concluded that Caribou Creek was fully supportive of all beneficial uses. Since that time, the 1996 Guidance methodology was discounted and no longer considered a valid measure of support status. It was removed from the water quality standards in April 2000. We currently do not have an approved method of determining support status. Since the standards change, additional data from the Cumulative Watershed Effects Analysis was examined and prompted this revision of the Sub-basin Assessment. This recent analysis concluded that Caribou Creek was impaired due to sediment and temperature. A TMDL was developed for Caribou Creek based upon the 1995 Reconnaissance data and the Cumulative Watershed Effects data. Results of sediment modeling indicate that yearly sediment transport to the stream exceeds natural background by four times. Temperature will not be addressed at this time pending an anticipated change to this standard.

1. Physical and Biological Characteristics

Caribou Creek is located in the upper reaches of the Pack River watershed. It comprises 9,173 acres, of that 9,154 acres are managed for timber production. A small number of rural residences exist in the lower drainage. Elevation ranges from 2,155 feet at the confluence with the Pack River up to 6,448 feet at the headwaters on Keokee Mountain. Precipitation ranges from 30-50 inches primarily as snow and spring rain. High volume runoff occurs during spring snowmelt and major rain-on-snow events. Geology of the area is primarily glacial till derived from granitics, alluvial deposits and weakly weathered granite mountain slopes and ridges. Caribou Creek may have historically supported a population of bull trout or been used by bull trout as thermal refuges (Corsi et al.).

2. Pollutant Source Inventory

<u>Point Source Discharges</u>
No point source discharge permits have been issued for Caribou Creek.

<u>Nonpoint Source Discharges</u>
Current management problems that exist in the Caribou watershed are as follows: 1) downcutting of the stream/overflow channel immediately below Mud Springs Reservoir; 2) the road in the southeast quarter of Section 16 which has a Cumulative Watershed Effects road score of 81 (very poor condition); and 3) the road near the center of Section 6 with a road score of 63.

2.a. Summary of Past and Present Pollution Control Efforts

Unknown.

3. Water Quality Concerns and Status

Caribou Creek was listed for sediment in the 1996 303(d) list. This listing was confirmed by the 1998 Cumulative Watershed Effects analysis and the 1995 Beneficial Use Reconnaissance Survey results. In 1998 another Beneficial Use Survey was conducted and its conclusion was full support. Both Surveys utilized the now discounted, 1996 Waterbody Assessment Guidance method to interpret the data. In April 2000, guidance to use the 1996 methodology was removed from the Idaho Water Quality Standards (IDAPA 58.01.02.053). No methodology has replaced the 1996 guidance to date (September 2000). The most recent Cumulative Watershed Effects data indicates that this stream is receiving excessive amounts of sediment and lacks sufficient canopy cover to maintain adequately low stream temperatures.

3.a. Applicable Water Quality Standards

Beneficial uses of Caribou Creek include domestic and agricultural water supply, primary and secondary contact recreation, cold water biota and salmonid spawning. Caribou Creek was listed as impaired for sediment pollution. Idaho's water quality standard for sediment is narrative, and states that, "Sediment shall not exceed quantities ...which impair designated beneficial uses. Temperature standards for salmonid spawning and bull trout also apply.

3.b. Summary and Analysis of Existing Water Quality Data

Results of the 1995 Beneficial Use Reconnaissance survey of Caribou Creek were a macrobiotic invertebrate score of 3.1, a habitat index score of 102 and two age classes of salmonid fish present. Results of the 1998 survey were a macrobiotic invertebrate score of 4.92, a habitat index score of 109 and two age classes of salmonid fish present. The Idaho Department of Lands conducted a Cumulative Watershed Effects analysis in this watershed in 1998. They found adverse conditions existed for canopy cover/stream temperature and sediment. The total sediment delivery score was in the high end of the moderate range, the result of numerous roads in poor condition and numerous mass failures. The report concluded that site specific best management practices must be developed to help restore stream quality. Channel stability index was also moderate, indicating that riparian zones have little plant cover, stream banks are undercut and the streambed lacks large organic debris. Existing small debris in the channel moves during high flows. Complete results of this analysis are found in Appendix B.

3.c. Data Gaps For Determination of Support Status

The lack of an approved assessment process for the determination of support status makes it difficult to determine the support status of this stream. Available data points towards impairment due to sediment and temperature.

Comments received concerning this TMDL expressed concern that clearcuts in this watershed have caused an accelerated runoff affecting water quantity, temperature, peak flows and bedload movement. Flow and habitat are two parameters that Idaho does not recognize as regulated pollutants under the Clean Water Act, even though these elements could prevent complete restoration of beneficial uses. If Idaho's position changes, these two parameters should be examined with respect to attaining full support.

4. Problem Assessment Conclusions

Poorly constructed roads and loss of canopy cover are causing excessive stream sedimentation and increased stream temperature. Pending the outcome of the proposed change to the temperature standard and lack of in-stream temperature data, temperature impairment will be addressed at a later date. A TMDL for sediment is indicated even though we lack a support status determination.

5. TMDL

See attached spreadsheet.

5.a. Numeric Targets

See attached spreadsheet.

5.b. Source Analysis

See attached spreadsheet.

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7

ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.d. Allocations

Load allocations are based upon land use as shown in the attached spreadsheet. Roads and stream banks are often the source of excess sediment.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition.

References

Corsi, C., DuPont J., Mosier, D., Peters, R., Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment . Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

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N. **GROUSE CREEK**

(tributary to the middle Pack River)

Summary: Grouse Creek was placed on the 1996 303(d) water quality impaired list due to sediment pollution. The 1996 Waterbody Assessment Guidance methodology using the 1994 Beneficial Use Reconnaissance data concluded that Grouse Creek was fully supportive of all beneficial uses. Grouse Creek was delisted based upon this finding in the 1998 303(d) list. The 1996 methodology was later discounted, and in April 2000, removed from the water quality standards. We currently do not have an approved method of determining support status. Since the standards change, new bank stability data has been collected and analyzed. Using the bank stability data and U.S. Forest Service data, it was determined that Grouse Creek mainstem was impaired due to sediment. Yearly sediment transport to the stream exceeds natural background by two and one half times.

1. Physical and Biological Characteristics

[The following information was summarized from the Grouse Creek Environmental Assessment, USFS, 1993.]

The Grouse Creek drainage is a 31,352 acre (127 km^2), third order watershed. The North Fork of Grouse Creek (9,016 acres, 36 km^2), Wylie Creek (1,966 acres, 8 km^2), Upper Grouse Creek (9,366 acres, 38 km^2) and the South Fork of Grouse Creek (4,386 acres, 18 km^2) are the major sub-drainages of Grouse Creek (Figure 1). The mainstem of Grouse Creek is 84% National Forest lands and the remaining area is in private ownership.

Elevations range from 6,600 feet (1992 m) at Mount Willard to approximately 2,300 feet (700 m) at the lower end of the drainage. Annual precipitation averages from 53 inches (135 cm) at the upper elevations to 35 inches (89 cm) near the mouth. The area has a high frequency of rain-on-snow flood events between 2,500 feet (762 m) and 4,500 feet (1372 m) elevation.

Glaciers deposited two types of materials, glacial till and outwash, on top of the underlying bedrock. Outwash is sorted and stratified sand and gravel laid down in valley bottoms by flowing water from the melting ice. Till is deposits made directly by the glacier when it melts. Most of the area is covered with glacial till with deeper layers often compacted by the weight of the ice and impermeable. The till closest to the surface was usually deposited as the glacier retreated and is commonly loose and permeable. Water frequently collects at the point of contact between these two layers.

Most of the soils in the area are formed of two different parent material types. The lower subsoil and substratum are formed from glacial till and have a sandy loam texture, moderate amounts of rock fragments, and poor water and nutrient holding capacity. Surface soils on the other hand are formed from volcanic ash with few rock fragments and high water and nutrient holding capacity.

The land use history of the Grouse Creek drainage is very similar to that of other drainages in the Pend Oreille area. Homesteading began in the late 1800's with early light timber harvesting occurring along the valley bottom from 1900 to about 1920. The very large western red cedars and white pines were easily accessible and the most sought after. Some primitive roads were constructed in valley bottoms. After 1920, timber harvest activity began to intensify. Between 1920 and 1930 the Humbird Lumber Company constructed a logging railroad along Grouse Creek with associated spur lines, loading areas, camps, logging chutes, flumes, and a pole road. By 1934 roughly 70% of the main Grouse Creek drainage had been cleared and/or burned. Logging was concentrated in the stream bottoms and proximal side slopes. The unharvested 30% of the drainage included higher elevations and ridge tops dominated by alpine fir which was smaller in size than the valley timber.

Stream changes occurred as a result of this activity. Large amounts of bedload sediment moved from Plank, Wylie, Flume and other headwater channels into the main Grouse Creek channel. As valley channels filled with bedload, the stream greatly accelerated its natural movement back and forth across the valley floor. The result is a river channel that today is much wider and shallower than expected. As bedload inputs from the headwaters diminish and large riparian trees are re-established Grouse Creek will regain its equilibrium and become a more naturally functioning channel. Today forestry is currently practiced on about 99% of the Grouse Creek watershed above the Wylie Creek confluence.

Grouse Creek contains important fishery resources. Gerrard rainbow trout utilize Grouse Creek heavily in the spring for spawning and rearing. Bull trout also move into the drainage in late spring and spawn in the fall. Grouse Creek provides habitat for both resident westslope cutthroat trout and cutthroat that move in and out of the drainage from the lake. Idaho Fish and Game data shows that bull trout redds in Grouse Creek have gradually declined from 1983 through 1995.

2. Pollutant Source Inventory

Point Source Discharges

There are no permitted point source discharges in Grouse Creek.

Nonpoint Source Discharges

The USFS's 1993 environmental assessment of Grouse Creek concluded that the mainstem of Grouse Creek may take a couple hundred years to regain equilibrium from its current state due to excess bedload (USDA 1993). Causes of excess bedload were activities associated with logging from the 1930's to the present.

2.a. Summary of Past and Present Pollution Control Efforts

In 1994 the USFS placed 62 structures in Grouse Creek, 26 of these were single wing deflectors, 22 point bars and 57 cover logs. Some of the single wall deflector sites had erosion control matting installed and seeded to stabilize loose soils. In 1995, the USFS placed 50 structures in Grouse Creek, 32 of these were single wing deflectors, three "V" notched, one drop log, three point bars and one root wad pool cover. In 1997, work continued with the removal of 20 boulder clusters and an unrecorded number of single wall deflectors, point bars, and lateral habitat cover logs. In 1999, the Hemlock Trail trailhead was relocated and decommissioned approximately 5,000 feet of Grouse Creek Road. This work included the removal of 11 culverts, re-contouring and revegetation. Willows were planted at stream crossings.

3. Water Quality Concerns and Status

The lower channel of Grouse Creek currently carries large amounts of bedload which has caused braided channels, bank erosion and a rapidly shifting channel. In 1996 Grouse Creek was determined to be water quality impaired due to sediment pollution and placed on the 1996 list of impaired waters.

3.a. Applicable Water Quality Standards

Idaho's water quality standard for sediment is narrative and states that; "Sediment shall not exceed quantities...which impair designated beneficial uses. Grouse Creek does not have designated uses and therefore, existing uses will be protected. Existing uses include agricultural and domestic water supply (USDA, 1993), cold water biota, salmonid spawning, and primary and secondary contact recreation (mean monthly peak flow of 246 cfs).

3.b. Summary and Analysis of Existing Water Quality Data

Conclusions of the 1993 U.S. Forest Service's environmental assessment of this watershed were that the lower reach of Grouse Creek was not a naturally functioning stream channel due to excessive amounts of bedload. The DEQ assessed the support status of the stream using data collected in 1994 from the Beneficial Use Reconnaissance Project. The conclusion of this assessment, utilizing the process outlined in the 1996 Waterbody Assessment Guidance, was that Grouse Creek fully supported all its beneficial uses. However, use of the 1996 Guidance process has been determined to be inadequate for the determination of support status. Scores for the various parameters measured were a macroinvertebrate biotic index score of 3.99 and a habitat index score of 79. Three age classes of salmonid fish were present during the survey. Results of the 1998 Cumulative Watershed Effects analysis concluded that the forestry portion (upper mainstem of Grouse Creek) of the watershed was rated overall low for sediment delivery to the stream. They did not evaluate the lower mostly privately owned, non-forested portion of the watershed. In August 2000, the DEQ evaluated bank stability in the mainstem of Grouse Creek. Data from that work has not yet been analyzed, however, the field crew reported extensive bank erosion downstream of National Forest land.

3.c. Data Gaps

As of September 2000, DEQ does not yet have an EPA approved methodology for assessing beneficial use support status. This data gap is not critical in this case since other data exists that was sufficient for this determination.

Comments received concerning this TMDL expressed concern that clearcuts in this watershed have caused an accelerated runoff affecting water quantity, temperature, peak flows and bedload movement. Flow and habitat are two parameters that Idaho does not recognize as regulated pollutants under the Clean Water Act, even though these elements could prevent complete restoration of beneficial uses. If Idaho's position changes, these two parameters should be examined with respect to attaining full support.

4. Problem Assessment Conclusions

Past forest practices have caused large quantities of bedload (sediment) to move down the Grouse Creek mainstem. Bedload continues to be transported to the mainstem from the North Fork sub-watershed (see North Fork Grouse Creek problem assessment). The forested portions of the mainstem above Wylie Creek are affected by this bedload but maintains beneficial uses. However, the lower gradient section of the creek where bedload settles out is in poor condition and requires a sediment TMDL to aid in its recovery.

5. TMDL

Problem Statement: Excess sediment is impairing the beneficial uses of cold water biota and salmonid spawning in the mainstem of Grouse Creek.

5.a. Numeric Targets

See attached spreadsheet.

5.b. Source Analysis

See attached spreadsheet.

5.d. Allocations

See attached spreadsheet.

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7

ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition.

References

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Idaho Department of Fish and Game. 1992. Memorandum To Chip Corsi, From Pat Cole, Subject: Grouse Creek Environmental Assessment Comments.

Idaho Department of Health and Welfare. 1989. Water Quality Status Report and Nonpoint Pollution Assessment. 1988. Division of Environmental Quality, Boise.

U.S.D.A. Forest Service. 1993. Grouse Creek Environmental Assessment. Idaho Panhandle National Forest. Sandpoint Ranger District.

Grouse Creek Mainstem: Land Use Information

Land Use		
Sub-watershed	Grouse mainstem	*Explanation/Comments*
Pasture (ac)	**7,078**	
Forest Land (ac)	**16,848**	
Unstocked Forest (ac)	**1,192**	Includes once burned areas
Highway (ac)	1	State or County Paved Highways
Double Fires (ac)	268	Areas which have been burned over twice

Road Data		
Sub-Watershed	Grouse mainstem	
1. Forest roads (total miles)	**42**	
CWE road score (av)	20.9	
*Sediment export coefficient (tons/mi/yr)	**5.1**	
#Total Forest Rd Failures (cubic yds delivered)	**57**	*Cumulative Watershed Effects Data*
##2. Unpaved Co.& priv. roads (total miles)	50.3	
Paved Co.&priv. roads (total miles)	3	
Total C&P Rd Failures (cubic yds delivered)	68.3	*Based on weighted average of forest road failures.*
###Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**1.7**	*95 tons/yr/mi*
good condition	**0.5**	*47.5 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1999. Good Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1ton/2000lbs = 47.5 tons/yr/mi
Poor Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1ton/2000lbs = 95 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##County and private road erosion derived from using the same method as forest roads. Since the method used for foest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.
###Source of data from DEQ 2000 bank inventory survey.

Grouse Creek Mainstem: Sediment Yield

Explanation/Comments

Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr

Sediment Yield From Land Use

Watershed:	Grouse mainstem	*Yield Coeff. (tons/ac/yr)*	
Pasture (tons/yr)	990.9	*0.14*	
Forest Land (tons/yr)	640.0	*0.038*	
Unstocked Forest (tons/yr)	20.1	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0	*0.034*	
Double Fires (tons/yr)	4.6	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**1655.6**		

(Values taken from WATSED and RUSLE models see below explanation [#])

*Sediment Yield From Roads

Watershed:	Grouse mainstem	Explanation/Comments
Forest Roads (tons/yr)	**214.2**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**81.6**	***Assumes soil density of 1.7 g/cc and a conversion factor of 1.431.*
County and Private Roads (tons/yr)	256.5	
Co. and Private Road Failure (tons/yr)	97.7	

*Percent fines and percent cobble of the Pend Oreille - Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.14) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.034) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Grouse Creek Mainstem: Sediment Exported To Stream

	Grouse Creek mainstem
Land use export (tons/yr)	1655.6
Road export (tons/yr)	470.7
Road failure (tons/yr)	179.3
Bank export (tons/yr)	
poor condition	161.5
good condition	23.8
Total export (tons/yr)	**2490.9**
*Natural Background Mass Failure (tons/yr)	25.8

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure associated with roads.

Grouse Creek Mainstem

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	23,926			
Presently Forested	16,848			
*Estimated Historically Forested	23,926	0.038		909.2
Estimated Historically Pasture	0	0.14		0
Natural Mass Failure (tons/yr)				25.8
Background Load = Target Load			**Target Load**	**935**
			Existing Load	**2490.9**
			Load Reduction	**1555.9**

*Based upon interview with Stanley Jacobsen (USFS, 1992).

O. **NORTH FORK OF GROUSE CREEK**

(tributary to Grouse Creek)

Waterbody Type:	Stream
Ecoregion:	Northern Rockies (HUC #17010214053210)
Designated Uses:	none, existing uses are agricultural and domestic water supply, cold water biota, and primary and secondary contact recreation.
Size of Waterbody:	7.3 miles long
Size of Watershed:	9,856 acres (USFS database); 10,805 acres (IDL database)

Summary: The North Fork of Grouse Creek problem assessment concluded that the stream is impaired due to excess sediment. A target load of 684.4 tons/yr was developed based upon historical land use. To achieve the target load a reduction of 1,687.4 tons/yr of sediment is required for the watershed.

1. Physical and Biological Characteristics

[Refer to the Grouse Creek problem assessment for general physical characteristics of the entire watershed.]

The upper 4 miles (54%) of the North Fork of Grouse Creek is owned by the state and W-I Forest Products. This area remained mostly unroaded until the mid-1970s. Much of the riparian areas of the lower North Fork are in private ownership either by individual homeowners or by W-I Forest Products.

2. Pollutant Source Inventory

Point Source

There are no permitted point source discharges in the North Fork of Grouse Creek.

Nonpoint Source

The primary pollutant, sediment, was the result of various nonpoint source activities conducted over the last thirty years. Unlike other portions of the watershed, the North Fork of Grouse Creek was not logged in the 1920s and in 1934 less than 5% of the drainage had been cleared for homesteading. However, in the last 30 years the USFS, the State and W-I Forest Products have all had timber sales in the drainage. The USFS harvested timber on the Sand Ridge side in the early 1960s. In the 1970s, timber harvesting continued further north to Sand Mountain and into the Dyree Creek drainage. In the mid-1970s, a relatively large timber sale was conducted in parts of the North Fork of Grouse and BRC watersheds. In the early 1990s, overstory trees were removed from previously harvested stands on Sand Ridge. The upper four miles of the North Fork remained unroaded until about the mid 1970s.

As a result of this timber sale activity, haul roads became a source of large amounts of bedload due to mass wasting problems. This bedload caused the stream to alter channel type to a more braided form below Dyree Creek. Further downstream the braided channel returns to a single thread channel, but is aggrading with 88% of the streambed moving downstream. Again, this indicates recent sources of dis-equilibrium that have not yet either stabilized or fully worked their way downstream.

At BRC Creek, the North Fork is also moving bedload through the system, although the channel type is representative of a less impacted form. Data collected by the USFS in 1989 thru 1992 shows the effect on the stream of the excess bedload movement through this reach. By 1992 the channel had become wider, had split late season flows and began undercutting the right bank. The outlook of this situation was that if bedload forces continue undercutting the bank, riparian vegetation will not be able to hold the bank together. The right bank will fail and the stream will become shallower and wider at this spot. Trends of equilibrium for Grouse Creek and North Fork of Grouse Creek are conceptually displayed in Figure 1.

2.a. Summary of Past and Present Pollution Control Efforts

All restoration measures recommended for the North Fork Grouse by the Grouse Creek Environmental Assessment were implemented by the U.S. Forest Service.

3. Water Quality Concerns and Status

Nutrients and sediment were identified as primary pollutants of the tributaries to the Pack River by DEQ in 1989 (Idaho Department of Health and Welfare, 1989). In 1996 the North Fork of Grouse Creek was determined to be water quality impaired due to sediment pollution and placed on the 1996 list of impaired waters. After the listing, DEQ assessed the support status of the stream using data collected in 1996 from the beneficial use reconnaissance project. The conclusion of this assessment, utilizing the process outlined in the 1996 Waterbody Assessment Guidance, was that the lower portion of the North Fork does not support all of its beneficial uses. Scores for the various parameters measured in the lower and upper reaches were macroinvertibrate biotic index scores of 2.02 and 3.89 and habitat index scores of 107 and 113, respectively. Salmonid spawning was not assessed in the North Fork of Grouse Creek.

3.a. Applicable Water Quality Standards

Idaho's water quality standard for sediment is narrative, and states that, "Sediment shall not exceed quantities ...which impair designated beneficial uses. The North Fork of Grouse Creek does not have designated uses and therefore, existing uses will be protected. Existing uses include agricultural and domestic water supply (USDA, 1993), cold water biota, salmonid spawning, and primary and secondary contact recreation (mean monthly peak flow of 111 cfs).

3.b. Summary and Analysis of Existing Water Quality Data

Two models were used to aid in the USFS's analysis of the Grouse Creek watershed (USDA, 1993). The WATSED model (USDA, no date) was used to approximate sediment delivery and water yield for each drainage. The "Rain-On-Snow" model developed by Kappesser (1991) evaluates the risk of increasing peak flows from rain-on-snow events. These models simplify, for analysis, extremely complex physical systems and are developed from a limited data base. Stream flow data used in the models had been recorded by the USFS for the North Fork of

Grouse Creek since 1985.

Results from these analyses quantify the relative differences between natural and existing conditions. Table 1 shows the expected natural mean monthly peak flows and routed sediment amounts versus the existing mean monthly flows and existing routed sediment. Routed sediment amounts are twice that expected under natural conditions.

Past water quality sampling is limited to USFS data and included total suspended sediment and turbidity taken at the North Fork of Grouse Creek gauge site. Data indicates that In 1975, 1979 and 1980 there were high sediment flushes. The highest recorded sediment movement was over 68,000 tons per day and occurred in 1975. Over eight miles of road were constructed in the North Fork drainage at that time. Turbidity was high during that time period also, reaching a high of 28 JTUs in 1975 (1 JTU=1 NTU). Background turbidity levels were very low (<5 JTU).

Watershed improvement needs were identified by the USFS during the summers of 1991 and 1992. For the North Fork of Grouse Creek these include the following:

* Increase woody debris in Dyree Creek in order to control the streambed gradient and reduce bedload inputs to the North Fork.

* Road #215 in Section 4 on the east bank of the North Fork has chronic mass wasting . Obliteration of an existing skid road and restoration of the road prism to natural contours would eliminate the problem of concentrating road surface runoff onto areas susceptible to landslides.

* The lower reaches of the North Fork would benefit from cedar plantings to help re-establish river banks and provide a source of large woody debris.

* Approximately one mile upstream from the confluence with Grouse Creek, an old road exists which should be permanently closed and revegetated to prevent its erosion during flood events.

The Beneficial Use Reconnaissance 1996 data was used to determine support status using the 1996 Waterbody Assessment Guidance process. The macrobiotic invertebrate index score for the lower sample site was 2.02 and the habitat index score was 107 indicating that the cold water biota use is impaired and the stream requires a TMDL. No fish data was collected by the Reconnaissance project.

The Cumulative Watershed Effects results for sediment delivery in the North Fork of Grouse Creek watershed was rated moderate. The temperature rating was high, indicating that site specific best management practices are required to address this problem.

3.c. Data Gaps For Determination of Support Status

Salmonid spawning was not assessed using DEQ's 1996 Waterbody Assessment Guidance.

4. Problem Assessment Conclusions

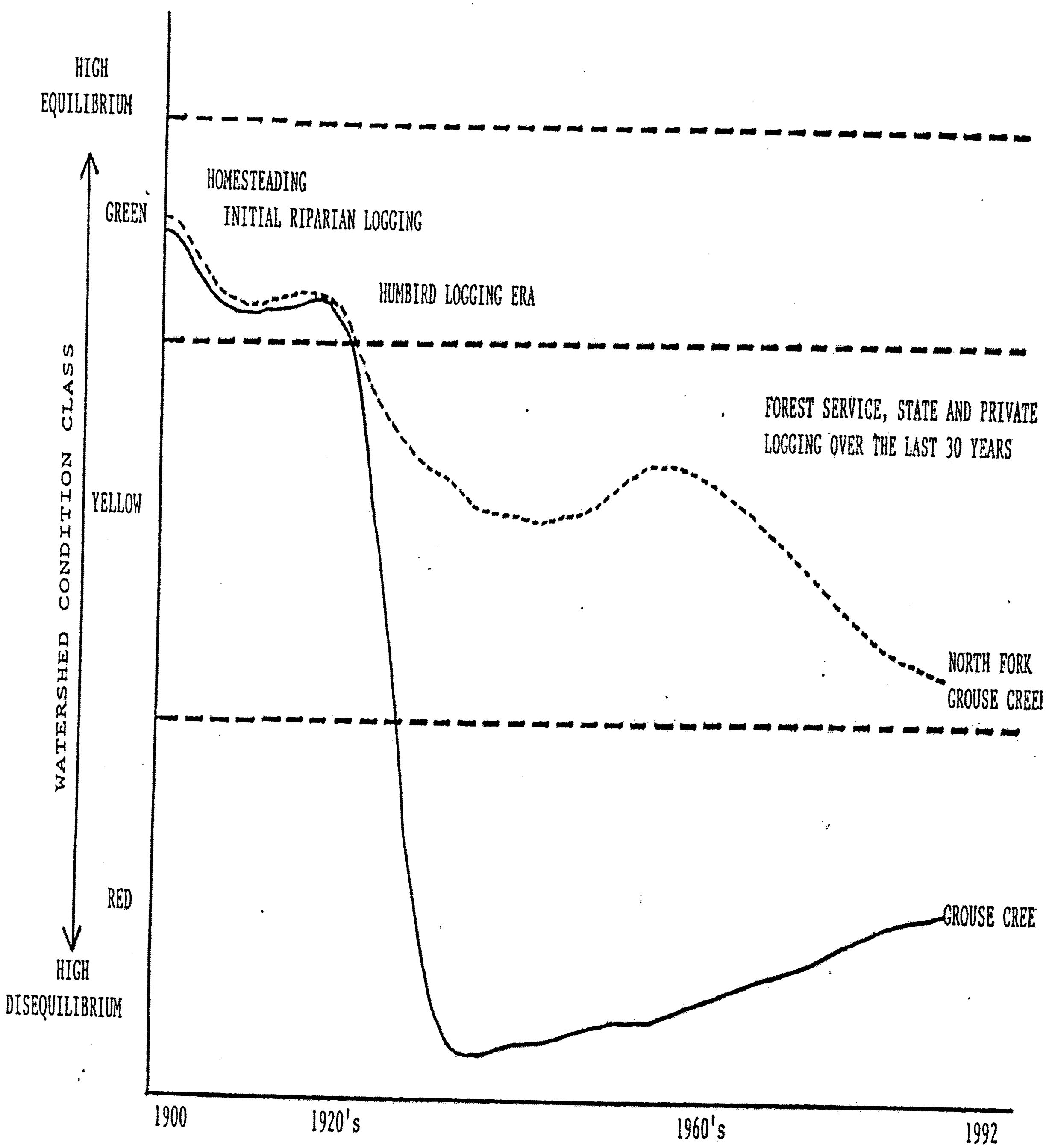
Table 1.

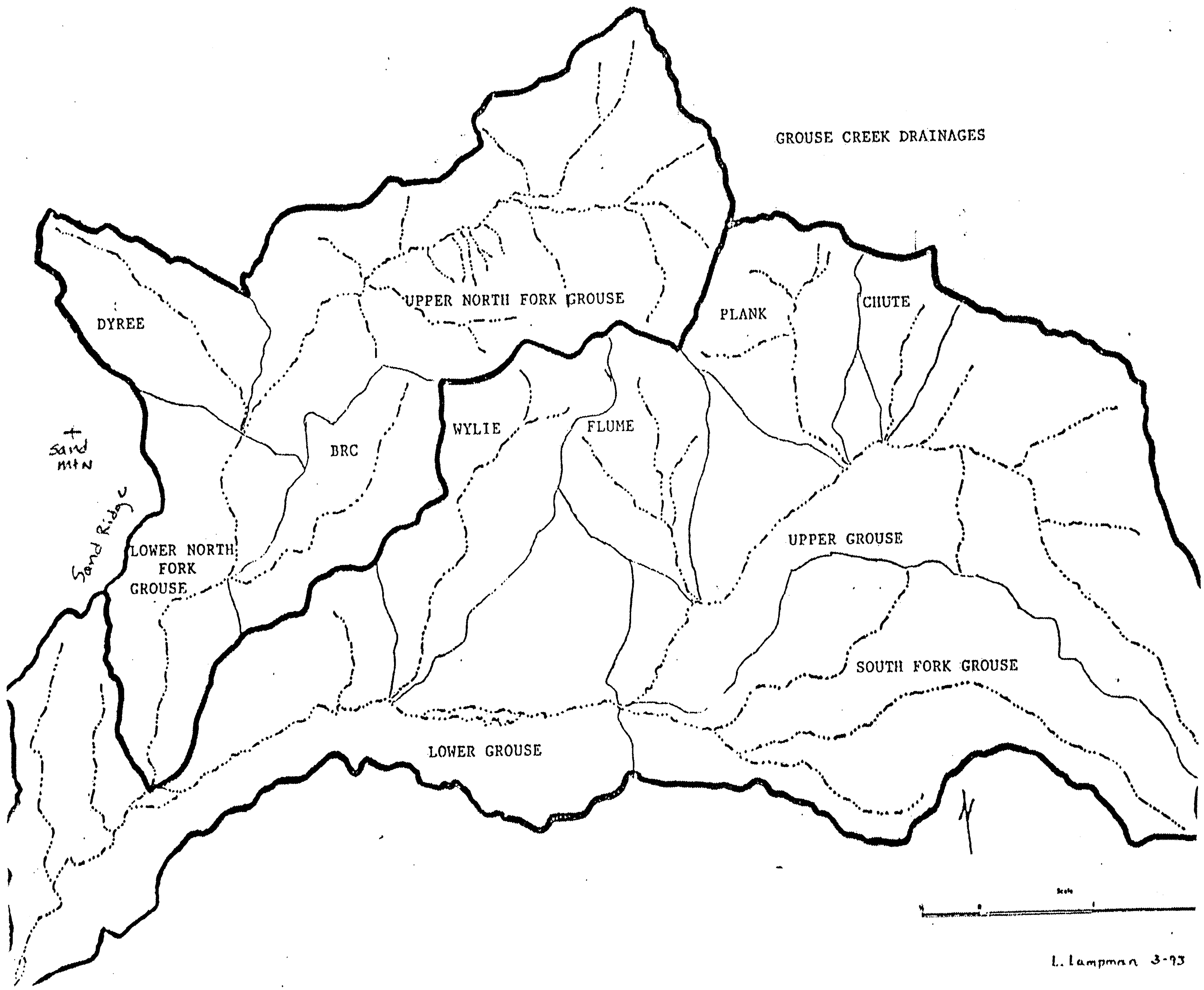
NATURAL AND EXISTING SEDIMENT AND WATER YIELD PER SUBDRAINAGE

NAME OF DRAINAGE	WATSED NATURAL MEAN MONTHLY PEAK FLOW (cfs)	WATSED EXISTING MEAN MONTHLY PEAK FLOW (cfs)	% INCREASE IN EXISTING OVER NATURAL	WATSED NATURAL ROUTED SEDIMENT (tons/sq mi)	WATSED EXISTING ROUTED SEDIMENT (tons/sq mi)	% INCREASE IN EXISTING OVER NATURAL	EXISTING RAIN ON SNOW RISK RATING
SOUTH FORK GROUSE	36.5	36.9	1	25.3	28.3	12	1.01
WYLIE	16.1	16.7	4	35.0	46.9	34	1.06
CHUTE	4.9	5.1	5	48.2	48.2	0	1.17
PLANK	12.5	13.1	5	29.1	29.1	0	1.29
UPPER NORTH FORK	38.1	38.5	1	24.6	36.7	49	1.06
DYREE	6.6	7.1	8	30.1	96.9	222	1.25
BRC	10.9	11.2	3	31.9	65.7	106	1.24
FLUME	10.4	10.7	3	36.1	40.1	11	1.00
ALL NORTH FORK	70.3	73.1	4	21.5	42.6	98	1.22
UPPER GROUSE	80.1	82.5	3	23.1	27.0	17	1.15
ALL GROUSE	246.0	253.4	3	18.1	26.1	44	1.15

Figure 1.

CONCEPTUAL EQUILIBRIUM TRENDS SINCE 1900




GROUSE CREEK DRAINAGES
UPPER NORTH FORK GROUSE
DYREE
PLANK
CHUTE
WYLIE
FLUME
BRC
Sand MtN
Sand Ridge
LOWER NORTH FORK GROUSE
UPPER GROUSE
SOUTH FORK GROUSE
LOWER GROUSE
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Based upon DEQ's assessment, cold water biota is a use not fully supported in the North Fork of Grouse Creek. Excess bedload, channel dis-equilibrium and a lack of large woody debris are the major limiting factors to achieving full support. A reduction of sediment entering the stream, a re-establishment of large woody vegetation along the channel and time for the existing bedload in the stream to move through the system are elements required to achieve full support status for the North Fork of Grouse Creek. Primary pollutant sources are roads.

5. TMDL

Two methods were used to calculate the sediment load reduction required for the North Fork. The first TMDL is based upon information obtained from the USFS Grouse Creek Environmental Assessment (USDA, 1993). The resulting target loads and load reductions are presented in tons per square miles, however, they can also be presented as tons/mi²/yr. It was emphasized that these values are relative, not actual load amounts. Error for this analysis is approximately 100% (personal communication Hefner 1999). The second analysis is based primarily upon Cumulative Watershed Effects analysis data and other information. To be consistent with the rest of the basin TMDLs, method 2 will be used to calculate target loads and load reductions. Method 1 is shown for comparison purposes only.

Method 1

5.a. Numeric Targets

Based on the USFS analysis (USDA, 1993) natural background sediment loads in the North Fork of Grouse Creek are:

Tributary	Area (mi²)	X	Bckgrnd Erosion Rate (t/mi²/yr)	=	Bckgrnd Load (t/yr)
Lower North Fork	3.0	X	21.5	=	64.5
North Fork Above Dyree Creek	8.4	X	24.6	=	206.6
Dyree Creek	1.9	X	30.1	=	57.21
BRC Creek	2.1	X	31.9	=	67.0
TOTAL					**395.3**

5.b. Source Analysis

Based on the USFS analysis (USDA, 1993) existing sediment loads for the North Fork of Grouse Creek are:

Tributary	Area (mi²)	X	Existing Erosion Rate (t/mi²/yr)	= Existing Load (t/yr)
Lower North Fork	3.0	X	42.6	127.8
North Fork Above Dyree Creek	8.4	X	36.7	308.3
Dyree Creek	1.9	X	96.9	184.1
BRC Creek	2.1	X	65.7	138.0
Total				**758.2**

5.c. Linkage Analysis

The cause of stream channel disequilibrium and the presence of excess bedload in the channel can be assessed by measuring certain parameters of the stream. The largest particle size commonly moved by the stream and the particle size distribution of the streambed on a riffle (Wolman Pebble count) were used to develop the Riffle Armor Stability Index (RASI) (Kappesser, 1992) values for the North Fork. The values obtained by this analysis are represented by the "D" number, which is simply the percentile of the streambed particle sizes commonly moved by the stream (see Table 2).

Table 2. Riffle Armor Stability Index Values For the North Fork of Grouse Creek.

Stream	Largest Particle Size Transported	RASI Value
North Fork		
above FS road #215	179mm	D66 (equilibrium)
above Dyree Creek	179mm	D82 (?)
below Dyree Creek	N/A	N/A (braided channel-total disequilibrium)
above BRC Creek	108mm	D88 (aggrading)
below BRC Creek	123mm	D82 (aggrading)
gauge station	110mm	D71 (aggrading)
Dyree Creek	111mm	D81 (aggrading)
BRC Creek	138mm	D44 (equilibrium)

These data indicate that sections of streambed are moving abnormally large amounts of cobble size and smaller sediment downstream, disrupting beneficial uses of cold water biota and salmonid spawning. Actively eroding slopes and banks in this watershed should be repaired to stop the supply of bedload to the streams.

To determine how much sediment is still entering the system, two additional models were used.

WATSED (USDA no date) estimates current sediment delivery and water yield, and the "Rain on Snow" model (Kappensser 1991) evaluates the risk of increasing peak flows from rain-on-snow events. Neither model provides an absolute measure against verifiable standards. However, they do provide a numerical means of comparing one stream with another or one stream over time. Repetition of all three models can demonstrate change in the pollutant load entering the stream and the location of excess bedload still present in the system. Studies have shown that WATSED typically under-estimates mean monthly peaks by 34%, as evidenced by comparing actual flow at the North Fork gauge station with predicted flows. Flows shown in Table 1 are model generated and have not been adjusted to more accurately reflect actual flows. Increasing the flow by 34% did not affect the model values for sediment delivery.

5.d. Allocations

The WATSED analysis indicates that a reduction of 362.9 tons/yr is required for the North Fork of Grouse Creek, of which 101.7 tons/yr of reduction should come from the North Fork above Dyree Creek. Dyree Creek requires a reduction of 126.9 tons/yr, the Lower North Fork 63.9 tons/yr, and BRC Creek a reduction of 71.0 tons/yr.

5.c. and 5.e. Monitoring Plan for Method 1 and Monitoring Plan and Linkage Analysis for Method 2

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only

one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

Method 2

See attached spreadsheet.

5.f. Margin of Safety

Method 1

The load reduction estimated by WATSED (362.9 tons/yr) is 4.6 times smaller than the load reduction predicted by Method 2 (1,687.4 tons/yr). The percent error of the WATSED model is approximately +-100% of actual loads. The WATSED model does not provide an absolute measure against verifiable standards, however, it does provide a numerical means of comparing one stream with another or over time. Because of the error associated with the WATSED estimate, assigning a margin of safety would just increase the error of the method. Use of natural background as a target is the most conservative approach available and requires no margin of safety.

Method 2

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition. Natural background is used as the target load which is the most conservative assumption available.

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North Fork Grouse Creek: Land Use Information

Land Use		**Explanation/Comments**
Sub-watershed	N. Fork Grouse	
Pasture (ac)	**8**	
Forest Land (ac)	**9529**	
Unstocked Forest (ac)	**1268**	Includes once burned areas
Highway (ac)	0	State or County Paved Highways
Double Fires (ac)	0	Areas which have been burned over twice
Road Data		
Sub-Watershed	N.Fork Grouse	
1. Forest roads (total miles)	**55**	
CWE road score (av)	29.6	
*Sediment export coefficient (tons/mi/yr)	**10.2**	
#Total Forest Rd Failures (cubic yds delivered)	**628**	*Cumulative Watershed Effects Data*
##2. Unpaved Co.& priv. roads (total miles)	5.2	
Paved Co.&priv. roads (total miles)	0	
Total C&P Rd Failures (cubic yds delivered)	59.4	*Based on weighted average of forest road failures.*
###Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**1.9**	*95 tons/yr/mi*
good condition	**7.3**	*47.5 tons/yr/mi*

*McGreer et al. 1997

**Stevenson 1999. Good Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1ton/2000lbs = 47.5 tons/yr/mi

Poor Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1ton/2000lbs = 95 tons/yr/mi

#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.

##County and private road erosion derived from using the same method as forest roads. Since the method used for foest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.

###Source of data from 1996 aerial photos.

North Fork Grouse Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments
Watershed:	N.F.Grouse	*Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr* *Yield Coeff. (tons/ac/yr)*
Pasture (tons/yr)	1.1	*0.14*
Forest Land (tons/yr)	362.1	*0.038*
Unstocked Forest (tons/yr)	21.6	*0.017 (this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0	*0.034*
Double Fires (tons/yr)	0	*0.017 (this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**384.8**	*(Values taken from WATSED and RUSLE models see below explanation [#])*

*Sediment Yield From Roads		
Watershed:	NF Grouse	
Forest Roads (tons/yr)	**561.0**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**898.7**	***Assumes soil density of 1.7 g/cc and a conversion factor of 1.431.*
County and Private Roads (tons/yr)	53	
Co. and Private Road Failure (tons/yr)	85	

*Percent fines and percent cobble of the Pend Oreille - Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.14) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.034) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

North Fork Grouse Creek Watershed: Sediment Exported To Stream

	NF Grouse Watershed
Land use export (tons/yr)	384.8
Road export (tons/yr)	561.0
Road failure (tons/yr)	898.7
Bank export (tons/yr)	
poor condition	180.5
good condition	346.8
Total export (tons/yr)	**2371.8**
*Natural Background Mass Failure (tons/yr)	322

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure associated with roads.

North Fork Grouse Creek Watershed

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	9537			
Presently Forested	9529			
Estimated Historically Forested	9537	0.038		362.4
Estimated Historically Pasture	0	0.14		0
*Natural Mass Failure (tons/yr)				322
Background Load = Target Load			**Target Load**	**684.4**
			Existing Load	**2371.8**
			Load Reduction	**1687.4**

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LOWER PACK RIVER
(tributary to north Pend Oreille Lake)

Waterbody Type:	river
Ecoregion:	Northern Rockies
Designated Uses:	Domestic and agricultural water supply, cold water biota, salmonid spawning, and primary and secondary contact recreation.
Size of Waterbody:	approx. 40 miles long
Size of Watershed:	101,207 acres

Summary: The Pack River was listed for nutrient, sediment, dissolved oxygen, habitat alterations, pathogens, and pesticide pollution. The conclusions of this problem assessment is that the Pack River is water quality limited due to excess sediment and nutrients. Monitoring data indicate that dissolved oxygen, pesticides and pathogens concentrations do not violate Idaho Water Quality Standards. EPA requests that additional pathogen data be collected in 2001 before a listing decision is made. Target load for sediment is **15,635** tons/yr (a reduction of 45,465.6 tons/yr). Target loads for nutrients are: **5,307** kg/yr total phosphorus (a reduction of 15,293 kg/yr) and **45,815** kg/yr total nitrogen (a reduction of 51,985 kg/yr).

1. Physical and Biological Characteristics

The Pack River is the second largest tributary to Lake Pend Oreille, and is in turn fed by a number of significant tributary watersheds. The watershed encompasses 101,207 acres of Bonner and Boundary counties in north central Idaho, and drains in to the northern tip of Lake Pend Oreille between the communities of Hope and Sandpoint, Idaho.

Climate. The climate of the Pack River watershed is middle latitude continental (Corsi 1998). Climatic conditions are influenced by both continental and marine weather patterns. Frequent winter storms pass over the area from November through March. Summer storms, however, generally pass farther north resulting in a relatively dry climate.

Hydrology. The Pack River and its tributaries often experience one or more run-off events. Mid-winter rain-on-snow events can result in rapid snowmelt, and in some years the peak flow from tributary watersheds occurs during these events. Due to high precipitation results, location in relation to the lake and prevailing winds, tributaries draining the Cabinet Mountains are particularly susceptible to rain-on-snow events (Corsi 1998).

Geology. The geologic parent materials located in the Pend Oreille Lake watershed are the result of millions of years of sedimentation, metamorphosis, uplift, and intrusion. Streams on the northeast side of the watershed (in the Cabinet mountains) are primarily within the Belt Series bedrock type, and streams draining the Selkirk Mountains are largely within the Kaniksu batholith (granitic bedrock type) (Savage 1965).

The Belt Series are metamorphic sedimentary deposits comprised partially by the Cabinet Mountains. Sediments of clay, silt, and sand settled out of the brackish waters of shallow Precambrian seas, metamorphosed, and began to fold and fault. The metamorphosed rocks include argillite, siltite, quartzite, and dolomite.

An igneous intrusive, known as the Kaniksu Batholith, comprises the Selkirk Mountains which make-up the northwest section of the drainage. This intrusion is composed of granodiorites and quartz monzonite.

Soils. Soils found in the watershed are mostly derived from the erosion of Precambrian metasediments and granitic batholith, volcanic deposition, glacial outwash, glacio-lacustrine sediments, and alluvium. Most land types have 10 inches or more of surface soils composed of Mt. Mazama volcanic ash, which has very high water infiltration rates. (Hoelscher 1993).

The area adjacent to the Pack River Mainstem is dominated by two soil types: Pend Oreille Rock outcrop-Treble unit and Mission-Cabinet-Odenson unit. Both are poorly suited to roads, dwellings, and recreational development. The Pend Oreille-Rock outcrop-Treble unit is poorly suited because of steep slopes (5-65%), erosion hazards, and areas of rock outcrop. The Mission-Cabinet-Odenson unit is equally poorly suited because of a seasonal perched water table, very slow permeability, and a hazard of frost heaving (Hoelscher 1993).

Watersheds in the Cabinet Mountains tend to be more prone to rapid run-off events due to the effects of scour by glacial advances. These glacial events resulted in highly dissected watersheds (i.e. high density of streams), shallow soils, and subsoil compaction of glacial tills.

The Pack River basin has more glacial fluvial deposits than any other basin in the Pend Oreille watershed, and the underlying geology is largely granitic in origin. As a result sand sized sediment is the primary material that is eroded and transported in streams. Fish habitat features are less likely to change from channel adjustments, but the river is prone to high levels of fine sediment which occur where hill side or stream bank erosion rates, and in-channel deposition, is high.

Loss of riparian vegetation and associated root masses due to fire, salvage, timber harvesting, livestock grazing or clearing reduces bank stability and results in delivery of fine sediment to the stream channel.

Land Ownership. The Pack River basin supports diverse land uses and contains lands under private, state, and federal ownership. Land ownership for the entire watershed (101,207 acres) can be broken down to the following percentages: US Forest Service - 55.0%; Private lands - 36.0%; State lands - 6.6%; and Bureau of Land Management - 2.4%. Primary ownership of the headwaters is federal (Forest Service), while the lower reaches are under private ownership.

Land Use. Land uses of the Lower Pack River, as identified by the IDHW-DEQ (1993) are reported out of a total of 106,993 acres (43,299 hectares) as follows: Forest - 87524 acres (35,420 hectares) (81.8% of total); Agriculture - 5266 acres (2,131 hect.) (4.9%); Livestock - 6365 acres (2,576 hect.) (6.0%); Timber/Grazing - 1,223 (2.8); Mining - 15 acres (6 hect.); Transportation - 694 acres (281 hect.) (0.6%); Residential - 3311 acres (1,340 hect.) (3.1%); Commercial - 12 acres (5 hect.); Industrial - 74 acres (30 hect.) (0.1%); Public parks and recreation - 361 acres (146 hect.) (0.3%); Surface water - 356 acres (144 hect.) (0.3%). These uses, coupled with the Sundance fire in 1967, have influenced fish habitat conditions and water quality in the Pack River.

2. Pollutant Source Inventory

Point Source Discharges

There are no permitted point source discharges to the Pack River or its tributaries.

Nonpoint Source Discharges

There were five primary nonpoint sources of pollution identified by the Panhandle Bull Trout Technical Advisory Team as limiting water quality in the Pack River Mainstem watershed (Corsi et al. 1998). These sources are identified and described as follows:

Urbanization - Significant floodplain development, increased urban run-off, stream riparian zone clearing, and stream channel alterations are all factors associated with urban development which currently limit water quality and beneficial uses in the watershed.

Roads - Pack River has an extensive road system on private, state and federal lands. Because of the sandy soils, fine sediment is readily transported from roads to stream channels. Three railroads (Burlington Northern Santa Fe, Union Pacific, and Montana Rail Link) and two highways (US 95 and Idaho 200) cross lower Pack river, creating a risk from toxic spills.

Wildfire - The Sundance Fire, which occurred in 1967, was the last major forest fire in the Pack River watershed. It burned nearly 55,000 acres of mature and second growth timber in the Selkirk Mountains, Pack river and Roman Nose Creek drainages (USDA 1992). The fire burned a large portion of the riparian areas in the upper Pack River drainage. Legacy effects of the Sundance Fire are still visible in the Pack River system.

Agriculture/Livestock Grazing - Use of land for agriculture practices has been ongoing for many years in the Pack River drainage. Grazing occurs in the lower 2/3 of the watershed, and much of the Pack River is considered open range. Crop production occurs in the watershed from below the Highway 95 bridge to the inlet at Lake Pend Oreille. Large cedar trees and riparian vegetation was removed years ago. Impacts to the stream channel in lower reaches have occurred over a long period of time and continue to be a factor in the decreasing habitat condition today.

Timber Harvest - Most timber harvest since 1967 has taken place on private and federal lands in the lower 2/3 of the watershed that were not burned by the Sundance Fire. Salvage logging occurred in burned areas, possibly reducing large woody debris recruitment to stream channels. Harvest is currently taking place in areas missed by the fire where merchantable timber was left (Sundance Missed Timber Sale). Timber harvest on private lands is also occurring.

2.a. Summary of Past and Present Pollution Control Efforts

As a result of citizen concerns about increased aquatic weed and algae growth in the Clark Fork River, Pend Oreille Lake and Pend Oreille River, the U.S. Congress added language to the 1987 Clean Water Act Amendments (P.L.100-4, Feb.4, 1987) that directed EPA to study the sources of nutrient pollution in the basin. A comprehensive three year study led to the development of the Clark Fork-Pend Oreille Basin Water Quality Study, A Summary of Findings and a Management Plan (EPA 1993), designed to protect and restore water quality in the watersheds from nutrient pollution. The Tri-State Implementation Council was established in October 1993, to oversee implementation of the Plan. The Council's primary goals and accomplishments are directed towards protection of Pend Oreille Lake and Clark Fork River. Examples of accomplishments which work to protect water quality in the Pack River include:

1. A basin wide phosphate detergent ban.
2. Offered educators tours of the watershed.
3. Established and currently maintaining a water quality monitoring network throughout the basin.
4. Assisted Bonner County in developing an effective stormwater and erosion control ordinance.

Washington Water Power, as part of their relicensing process for the Noxon and Cabinet Gorge hydro-power projects, agreed to certain protection, mitigation, and enhancement measures. Many of these projects will benefit the water quality of the Pack River. Stream improvement projects, fish passage projects, habitat restoration, bank stabilization and similar types of activities should benefit both fish habitat and water quality. Funding over the next 45 years should result in a substantial number of improvement projects being achieved.

In 1993, Bonner County adopted a stormwater ordinance which, if enforced, would provide for adequate protection of the lake and its tributaries from sedimentation as a result of various land disturbing activities.

The Idaho Forest Practices Act has recently added the Cumulative Watershed Effects Process for Idaho (Idaho Cumulative Effects Task Force 1995) added to it as a tool to evaluate problem watersheds. This process enables the forest practices advisor to recommend additional protection measures to address cumulative effects of timber harvest. In areas which have been heavily roaded or are prone to unstable geology, site specific Best Management Practices, developed from this process should significantly reduce sedimentation of streams.

In addition, Pend Oreille Lake has been designated a Special Resource Water (IDAPA 16.01.02.056). As a tributary to a Special Resource Water, the Pack River cannot have a point source discharge which will result in a reduction of ambient water quality of the lake.

In June 1995, the US Fish and Wildlife Service status review found listing bull trout (*Salvelinus confluentus*) as threatened or endangered was warranted under the Endangered Species Act. On July 1, 1996, Governor Phil Batt and the State of Idaho issued a Bull Trout Conservation Plan outlining proactive measures to be taken by the state to restore bull trout populations in Idaho. The Plan utilizes the Basin Advisory Group and Watershed Advisory Group framework, initially developed for dealing with 303(d) water quality listed streams under Idaho Code (39-3601). The plan would provide for local development of watershed specific plans to maintain and/or increase bull trout populations and meet the needs of the surrounding communities in Idaho. While the state will not mandate how local communities protect the species, it will insist on meeting the goal of protecting and maintaining the species (Corsi 1998).

The *Lake Pend Oreille Key Watershed Bull Trout Problem Assessment,* completed in 1998, addresses the Pack River as a tributary to Lake Pend Oreille relative to bull trout populations. The mainstem Pack River was designated a key migratory corridor for bull trout between Lake Pend Oreille and important spawning and rearing areas in the upper reaches of the river and its significant tributaries (Corsi 1998).

3. Water Quality Concerns and Status

In 1996 the mainstem Pack River (Hwy. 95 to Pend Oreille Lake) was added to the 303(d) list as water quality impaired, due to excess nutrients, sediments, low dissolved oxygen gas, excessive habitat alterations, pathogens, and pesticides.

The Pack River has designated uses of domestic and agricultural water supply, cold water biota, salmonid spawning, and primary and secondary contact recreation. Of these beneficial uses, only industrial water supply, wildlife habitat, and aesthetics were identified as having full support status according to 1996 Waterbody Assessment Guidance analysis. This segment was also listed in the 1994 305(b) report as a Stream Segment of Concern for the same pollutants mentioned in the 1996 303(d) list.

Fine sediment, lack of large woody debris to create pools and cover, and elevated temperatures resulting from loss of shade (habitat alterations) are believed to be significant limiting factors of bull trout production in the Pack River. Three railroads and two highways cross lower Pack River in the migration corridor, creating a risk to migrating bull trout from toxic spills.

The Pack River has been found to contribute the highest ratio of nutrients per unit of land of any watershed in the Pend Oreille Basin. This is likely a result of the high ratio of sediment that is produced within the watershed due to the geology of the watershed and the heavy land use in the lower reaches of the Pack River (Hoelscher, et al. 1993).

There is also some evidence that the Pack River is nitrogen limited at certain times of the year. The ratio of nitrogen to phosphorus found in the Pack River in 1989 was approximately 5:1. A total nitrogen to total phosphorus ratio in lakes greater than 15:1 indicates phosphorus limitation. A lower ratio is typically found in eutrophic lakes with frequent algae blooms. Specific information on nutrient ratios for rivers was not found.

The cause for the listing of pesticides as a pollutant may have been due to the construction of a golf course at the mouth of the Pack River. Other reasons for the listing may have been pesticides used for the road side spraying of noxious weeds, fungicide use in a tree nursery, or lawn care products.

3.a. Applicable Water Quality Standards

Designated beneficial uses of the Pack River include: agricultural water supply, domestic water supply, primary and secondary contact recreation, cold water biota, and salmonid spawning.

Uses reported to be currently impaired or not fully supported are: agricultural and domestic water supply due to pathogens and pesticides; primary and secondary contact recreation due to excess nutrients; cold water biota due to excessive sediment, low dissolved oxygen and pesticides; and salmonid spawning due to sediment and low levels of dissolved oxygen.

The Pack River has been found to be the second greatest source of nutrients to Pend Oreille Lake. The state water quality standards under IDAPA 16.01.02.200.06 states, "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses. Identifying and controlling nutrient sources in the Pack River watershed has been proposed as a management alternative for reducing nearshore eutrophication in Pend Oreille Lake (Hoelscher, et al. 1993).

Pesticides are limited in surface waters by either the National Toxics Rule, adopted (with changes) to the Idaho Standards in 1997 or the general surface water quality criteria (IDAPA 16.01.02.200.02) which requires that surface waters shall be free from toxic substances which impair beneficial uses.

Pathogens are limited to fecal coliform bacteria organisms of no more than 500/100 ml at any time; and 200/100 ml in more than 10% of samples taken over a 30 day period; and a geometric mean of 50/100 ml based on a minimum of five samples taken over a 30 day period.

The Idaho Water Quality Standards narrative criteria (IDAPA16.01.02.200) states that sediment shall not exceed, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Such impairment is determined through water quality monitoring.

Dissolved oxygen in the Pack River must exceed 5 mg/l at all times.

3.b. Summary and Analysis of Existing Water Quality Data.

The Pack River was evaluated at several sites for beneficial use status as part of *The 1992 Idaho Water Quality Status Report.* In this report, most upstream sites were evaluated only for cold water biota and salmonid spawning beneficial uses, which were rated as partially supported or supported but threatened. The reach between Gold Creek and Rapid Lightning Creek (the furthest downstream reach evaluated) included a fish tissue analysis, which indicated that high amounts of pesticides were cycling through the system (IDHW-DEQ 1992). Pesticide sampling was conducted in June 2000. Results were no detectable concentrations of pesticides.

Beneficial Use Reconnaissance Project data collected in 1994 found the mainstem Pack River stream substrate to be made up of 100% fines (< 6 mm) in a reach studied near the Pack River

School. The Habitat Index developed for this reach scored a 56, which results in an Impaired rating. The Macrobiotic Index for this reach showed a score of 4.04 which resulted in a Not Impaired status for this community. This data has since been determined to be not applicable to the mainstem Pack River, since it was conducted under the Wadable Stream criteria. This segment of the Pack was determined to better fit the Large River protocol instead. In 1997 a Large River Survey was conducted 100 meters below the Colburn Rd. bridge. No support status conclusions are available from this data.

In 1997 and again in 2000 dissolved oxygen (Table 1.) and bacteria samples were taken along the lower Pack River. The presence of E. coli was tested for in five samples taken in August, 2000. All samples were below the 406 e. coli organisms/100 ml as required by the Idaho Water Quality Standards for single sampling events. Results were 3, 7, 40, 13 and 120 organisms. The July and August 1997 sampling of fecal coliform, 80/100 and 44/100 ml, were also below the previous standard for fecal coliform of 800/100 ml. Additional sampling will be conducted in 2001 to achieve the five samples per site over a thirty day time period to meet water quality standards requirements.

Table 1. Dissolved oxygen (mg/L).

Site #	Surface	One Meter	Two Meter	Three Meter	Four Meter	Bottom
1.	7.89	-	8.28	-	8.14	7.96
2.	7.96	8.00	7.95	-	-	-
3.	8.39	8.39	8.40	8.41	-	-
4.	8.27	8.20	-	-	-	-
5.	7.92	7.93	-	-	-	-

These values indicate that low dissolved oxygen is not currently impairing beneficial uses the mainstem Pack River.

In 1998, the Pack River was evaluated as part of the Cumulative Watershed Effects program developed by the Idaho Department of Lands. This program has been instated as part of the Idaho Forest Practices Act. In contrast to indirect indicator and model-based approaches, this program relies on direct observations made in the stream and on the surrounding landscape. The process consists of an assessment of fine sediment in stream bottoms, channel stability, sediment delivery, water temperature/stream shade, nutrients, and hydrology, as affected by forest practices. This evaluation produced results on forested lands near the headwaters of the Pack River as summarized below by Dechert et. al. (1999):

Category	Scores	Ratings
Channel Stability Index	52	Moderate
Canopy Removal Index	0.16	N/A
# Segments w/Low Temp	19/24	*
# Segments w/High Temp	5/24	*
Canopy Closure/Temperature Rating	*	High
Roads	29.9	Low
Skid Trail	2	Low
Mass Failure	47.2	High
Total Sediment Delivery	79.1	Moderate
Nutrient Current Condition	32	Moderate
Nutrient Hazard Rating	*	Moderate
Overall Nutrient Rating	*	Moderate
Hydrologic Risk Rating	*	Low
CWE Surface Erosion Hazard	*	Low
CWE Mass Failure Hazard Rating	*	Low

This data indicates the following results:

a) Sediment delivery from forest practices to waterways is low for the upper watershed as a whole.

b) The nutrient condition of Pack River Headwaters is moderate, so no adverse condition exists. Most indicators of nutrient impacts occur in the Pack River mainstem where land uses other than forestry predominate.

c) For the forested portions of the watershed, the hydrologic rating is low, so no hydrologic adverse condition exists.

d) It is concluded that current forest management practices as specified by the Idaho Forest Practices Act are adequate to protect water quality and beneficial uses for the forested portions of the Pack River Headwaters watershed.

In general, the Watershed Effects analysis of Pack River Headwaters concludes that forest practices have not contributed significantly to water quality problems occurring in the headwaters of the Pack River. The mainstem, of course, has many tributaries which contribute flow and pollutants, of which there may be significant contributors of sediment.

These conclusions indicate that sources of pollution impairing beneficial uses in the mainstem Pack River are occurring in places other than the Pack headwaters, such as tributary streams and land uses along the lower reaches of the Pack River. Many tributary streams have been evaluated by the Cumulative Watershed Effects program and can be reviewed individually in Appendix B.

Nutrient budgets for the Pend Oreille Lake and Pend Oreille River upstream of Albeni Falls Dam were developed for the 1989 and 1990 water years. Frenzel (Frenzel 1991b) identified and quantified nutrient inputs from point and nonpoint sources. These data were required as an input to the nutrient load/lake response model used to assess open-lake water quality.

Nutrient budgets were calculated from the hydrologic budgets and sampled nutrient concentrations. Nutrient samples from gauged streams were collected using standard U.S. Geological Survey cross-sectional and depth-integrating methods. During snowmelt runoff in May and June, samples were collected biweekly and during the rest of the year monthly in the Pack River. Total phosphorus and total nitrogen loads were estimated for all nutrient sources (Frenzel 1991b).

According to Frenzel, in 1989 the Pack River produced a total phosphorus load estimated at 20,600 kg of phosphorus (4.4 kg margin of error). This results in a percentage contribution of almost three times more phosphorus inflow to Lake Pend Oreille (6.3% of total Lake inflow) than of total hydrologic flow (2.2% of total Lake inflow). Similar results were reported in 1990 (1991 a,b).

Total nitrogen in the Pack River was estimated to be 97,800 kilograms in 1989, with a large margin of error (52,100) due to inadequacies inherent in nitrogen sampling techniques. This was determined to be approximately 2.2% of the total Pend Oreille Lake nitrogen load. Again, similar results were reported for 1990 (Frenzel 1991b).

Frenzel also developed watershed nutrient export coefficients as another way of expressing nutrient loads. This coefficient was calculated by dividing load by drainage area. Watershed export coefficients developed for the Lake Pend Oreille watersheds showed that the largest export coefficient for total phosphorus and total nitrogen in the basin were from the Pack River. From a drainage area of 56,640 hectares, a coefficient was developed that resulted in 0.364 kg/ha for total phosphorus and 1.73 kg/ha for total nitrogen in the Pack River watershed (1991a).

In 1999, the Tri-State Water Quality Council developed a voluntary nutrient target for the Clark Fork River and the Pend Oreille Lake. The targets they agreed upon were the product of all available data and a rigorous scientific evaluation by qualified scientists who had, or are currently studying this sub-basin. Their draft nutrient targets are:

*326,000 kg/yr total phosphorus allocated to the lake
*65,000 kg/yr total phosphorus allocated to Pend Oreille Lake tributaries (excluding the Clark Fork River)
*260,000 kg/yr total phosphorus allocated to the Clark Fork River

*7.8 ug/l phosphorus concentration for the open waters of Pend Oreille Lake
*15:1 trigger value of total nitrogen to total phosphorus

A nitrogen to phosphorus ratio trigger value of 15:1 or lower was established for the Clark Fork River and Pend Oreille Lake to serve as an indicator of potential changes to water quality (Watkins, 1999). Since the Clark Fork River exerts such a strong influence on Pend Oreille Lake water quality, an increase in nitrogen could have unfavorable effects in some near-shore areas. Even though the Council's nutrient target for the lake addresses only the open water area of the lake, they felt it would be remiss to allow a nutrient present in the open water to impact bays, particularly along the northern portion of the lake. The nitrogen trigger value developed by the Council is particularly useful in the evaluation of phosphorus enriched waters, where there may be ample amounts of phosphorus for plant growth but insufficient nitrogen. Using the Council's trigger value of 15:1 (N to P) as a baseline, data indicates that the 5:1 nitrogen to phosphorus ratio in the Pack River is low enough to result in significant nutrient enrichment problems due to nitrogen.

To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, EPA Gold Book states that "...total phosphates as phosphorus should not exceed 50 ug/l in any stream at the point where it enters any lake or reservoir." (EPA 1986). Based upon Frenzel's work, average concentration of the Pack River was 43 ug/l. This is an indication that phosphorus as well as nitrogen are contributing to enrichment of the Pack River.

3.c. Data Gaps for Determination of Support Status

Currently, existing watershed data is only available for the upper reaches (headwaters) of the Pack River and its tributaries through the Cumulative Watershed Effects program. Little data is available concerning nutrient and sediment pollutants in the mainstem (Hwy. 95 to Pend Oreille Lake). As was mentioned, there is no guidance developed to date as to how the 1997 Large River Survey data should be interpreted for conclusions regarding beneficial use support status. The wadable stream Reconnaissance data was determined to be not applicable.

Conclusion of Problem Assessment

The mainstem Pack River has been listed as not supporting its designated beneficial uses. The information currently available suggests that nutrients and sediment are pollutants causing this impairment. It is apparent from current data that there are widespread and diverse impacts affecting this river segment and additional study is required. Pesticides and dissolved oxygen have been discovered to be within full support limits, and therefore will be de-listed for these pollutants. Pathogens will be deferred until fall 2001 so additional samples can be taken per EPA's instructions.

5. TMDL

Because nutrients are often bonded to sediment, excess sediment is often the source of nutrient pollution. This is probably true for nutrient sources in the forested portions of the Pack River watershed and a TMDL for sediment may be sufficient for both pollutants. However, due to mixed land uses and other potential sources of nutrients in the lower portion of the watershed, it would be more conservative to not assume that all nutrients are coming from sediment. A separate TMDL for nutrients will be written to insure that other sources are not missed as potential sources for reduction. The nutrient TMDL will include load limits for phosphorus as well as nitrogen. The 1989 data shows that nitrogen may be limiting during certain times of the year. This may be true also for near-shore areas of Pend Oreille Lake in the vicinity of the Pack River delta.

5.a. Numeric Targets

<u>Nutrients</u>
Frenzel sampled phosphorus and nitrogen along the Pack River in 1989 and 1990 as part of a

larger study of the Pend Oreille Lake (Frenzel 1991). This data is the only information found concerning phosphorus and nitrogen loading in the Pack. The data is as follows:

*Total phosphorus load was 20,600 kg/yr or 6% of the phosphorus load to the lake. Error of the sample was calculated to be 4.4%.

*Nitrogen load was 97,800 kg/yr or 2% of the nitrogen load to the lake. Error of this sampling was high, 51.2%, due to laboratory error.

*Flow of the Pack River was 480 cubic hectometers (1 hectometer = 1,000,000 cubic meters), which is 1.8% of the total inflow to the lake. Error of this measurement was 15%. This percent flow was calculated using the tributaries to the lake and down to the Albani Falls dam. Using a revised inflow to the lake of 24,910hm³ the flow of the Pack River becomes 1.9% of the total inflow to the lake.

*The nitrogen to phosphorus ratio of the Pack River was approximately 5:1.

Other available information that could be used to formulate a target nutrient load is as follows:

The Tri-State Council's voluntary nutrient target for the Clark Fork River and the Pend Oreille Lake have established some draft phosphorus targets for those waterbodies based upon Frenzel's work:

*326,000 kg/yr total phosphorus allocated to the lake
*65,000 kg/yr total phosphorus allocated to Pend Oreille Lake tributaries (excluding the Clark Fork River)
*260,000 kg/yr total phosphorus allocated to the Clark Fork River

*7.8 ug/l phosphorus concentration for the open waters of Pend Oreille Lake
*15:1 trigger value of total nitrogen to total phosphorus

Lacking a target nutrient concentration for the river from either literature or field data, this TMDL will utilize the Tri-State Council's draft nutrient target and allocations to calculate phosphorus load reductions for the Pack River which are protective of Pend Oreille Lake water quality. There are 328,651 kg/yr total phosphorus allocated to the lake. The Pack River is 1.9% of the inflow to the lake. By multiplying these two numbers you get a flow weighted value of the phosphorus load allocated to the Pack River which is 6,244 kg/yr. The flow calculation has an error of 15% which would reduce this target load to **5,307 kg/yr.** The Council's load allocation for the lake tributaries other than the Clark Fork River is 69,151 kg/yr. Subtracting the Pack River load allocation leaves a 62,907 kg/yr allocation to the lake from sources other than the Clark Fork and Pack Rivers.

Nitrogen load will also be calculated based upon inflow to Pend Oreille Lake. The nitrogen load entering Pend Oreille Lake from the Pack River measured by Frenzel was 97,800 kg/yr or 2.2% of the total load entering the lake. By multiplying these two numbers you get a flow weighted value of 95,648 kg/yr. Reducing this by the margin of error in sampling (52.1%) the target load becomes **45,815 kg/yr.** As better data becomes available, this target load can be further refined.

Sediment
See attached spreadsheet.

5.b. Source Analysis

Nutrients
Source of nutrient in the Pack River have been previously discussed in the problem assessment section.

Sediment
See attached spreadsheet and Appendix B.

5.c. Linkage Analysis

Nutrients
Both phosphorus and nitrogen load limits are included in this TMDL. Measurement of nutrient reductions can be done directly by measuring nitrogen and phosphorus concentrations and flow.

5.d. Allocations

Nutrients
The data set for nutrient concentrations and flows for Pack River tributaries is minimal. Most tributaries have no information on nutrients. Allocation of loads to tributaries can be done once this information is collected. Until that time, the load for the Pack River is the only allocation. There are no point source discharges in this watershed.

Sediment
See attached spreadsheet.

5.e. Monitoring Plan

Nutrients
Nutrients will be sampled as a part of DEQ's once every five year beneficial use reconnaissance monitoring. Sampling time and location should duplicate that of Frenzel's work. Results should be flow weighted to insure that values are comparable to the target values. If one sampling effort shows that loads have been reduced to the target level, then a second sampling within the next two years should verify that fact prior to de-listing. To avoid prematurely de-listing the river the two "full support" determinations should be combined with a list of nutrient reduction measures achieved in the watershed that equate to the observed reduction. This is required due to the variable nature of nutrient concentrations which are dependent, in part, on weather and precipitation runoff patterns throughout the winter and spring months.

5.c. and 5.e. Sediment Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative

Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.f. Margin of Safety

Nutrients

The margin of error is incorporated into the phosphorus and nitrogen target load calculations in section 5.a. by reducing the target load by the amount of error found in the data analysis. Adding an additional arbitrary margin of safety would only add to the error of the analysis, not aid in recovering beneficial uses. Because this is the case, the margin of safety exists additionally in the monitoring plan of this TMDL.

Sediment

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. Explanations of some of the values have not been detailed as yet on the spreadsheets pending their revision. Background loading from land uses and stream bank erosion coefficients are being revised to be specific to the Pend Oreille watershed. Once the revised values are received the "Sediment Yield" portion of the spreadsheet will more fully explain the source of the values. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition.

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Pack River Watershed: Land Use Information

Land Use Sub-watershed	Pack headwaters	McCormick Creek	Minor Mid - Pack	Minor Lower Pack	***Explanation/Comments***
Pasture (ac)	**50**	**9**	**6,400**	**35051**	
Forest Land (ac)	**14209**	**4346**	**37338**	**18057**	
Unstocked Forest (ac)	***5156**	***2280**	**10081**	**1445**	*Includes once burned areas*
Highway (ac)	**0**	**0**	**0**	**4.5**	*State or County paved highways*
Double Fires (ac)	**1147**	**75**	**8017**	**0**	*Areas which have been burned over twice*

Road Data Sub-Watershed	Pack Headwaters	McCormick Creek	Minor Mid-Pack Tribs.	Minor Lower Pack Tribs.	
1. Forest roads (total miles)	**46**	**12**	**59**	**154**	
CWE road score (av)	29.9	28.9	##25	##23	
**Sediment export coefficient (tons/mi/yr)	**10.4**	**9.6**	**7.0**	**6.0**	
#Total Forest Rd Failures (cubic yds delivered)	**689**	**865**	**874.4**	**387.2**	*Cumulative Watershed Effects data*
###2. Unpaved Co.& priv. roads (total miles)	0	0	**8**	**103**	
Paved Co.&priv. roads (total miles)	0	0	0	19.5	
Total C&P Rd Failures (cubic yds delivered)	0	0	**118.5**	**259**	*Based on weighted average of forest road failures.*
####Stream bank erosion-both banks (mi)					*__***erosion coefficients__*
poor condition	0	0	**2.75**	**6.25**	*95 tons/yr/mi*
good condition	0	0	**17.5**	**14**	*47.5 tons/yr/mi*

*Erosion attributed to the Sundance Fire.
**McGreer et al. 1997
***Stevenson 1999. Good condition: 5,280'/mi X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1 ton/2000lbs = 47.5 tons/yr/mi.
Poor condition: 5,280'/mi X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1 Ton/2000lbs = 95.0 tons/yr/mi.
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. Thses two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##Presumed CWE score for roads and road failures derived from a weighted average of CWE scores by geologic type from watersheds assessed by CWE in the Pend Oreille watershed.
###County and private road erosion derived from using the same method as forest roads. Since the method used for forest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.
####Source of data from 1996 aerial photos.

Pack River Watershed: Land Use Information (cont.)

Land Use						
Sub-watershed	Homestead	Jeru	Martin	Lindsey	Hellroaring	Caribou
Pasture (ac)	**0**	**0**	**0**	**3**	**5**	**19**
Forest Land (ac)	**2335**	**3556**	**2314**	**2401**	**7723**	**9154**
Unstocked Forest (ac)	***735**	***1793**	**461**	**369**	**1333**	**1081**
Highway (ac)	0	0	0	0	0	0
Double Fires (ac)	**1952.8**	**190.9**	**2212.7**	**33.1**	**137.0**	**0**

Road Data						
Sub-Watershed	Homestead	Jeru	Martin	Lindsey	Hellroaring	Caribou
1. Forest roads (total miles)	**8.1**	**15.9**	**5.4**	**15.9**	**40.8**	**45**
CWE road score (av)	32.6	16.3	13	29.2	59.8	35.4
**Sediment export coefficient (tons/mi/yr)	**12.9**	**3.6**	**2.8**	**9.8**	**76.9**	**16.2**
#Total Forest Rd Failures (cubic yds delivered)	**14**	none	**27**	0	**361**	**981**
2. Unpaved Co.& priv. roads (total miles)	0	0	0	0	**1.0**	**1.5**
Paved Co.&priv. roads (total miles)	0	0	0	0	0	0
###Total Road Failures (cubic yds)	0	0	0	0	**8.8**	**32.7**
####Stream bank erosion-both banks (mi)						
poor condition	0	0	0	0	0.5	0.2
good condition	0	0	0	0	0	0.3

Pack River Watershed: Land Use Information (cont.)

Land Use

Sub-watershed	Berry	Sand	Colburn	NF Grouse	Grouse	Lwr Grouse
Pasture (ac)	**80**	**15**	**1064**	**8**	**45**	**8498**
Forest Land (ac)	**6002**	**8032**	**4453**	**9529**	**16848**	**12747**
Unstocked Forest (ac)	**2128**	**251**	**945**	**1268**	**1192**	**1020**
Highway (ac)	0	0	**23.6**	0	0	**12.1**
Double Fires (ac)	0	0	0	0	**2287.6**	**25**

Road Data

Sub-Watershed	Berry	Sand	Colburn	NF Grouse	Grouse	Lwr Grouse
1. Forest roads (total miles)	**40**	**39**	**34.5**	**55**	**41.7**	**26**
CWE road score (av)	46.7	21.9	27.8	29.6	20.9	##22
**Sediment export coefficient (tons/mi/yr)	**35.7**	**5.6**	**8.8**	**10.2**	**5.2**	**5.5**
#Total Forest rd failures (cubic yds delivered)	**755**	**113**	**477**	**628**	**57**	**200**
2. Unpaved Co.& priv. roads (total miles)	**0.4**	**4.6**	**7.5**	**5.2**	**0.5**	**6**
Paved Co.&priv. roads (total miles)	0	0	0	0	0	**3**
###Total C&P rd failures (cubic yds)	**7.6**	**13.3**	**103.7**	**59.4**	**0.7**	**46.2**
####Stream bank erosion-both banks (mi)						
poor condition	**0.2**	1.0	0	1.9	3.0	**0.2**
good condition	0	0	0	7.3	1.5	**0.5**

Pack River Watershed: Land Use Information (cont.)

Land Use			
Sub-watershed	Gold	Rapid Lightning	Trout
Pasture (ac)	**924**	**1251**	0
Forest Land (ac)	**6007**	**61288**	**13286**
Unstocked Forest (ac)	**385**	**4903**	**1063**
Highway (ac)	0	0	0
Double Fires (ac)	0	0	0

Road Data			
Sub-watershed	Gold	Rapid Lightning	Trout
1. Forest roads (total miles)	**24**	**100**	**20**
CWE road score (av)	18.3	##27	##25
*Sediment export coefficient (tons/mi/yr)	**4.2**	**8.2**	**7.0**
##Total forest rd failures (cubic yds delivered)	0	**1760**	**295**
2. Unpaved Co.& priv. rds (total miles)	9	**14**	0
Paved Co. & priv. rds (total miles)	0	0	0
###Total C&P rd failures (cubic yds)	0	**246.4**	0
####Stream bank erosion -both banks			
poor condition	**0.5**	**6**	0
good condition	**0.4**	**4**	0

Pack River Watershed: Sediment Yield

Explanation/Comments
Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr

Sediment Yield From Land Use

Watershed:	Pack headwaters	McCormick	Yield Coeff. (tons/ac/yr) as shown in ( )	
Pasture (tons/yr)	7 (0.14)	1.3 (0.14)		
Forest Land (tons/yr)	539.9	165.1	*0.038*	
Unstocked Forest (tons/yr)	87.7	38.8	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0.0	0.0	*0.034*	
Double Fires (tons/yr)	19.5	1.3	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**654.1**	**206.5**	*(Values taken from WATSED and RUSLE models-see below explanation [#])*	

*Sediment Yield From Roads

Watershed:	Pack headwaters	McCormick	
Forest Roads (tons/yr)	**478.4**	**277.4**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**986**	**1237.8**	***Assumes soil density of 1.7 g/cc; conversion factor from cubic yds to tons = 1.431.*
County and Private Roads (tons/yr)	0	0	
Co. and Private Road Failure (tons/yr)	0	0	

*Percent fines and percent cobble-gravel average of the Pend Oreille-Priest-Prouty-Jeru-Treble series A&B soil horizons is 75% fines, 25% cobble-gravel (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: pasture obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: (revised watershed specific WATSED values to be provided by USFS)
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of pendings, landtype and years since harvest.
Highways (0.34) obtained from WATSED with the following inputs: Value obtained from the Coeur 'd Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Pack River Watershed: Sediment Yield

Sediment Yield From Land Use							
Watershed:	Minor Mid-Pack Tribs.	Minor Lwr Pack Tribs.	Homestead	Jeru	Martin	Lindsey	Hellroaring
Pasture (tons/yr)	1600 (0.25)	17175 (0.49)	0 (0.14)	0 (0.14)	0 (0.14)	0.42 (0.14)	0.7 (0.14)
Forest Land (tons/yr)	1418.8	1418.8	88.7	135.1	87.9	293.5	293.5
Unstocked Forest (tons/yr)	171.4	171.4	12.5	30.5	7.8	6.3	22.7
Highway (tons/yr)	0	0.1	0	0	0	0	0
Double Fires (tons/yr)	136.3	0	33.2	3.2	37.6	0.6	2.3
Total Yield (tons/yr)	**3326.5**	**18765.3**	**134.4**	**168.8**	**133.3**	**300.8**	**319.2**

*Sediment Yield From Roads							
Watershed:	Minor Mid-Pack Tribs.	Minor Lwr Pack Tribs.	Homestead	Jeru	Martin	Lindsey	Hellroaring
Forest Roads (tons/yr)	413	924	**104.5**	**57.2**	**15.1**	**155.8**	**3137.5**
Forest Road Failure (tons/yr)	1251.3	554.1	**20**	0	**38.6**	0	**516.6**
County and Private Roads (tons/yr)	56	618	0	0	0	0	**76.9**
Co. and Private Road Failure (tons/yr)	169.6	370.6	0	0	0	0	**12.6**

Pack River Watershed: Sediment Yield

Sediment Yield From Land Use

Watershed:	Caribou	Berry	Sand	Colburn	NF Grouse	Grouse
Pasture (tons/yr)	2.66 (0.14)	12 (0.15)	3.3 (0.22)	159.6 (0.15)	1.1 (0.14)	34.2 (0.76)
Forest Land (tons/yr)	347.8	228.1	305.2	169.2	362.1	640.2
Unstocked Forest (tons/yr)	18.4	36.2	4.3	16.1	21.6	20.3
Highway (tons/yr)	0	0	0	0.8	0	0
Double Fires (tons/yr)	0	0	0	0	0	38.9
Total Yield (tons/yr)	**368.9**	**276.3**	**312.8**	**345.7**	**384.8**	**733.6**

*Sediment Yield From Roads

Watershed:	Caribou	Berry	Sand	Colburn	NF Grouse	Grouse
Forest Roads (tons/yr)	**729**	**1428**	**218.4**	**303.6**	**561**	**216.8**
Forest Road Failure (tons/yr)	**1403.8**	**1080.4**	**161.7**	**682.6**	**898.7**	**81.6**
County and Private Roads (tons/yr)	**24.3**	**14.3**	**25.8**	**66**	**53**	**2.6**
Co. and Private Road Failure (tons/yr)	**46.8**	**10.9**	**19**	**148.4**	**85**	**0.7**

Pack River Watershed: Sediment Yield (continued)

Sediment Yield From Land Use				
Watershed:	Lwr Grouse	Gold	Rapid Lightning	Trout
Pasture (tons/yr)	849.8 (0.10)	240.2 (0.26)	950.8 (0.76)	0 (0.76)
Forest Land (tons/yr)	484.4	228.3	2329	504.9
Unstocked Forest (tons/yr)	17.3	6.5	83.4	18.1
Highway (tons/yr)	0.4	0	0	0
Double Fires (tons/yr)	0.4	0	0	0
Total Yield (tons/yr)	**1352.3**	**502.7**	**3363.2**	**522.1**

Sediment Yield From Roads				
Watershed:	Lwr Grouse	Gold	Rapid Lightning	Trout
Forest Roads (tons/yr)	**143**	**100.8**	**820**	140 422.1
Forest Road Failure (tons/yr)	**286.2**	0	**2518.6**	422.1
County and Private Roads (tons/yr)	**33**	**37.8**	**114.8**	0
Co. and Private Road Failure (tons/yr)	**66.1**	0	**352.6**	0

Pack River Watershed: Sediment Exported To Stream

	Pack Headwaters	McCormick Creek	Minor mid-Pack Tribs.	Minor lwr-Pack Tribs.	Homestead	Jeru	Martin
Land use export (tons/yr)	654.1	206.5	3326.5	18765.3	134.4	168.8	133.3
Road export (tons/yr)	478.4	277.4	469	1542	104.5	57.2	15.1
Road failure (tons/yr)	986.0	1237.8	1420.9	924.7	20	0	38.6
Bank export (tons/yr)							
poor condition	0	0	261.3	593.8	0	0	0
good condition	0	0	831.3	665	0	0	0
Total export (tons/yr)	**2118.5**	**1721.7**	**6309**	**22490.8**	**124.5**	**226**	**187**
*Natural Background Mass Failure (tons/yr)	1069	0	312.8	173.2	0	0	0

*Background mass failure is the difference between the estimated total mass failure observed in the watershed and mass failure contributed by roads.

Pack River Watershed: Sediment Exported To River

	Lindsey	Hellroaring	Caribou	Berry	Sand	Colburn
Land use export (tons/yr)	300.8	319.2	368.9	276.3	312.8	345.7
Road export (tons/yr)	155.8	3214.4	753.3	1442.3	244.2	369.6
Road failure (tons/yr)	0	529.2	1450.6	1091.3	180.7	831
Bank export (tons/yr)						
poor condition	0	47.5	19.0	19.0	95.0	0
good condition	0	0	14.3	0	0	0
Total export (tons/yr)	**456.3**	**4110.3**	**2606.1**	**2828.9**	**832.7**	**1546.3**
Natural Background Mass Failure (tons/yr)	0	432.2	450.8	0	45.8	334.9

Pack River Watershed: Sediment Exported To River

	NF Grouse	Grouse	Lwr Grouse	Gold	Rapid Lightning	Trout	Watershed Total
Land use export (tons/yr)	384.8	733.6	1352.3	502.7	3363.2	522.1	32,171.3
Road export (tons/yr)	561.0	219.4	176	138.6	934.8	140	11,293.0
Road failure (tons/yr)	898.7	82.3	352.3	0	2871.2	422.1	13,337.4
Bank export (tons/yr)							
poor condition	180.5	285	19.0	47.5	570	0	4,299.1
good condition	346.8	71.3	23.8	19.0	190	0	
Total export (tons/yr)	**2371.8**	**1391.6**	**1923.4**	**707.8**	**7929.2**	**1084.2**	**Grand Total: 61,100.8**
Natural Background Mass Failure (tons/yr)	322	25.8	93	0	837.1	141.7	Background Mass Failure Total: 4,238.3 tons/yr

Pack River Watershed

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	293,047			
Presently Forested	239,047			
Estimated Historically Forested	290,487	0.038		11,038.5
Estimated Historically Pasture	2560	0.14		358.4
Nat. Mass Failure (tons/yr)				4,238.3
Background Load = Target Load			**Target Load**	**15,635.2**
			Existing Load	**61,100.8**
			Load Reduction	**45,465.6**

Q. **GRANITE CREEK**

(tributary to southeast Pend Oreille Lake)

***Summary*:**
Granite Creek was found to fully support all of its beneficial uses. Beneficial Use Reconnaissance data from 1994, 1995 and 1997 all conclude that the stream is not impaired.

1. Physical and Biological Characteristics

Granite Creek is a 16,712 acre (68 km^2) sub-watershed located on the southeast side of Pend Oreille Lake. Granite Creek originates in the Coeur d'Alene Mountains on the eastern slope of Packsaddle Mountain (elevation 6,400 feet (1951 m)), and flows north and then east to the southern portion of the lake. Several smaller tributaries enter Granite Creek along the way. The Granite Creek sub-watershed also drains the south side of the Green Monarch Ridge (approximately 5,000 feet (1500 m) elevation). Portions of Granite Creek are not considered to be in dynamic equilibrium. Road building and timber harvesting are the causes of channel instability in the upper reaches of the creek, while floodplain development in the lower reaches of Granite Creek limits the ability of the stream to form new channels (PDO Bull Trout PA, 1998).

Rain on snow events occur in this area, but not as great as the north end of Lake Pend Oreille. However, rain on snow peak runoff events can be the largest peak flow of the year in this area (Packsaddle SFEIS, 1997).

The major tree cover types are predominantly Douglas-fir and grand fir. White pine blister rust and intense wildfires have shaped today's vegetative patterns. Past wildfires have removed in-channel woody debris and mature riparian trees (Packsaddle SFEIS, 1997).

The Sullivan Springs tributary of lower Granite Creek is an important kokanee and bull trout spawning area. There are areas of Granite Creek which remain in good condition for bull trout survival, while other reaches are not in good condition.

The lower Granite valley has been impacted by a large subdivision close to the lake, a road up the valley bottom, a power line corridor, and some smaller timber harvesting operations.

2. Pollutant Source Inventory

Point Source Discharges
No point source discharges are known to exist in the Granite Creek watershed.

Nonpoint Source Discharges
Excess bedload deposition, coupled with floodplain impacts which limit the ability of the stream to establish new channels in the reach between Kilroy Bay Road and Sullivan Springs. The primary sources of sediment in this watershed are:

Urbanization - Development in the floodplain has resulted in partial loss of floodplain function.

Because most of the development is within a depositional area, efforts to protect private property have reduced the ability of the stream to use its floodplain and create new channels. Removal of timber and road construction for access to lots has also impaired floodplain function. Granite Creek was reportedly dredged in the reach below the Kilroy Bay Road after a large flood in the early 1970's. A significant portion of the floodplain downstream from the Kilroy Bay Road has been subdivided and developed.

Roads - Road failures have occurred in upper reaches of the watershed. Road density is about 2 miles per square mile of watershed. A portion of the kilroy Bay Road failed during flooding in the winter of 1995-1996, and the road has been relocated. More information is being gathered for roads in this drainage.

Timber Harvest - Approximately 16% of the Granite Creek Watershed has been harvested. Modeling of flow responses to timber harvest suggests the Granite Creek drainage is at moderate risk for increased peak flows (Packsaddle Draft Environmental Impact Statement 1994). Past heavy timber harvesting in riparian areas and in some headwater areas has resulted in downcutting in several headwater reaches and accumulation of excess bedload material in downstream reaches.

2.a. Summary of Past and Present Pollution Control Efforts

A Record of Decision published by the Sandpoint Ranger District of the Idaho Panhandle National Forests in 1997 presented a Selected Alternative for forest management in which there are no proposed timber harvest units and associated road construction in Granite Creek (USDA 1997). This was established so that there would be no sediment yield increases in that watershed (USDA 1997). The selected alternative (Alternative 8) was chosen in part to protect the established beneficial uses in the Granite Creek Watershed.

3. Water Quality Concerns and Status

Granite Creek was listed in 1996 as water quality impaired due to sediment. The results of our Beneficial Use Assessment process for the years 1994, 1995 and 1997 are fully supporting all beneficial uses. Additional monitoring data also concluded that Granite Creek is impaired due to (high) temperature.

3.a. Applicable Water Quality Standards

N/A

3.b. Summary and Analysis of Existing Water Quality Data

Data collected from Granite Creek in 1994 showed full support of all established beneficial uses. Salmonid spawning was not assessed. With a macrobiotic index of 4.55, a habitat index of 107, and 17.4% fine materials in the substrate, Granite Creek was found to be not impaired.

Data collected in 1995 showed similar results. Macrobiotic Indices showed full support of cold water macroinvertebrate communities, and habitat scores were also fairly high. The percentage of fines in these surveys was significantly higher, with the upper site producing 30% fines (particles <6mm in diameter) and the lower site producing a score of 54.20% fines. A fish survey at the lower site again produced numerous salmonids (westslope cutthroat and brook sp.). Beneficial use data collected in 1997 had similar conclusions.

Continuous temperature data collected on Granite Creek from 6/21 through 9/27 produced a mean of approximately 10°C.

3.c. Data Gaps For Determination of Support Status

None

4. Problem Assessment Conclusions

The 1996 Waterbody Assessment Guidance analysis (per IDAPA 16.01.02.053.) indicates that Granite Creek is fully supporting all beneficial uses. Recommendation is to remove it from the 303(d) list of water quality impaired streams.

References

Corsi, C., DuPont J., Mosier, D., Peters, R., Roper, B. 1998. Lake Pend Oreille Key Watershed Bull Trout Problem Assessment . Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

Dechert, T., Raiha, D. And Saunders, V. 1999. Granite Creek Cumulative Watershed Effects Assessment. September. Idaho Department of Lands. Coeur d'Alene, Idaho.

U.S.D.A. Forest Service. 1997. *Packsaddle Final Environmental Impact Statement and Record of Decision.* Idaho Panhandle National Forest. Sandpoint Ranger District.

R. **GOLD CREEK**

(tributary to southeast Pend Oreille Lake)

Summary:
Gold Creek was placed on the 1996 303(d) list of water quality impaired streams for sediment and habitat alteration. The 1996 Waterbody Assessment Guidance methodology using the 1994 and 1998 Beneficial Use Reconnaissance data concluded that Gold Creek was fully supportive of all beneficial uses. Gold Creek was delisted based upon this finding in the 1998 303(d) list. The 1996 methodology was later discounted, and in April 2000, reference to it was removed from the water quality standards. Currently, we do not have an approved method of determining support status. Recently, new information became available concerning Gold Creek from the Idaho Geological Survey and Idaho Department of Land's Cumulative Watershed Effects analysis. Based upon this information it was determined that Gold Creek was impaired due to sediment and metals pollution. Yearly sediment transport to the stream exceeds natural background by 2,255.3 tons/yr. Metals pollution will not be dealt with until the next 303(d) listing cycle.

1. Physical and Biological Characteristics

The Gold and North Gold Creeks sub-watershed is located on the southeast side of Pend Oreille Lake. Elevation ranges from 6,000 feet (1859 m) near Packsaddle Mountain to 2300 feet (691 m) at Lakeview where the drainages enter the lake. The sub-watershed has both residual and continentally glaciated landscapes. The residual landscape is characterized by moderate to steep slopes with moderate to densely spaced draws. The drainage pattern is dominated by low to mid-order drainages. Slopes are concave to straight at lower elevations and become convex with increasing elevation. Continentally glaciated landscapes are characterized by gentle toe slopes and moderately steep side slopes perched just above Pend Oreille Lake.

Most of the residual part of the drainage is underlain by Precambrian Belt rock. There is also a small amount of Cambrian shale and quartzite and some Lakeview limestone. Lower substratum and surface bedrock are weakly weathered. The glaciated portion of the area has glacial till substratum derived mostly from metasedimentary bedrock sources. The major soils have volcanic ash influenced loess surface layers (12 inches (30cm) -24 inches (60 cm) thick). These layers have a silt loam texture, less gravel and cobble than the underlying residual material, and a high water and nutrient holding capacity. The subsoil and substratum are forming in primarily quartzite and siltite which has a sandy loam to loam texture and 35 to 75 percent subsoil rock fragments. The permeability of most soils are good, except in some of the glaciated soils and some residual draw bottoms and toe slopes where restrictive layers can restrict water movement (USDA, 1997).

The North Gold Creek portion of the sub-watershed includes North Gold and Branch North Gold Creeks. Overall the existing condition of surface erosion in the North Gold Creek portion of the sub-watershed is likely not out of the range of natural variability. Presently channels are still recovering from past fires in 1896, 1926, and 1934 that removed in-channel woody debris and mature riparian trees. Most north facing slopes in the Branch North Gold drainage are naturally highly susceptible to mass wasting. However, because there have been no activities in that area, it seems to be recovering from the previous fires. There has been some localized down cutting in the headwaters to the Branch North Gold as a result of harvesting, however, because of low frequency and distribution the effects have not manifested downstream. North Gold appears to be intermittent above Branch North Gold, yet most of the reaches in North Gold appear to be in dynamic equilibrium. Approximately the first mile of North Gold Creek is not in dynamic equilibrium, as evidenced by head cutting, high raw banks, loose of channel armoring, and extended periods of intermittent flow compared to reaches just upstream. The cause appears to be whole riparian clearing and in-channel woody debris removal while the property was in private ownership up until 5-10 years ago (USDA, 1997).

The steeper reaches below the confluence of Gold and North Gold Creeks are in equilibrium, with year-round flows. Riparian vegetative cover is mature, but most of the over-mature timber has been removed for wood products, creating diminished fish habitat complexity in the lower reaches.

The Gold Creek portion of the sub-watershed includes West Gold Creek, Chloride Gulch, Gold Creek, and Kickbush Gulch. Only Gold Creek is listed as water quality-limited. Overall the existing condition of surface erosion in the West Gold Creek and Kickbush Gulch drainages are likely not out of the range of natural variability. Channels in West Gold Creek drainage are also recovering from past fires. West Gold Creek is somewhat different from other drainages in the sub-watershed in that the forested riparian has not been burned or logged. However, cutting units in the headwaters have caused low frequency, localized down cutting but the effects are not realized downstream. Other portions of the drainage including Kickbush Gulch experience the same scenario of very scant in-channel woody debris which appears to have triggered headwater down cutting since the last fires of the mid-1930s. Intermittent channels in Kickbush Gulch are sporadic until the confluence with Cheer Creek, where year-round flow continues (USDA, 1997).

Chloride Gulch and Gold Creek above the confluence with West Gold Creek are not presently in dynamic equilibrium. Both channels go dry for most of the summer season. All intermittent reaches have diverged from normal ranges with regard to width/depth ratios, channel confinement, and/or channel sinuosity. They are also downstream areas from extensive mine waste deposits that are located in stream channels or flood plains. In Gold Creek alone the waste from the Conjecture Mine has already contributed an estimated 50,000 cubic yards (38228 m^3) of sediment into the channel with another 110,000 cubic yards (84101 m^3) available with future runoff. The Weber mine in Gold Creek and the Idaho Lakeview Mine in Chloride Gulch also have introduced and continue to supply these channels with exaggerated sediment supplies.

Approximately three river miles of West Gold Creek above the confluence with Chloride Gulch could serve as a realistic reference condition for similar streams at elevations between 2,600 feet (792 m) and 3,200 feet (975 m). These relatively "undisturbed" headwater streams differ from affected areas in the drainage in that they are less frequently down cut. Down cutting that does exist in the undisturbed areas is generally much older than the logged, unbuffered streams as evidenced by increased wood recruitment.

Below 2,600 feet (792 m) elevation channel hydrology is within ranges expected for the channel types on these landforms. Even the elevated sediment from past practices (homesteading and mining) pass through the reaches without affecting channel shape. However, the rate of alluvial fan development has probably been accelerated.

Both Gold and North Gold Creeks sub-watersheds are relatively undisturbed above 3,200 feet (975 m) and below 2,600 feet (792 m) elevation. In Gold Creek, past and existing mine waste deposits are the principle sources of sediment. The mines are on private land. North Gold Creek is relatively undisturbed compared to Gold Creek. Riparian treatment along the old homestead area is the chief source of sediment in this area. The homestead area is now under USFS management.

The Gold Creek watershed is 19.7 square miles (51 km^2), forested and primarily managed for timber production. There is recreational use of private land near the mouth of Gold Creek. There is 0.8 miles (1.3 km) of road per square mile of watershed (Patten,1998).

The majority of land is owned by the USFS, 43 acres (0.174 km^2) are privately owned old mining sites, and the town of Lakeview located at the mouth of Gold Creek. Lakeview is isolated in the winter with the primary means of access by boat. Outdoor recreation is the main economy of Lakeview.

History and Economics: Outdoor recreation is currently the main economy of Lakeview. The Gold Creek watershed was a boom area for mining beginning in the late 1800s. Silver, gold, lead, zinc, antimony and silica were mined from the upper reaches of the Gold Creek watershed. What remains of this industry are waste rock and tailings piles, old mill buildings and cleared but now vacant home sites.

2. Pollutant Source Inventory

Point Source Discharges

There have been no point source discharge permits issued for Gold Creek, however, numerous point sources from mine adits discharge to Gold Creek and its tributaries. Most discharges are seasonal and/or flow sub-surface.

Nonpoint Source Discharge

Nonpoint sources found to be threatening water quality in the Gold Creek watershed are outlined as follows:

Mining - Past mining operations in the watershed have impacted this stream and continue to affect channel equilibrium. Chloride Gulch and Gold Creek, above the confluence with West Gold Creek, both exhibit channel disequilibrium and intermittency as a result of excess bedload inputs stemming from mining operations. These streams tend to go dry for most of the summer season in areas where width/depth ratios, channel confinement, and channel sinuosity are outside normal ranges. All intermittent reaches in Gold Creek are located downstream of areas where extensive mine waste deposits were placed directly in the steam. Waste from the Conjecture Mine has already contributed an estimated 50,000 cubic yards of sediment into the channel, with another 110,000 cubic yards available with future runoff (USDA 1997). The Weber Mine in Gold Creek and the Idaho Lakeview Mine in Chloride Gulch have introduced and continue to supply the stream channel with large sediment loads (Corsi et al.,1998). Recent data collected by the Idaho Geological Survey indicates that mine adits and mine waste are causing elevated metals concentrations in water and soil. These levels often exceed standards for cold water biota.

Roads - The Kickbush Gulch slide has a history of failures which have contributed fine sediment to Gold Creek. A large road failure occurred in 1996 in the Kickbush area which contributed significant amounts of road and hill slope material to this stream.

Power Line - Separate Bonneville Power Administration and Washington Water Power (Avista) transmission lines span Gold Creek in the lower reach near Lakeview. Timber and vegetation were cleared in a 250 foot corridor for line construction in the early 1950's. The lines cross Gold Creek, then run parallel to West Gold Creek at one location. Loss of woody debris recruitment may affect this portion of the stream, and shade is diminished.

Timber Harvest - Approximately seven percent of the Gold Creek drainage has been logged. Long term recruitment of woody debris has been lost in some headwater tributaries due to past timber harvest. Post-fire salvage in riparian areas in some portions of the watershed has reduced large woody debris recruitment to streams. There is also the possibility of increased sediment bed loads occurring as direct and indirect results of timber harvest practices.

Wildfire - The Gold Creek stream channel is still recovering from past fires in 1896, 1926, and 1934 that removed live mature riparian trees.

Urbanization - Some residential home sites exist along the lower stream reach. Although not major, riparian impacts and stream bank disturbances have occurred.

Dams and Diversions - Migration by post-spawning bull trout and other salmonids out of Gold Creek may be hindered as an indirect result of lake level fluctuations by Albeni Falls Dam. Peak runoff flows in Pend Oreille tributaries generally occur before the Clark Fork River peaks and fills the lake to its summer elevation (2062 ft. mean sea level). Consequently, coarse bedload material carried downstream by Gold Creek during high flow is deposited in an alluvial fan which has formed near the winter lake level elevation.

2.a. Summary of Past and Present Pollution Control Efforts:

The Lakeview Local Working Committee identified sediment and bedload as the primary pollutants impairing fish habitat in Gold Creek. Other concerns expressed by the Committee include:

1. Closure of the landfill located near Gold Creek, which was achieved by 1994.
2. Reduce sediment delivery from Kickbush Slide.
3. Gravel bars at mouth of Gold Creek impairing fish passage.
4. The DEQ needs to explore how to rehabilitate old mining sites. DEQ sought to obtain grant money for preliminary site assessment, effort not successful.
5. Close ford that crosses Gold Creek under the BPA powerlines.
6. Prior to further timber harvesting activities, USFS should assess water yield impacts the work may cause. Models used for the analysis should be verified in the field. By 1994 the USFS was using a variety of watershed models and on the ground stream surveys.
7. Better communication between USFS engineers and foresters was recommended and achieved through regularly scheduled meetings.

8. BPA was informed of recommended BMPs for powerline slashing.
9. Better implementation of BMPs especially on inactive forest roads.
10. Mining and septic systems are other sources of pollution which need to be addressed.
11. Education of 250 land owners and operators about how to work near streams.
12. Noxious weed control needs to be addressed.

Some of the recommendations of the Lakeview Local Working Committee were not acted upon by the time the Committee was disbanded in 1994.

3. Water Quality Concerns and Status

In 1996 Gold Creek was added to the 303(d) list as water quality impaired due to excess sediment and habitat alteration. Gold Creek has existing uses of domestic water supply, cold water biota, salmonid spawning and primary and secondary contact recreation. Gold Creek is currently the second most important bull trout spawning stream in the Pend Oreille watershed. Excess bedload is considered to be the single greatest limiting factor for bull trout habitat in the Gold Creek watershed. This stream has been heavily impacted primarily due to mining and its associated activities. Mine waste and adit water are causing metals contamination of soils and water. Recently, the U.S. Forest Service has begun a process of site evaluation and search for responsible parties that may eventually result in a CERCLA ("Superfund") cleanup.

3.a. Applicable Water Quality Standards

Gold Creek was listed in 1996 as water quality impaired from its headwaters to Pend Oreille Lake for sediment and habitat alteration. Standards which address these pollutants are those for turbidity, cold water biota, salmonid spawning and domestic water supply.

3.b. Summary and Analysis of Existing Water Quality Data

a) Data Sources: USFS and DEQ
Twenty four percent of Gold Creek is 2% slope or less, 27% is above 6% gradient. Average flow is 20.4 cfs, high flow is 232 cfs, and low flow is 1.8 cfs. Rosgen stream classification B.

b) Water Column Data:
Kauffman and Rember (1998) sampled adit and stream water in the Lakeview mining district located in the Gold Creek drainage. Results of the analysis indicate numerous exceedences of the Environmental Protection Agency's *Quality Criteria for Water 1986* (Gold Book) limits for metals concentrations. Aquatic life and drinking water were the most frequently exceeded values. Metals that exceeded standards included aluminium, arsenic, cadimium, copper, iron, lead, manganese, mercury, and zinc.

c) Other Water Quality Data:
Fish tissue sampling indicated Pb and Hg levels may limit fish consumption (DEQ-Hoelscher memo). DEQ BURP data: MBI=4.56, HI = 78. Septic systems in the vicinity of the mouth of Gold Creek have been moved further uphill away from the creek. These

systems are now constructed on suitable soils, which has alleviated concerns about failed septic systems in this location (Ed Braun-PHD personal communication). Wildfires occurred in 1896, 1926 and 1934.

d) Beneficial Use Reconnaissance Data: Gold Creek was listed as impaired on the 1996 303(d) list for sediment and habitat alteration. The 1998 Beneficial Use Reconnaissance data recorded a stream temperature of 17.5°C. However, the 1997 Hobo continuous temperature measurements taken from 6/21 to 9/27 recorded an average temperature of approximately 8°C, which is below criteria for cold water biota, salmonid spawning, and bull trout. The Hobo data combined with field observations shows that Gold Creek meets the temperature standard only because the stream has been buried by excess bedload and mining related stream alterations. A macrobiotic index completed for data collected in 1994 produced a score of 4.56, and a Habitat Index score of 78. Other data collected at this time reported a Wolmann pebble count of 13.30% fines (particles <6mm diameter), discharge of 15.10 cfs, 45% canopy closure, and 22 pieces of large woody debris within bank full of a 140 meter reach. In 1998 the upper and lower portions of Gold Creek were again assessed. The upper site had a macrobiotic index score of 3.57 and a habitat index score of 55. The lower site had a macrobiotic index score of 4.8 and a habitat index score of 89.

e) Cumulative Watershed Effects Data:
In 1998, Gold Creek was evaluated as a part of the Cumulative Watershed Effects program developed by the Idaho Department of Lands. This program has been instated as part of the Idaho Forest Practices Act. In contrast to indirect indicator and model-based approaches, this program relies on direct observations made in the stream and on the surrounding landscape. The process consists of an assessment of fine sediment in stream bottoms, channel stability, sediment delivery, water temperature/stream shade, nutrients, and hydrology, as affected by forest practices. This evaluation produced results on forested lands in the Gold Creek watershed as summarized below by Dechert et al. (1999):

Category	**Scores**	**Ratings**
Channel Stability Index	53.5	Moderate
Canopy Removal Index	0.29	N/A
# Segments w/Low Temp	6/9	*
# Segments w/High Temp	3/9	*
Canopy Closure/Temperature Rating	*	High
Roads	22.8	Low
Skid Trail	2	Low
Mass Failure	12.5	Low
Total Sediment Delivery	37.3	Low
Nutrient Current Condition	25	Low
Nutrient Hazard Rating	*	High
Overall Nutrient Rating	*	Moderate
Hydrologic Risk Rating	*	Moderate
CWE Surface Erosion Hazard	*	Low
CWE Mass Failure Hazard Rating	*	High

This data indicated the following results:

a) Adverse conditions are identified for three canopy closure/stream temperature segments. Cumulative watershed effects management practices will be developed to address this situation.

b) Two road segments are identified as significant management problems. These roads require attention of the land managers.

c) The guidelines developed by the Lakeview Local Working Committee for the Stream Segment of Concern program should continue to be implemented.

3.c. Data Gaps For Determination of Support Status

Gold Creek requires additional metals monitoring, total suspended solids and turbidity sampling. In addition, comments received concerning this TMDL expressed concerns that clearcuts in this watershed have caused an accelerated runoff affecting water quantity, temperature, peak flows and bedload movement. Flow and habitat are two parameters that Idaho does not recognize as regulated pollutants under the Clean Water Act, even though these elements could prevent complete restoration of beneficial uses. If Idaho's position changes, these two parameters should be examined with respect to attaining full support.

4. Problem Assessment Conclusions

In the absence of an approved beneficial use assessment process, other available data indicates that Gold Creek is not supporting its beneficial uses. Excess sedimentation, primarily from past mining practices, are causing this impairment. Gold Creek is also impaired due to metals pollution and requires listing for this impairment and additional monitoring for metals. Stream temperature is kept low artificially, due to its sub-surface flow resulting from mining impacts. If surface flows were restored, inadequate canopy cover would cause elevated temperatures. A temperature TMDL should be considered for this situation, particularly because of its importance to bull trout.

5. TMDL

Problem Statement: Excess sediment is impairing the beneficial uses of cold water biota and salmonid spawning in Gold Creek.

5.a. Numeric Targets

See attached spreadsheet.

5.b. Source Analysis

See attached spreadsheet.

5.d. Allocations

See attached spreadsheet.

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used

exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition.

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Gold Creek: Land Use Information

Land Use		*Explanation/Comments*
Sub-watershed	Gold Creek	
Pasture (ac)	**0**	
Forest Land (ac)	**6,592**	
Unstocked Forest (ac)	**6,592**	Includes once burned areas
Highway (ac)	0	State or County Paved Highways
Double Fires (ac)	2197	Areas which have been burned over twice
Road Data		
Sub-Watershed	Gold Creek	
1. Forest roads (total miles)	**49.6**	
CWE road score (av)	22.8	
*Sediment export coefficient (tons/mi/yr)	**5.8**	
#Total Forest Rd Failures (cubic yds delivered)	**40**	*Cumulative Watershed Effects Data*
##2. Unpaved Co.& priv. roads (total miles)	0.6	
Paved Co.&priv. roads (total miles)	0	
Total C&P Rd Failures (cubic yds delivered)	0	*Based on weighted average of forest road failures.*
###Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**15.4**	*95 tons/yr/mi*
good condition	**6.2**	*47.5 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1999. Good Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1ton/2000lbs = 47.5 tons/yr/mi
Poor Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1ton/2000lbs = 95 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##County and private road erosion derived from using the same method as forest roads. Since the method used for foest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.
###Source of data from DEQ 2000 bank inventory survey.

Gold Creek: Sediment Yield

Sediment Yield From Land Use		*Explanation/Comments*
		Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr
Watershed:	Gold Creek	*Yield Coeff. (tons/ac/yr)*
Pasture (tons/yr)	0.0	*0.14*
Forest Land (tons/yr)	250.5	*0.038*
Unstocked Forest (tons/yr)	112.1	*0.017 (this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0	*0.034*
Double Fires (tons/yr)	37.3	*0.017 (this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**399.9**	*(Values taken from WATSED and RUSLE models see below explanation [#])*

*Sediment Yield From Roads		
Watershed:	Gold Creek	
Forest Roads (tons/yr)	**287.7**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**57.2**	***Assumes soil density of 1.7 g/cc and a conversion factor of 1.431.*
County and Private Roads (tons/yr)	**3.5**	
Co. and Private Road Failure (tons/yr)	0	

*Percent fines and percent cobble of the Pend Oreille - Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.14) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.034) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Gold Creek: Sediment Exported To Stream

	Gold Creek
Land use export (tons/yr)	399.9
Road export (tons/yr)	291.2
Road failure (tons/yr)	57.2
Bank export (tons/yr)	
poor condition	1463.0
good condition	294.5
Total export (tons/yr)	**2505.8**
*Natural Background Mass Failure (tons/yr)	0

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure associated with roads.

Gold Creek

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	6,592			
Presently Forested	6,592			
Estimated Historically Forested	6,592	0.038		250.5
Estimated Historically Pasture	0	0.14		0
Natural Mass Failure (tons/yr)	0			0
Background Load = Target Load			**Target Load**	**250.5**
			Existing Load	**2505.8**
			Load Reduction	**2255.3**

TRIBUTARIES TO PEND OREILLE RIVER

S. COCOLALLA LAKE

Waterbody Type:	Lake
Ecoregion:	Northern Rockies
Designated Uses:	agricultural and domestic water supply, cold water biota, primary and secondary contact recreation, and Special Resource Water.
Size of Waterbody:	805 acres (3.3 km^2)
Size of Watershed:	64.5 square miles (41,298 acres)
TMDL Indicators:	8 ug/l total phosphorus
Model Analysis:	load-response relationship

Summary
Cocolalla Lake is impaired due to low dissolved oxygen and nutrient pollution. A target of 8µg/l total phosphorus was developed which, if achieved, should reduce the trophic level of the lake to a point where theoretically, internal nutrient cycling will not occur. If the internal nutrient cycling does not occur, the lake will meet the dissolved oxygen standard. The phosphorus load reduction of 2,693 kg/yr is 89% lower than existing conditions. The nutrient narrative standard will be met before the oxygen standard, as phosphorus reductions will reduce the occurrence of nuisance algal blooms.

1. Physical and Biological Characteristics

The Cocolalla Lake sub-watershed occupies a major portion of the land mass between the southern arm of Pend Oreille Lake and the Pend Oreille River. The sub-watershed area is approximately 60 square miles (155 km^2) (Rothrock, 1995). The sub-watershed is heavily forested with foothill to mountainous terrain up to 4,500 feet (1,372 m) in elevation with slopes ranging from 15-50%. Cocolalla Lake is in the middle of the sub-watershed at about 2,200 feet (676 m) elevation. Average annual rainfall is about 37 to 40 inches (94 -102 cm), average maximum temperature during July and August is 80°F (26.7°C), and there can be many days above 90°F (32.2°C). The winters are cold and the lake usually freezes over by December.

There are five tributaries to Cocolalla Lake: Cocolalla Creek, Fish Creek, Butler Creek, Westmond Creek, and Johnson Creek. Cocolalla Creek is the only outflow from the lake, which flows into Round Lake and eventually into the Pend Oreille River. The last two miles of Cocolalla Creek comprises a large slough, whose water level is affected by the rise and fall of the Pend Oreille River level.

Cocolalla Lake has a surface area of 805 acres (3.3 km^2) and a mean depth of 27.7 feet (8.4m). All but the east shoreline is developed with primarily seasonal homes. The lake receives heavy recreational use during all seasons, but especially during the summer months.

Dense conifer forest comprises 63% of the watershed, 20% is open conifer forest, 10% in cropland and grazing, with the remainder as clearcuts, home sites, and roads. Fifty percent of the watershed is privately owned.

Cocolalla Lake is bordered by batholith granites near Black Pine Mountain (Rothrock, 1995). The bedrock consists of the Selkirk Crest quartz monzonite (Tertiary) and metamorphic rocks (Precambrian). The valleys are filled with sediments from: erosion of the mountains, lake deposits, glacial till, and glacial outwash. There are three general soil map units common in the watershed, each with one or more detailed map units. In the foothills and mountains the general soil unit is the Pend Oreille-Rock outcrop-Treble on 5-65% slope. These soils are considered poorly suited to roads, dwellings, and recreational development due to slope, a hazard of erosion, and the areas of Rock outcrop. The second soil unit is the Bonner gravelly silt loam. Runoff from this soil is slow and the hazard of water erosion is slight. It is found along Cocolalla Lake shoreline and is poorly suited for septic systems. It is well suited for hay, pasture and livestock grazing The third soil unit is the Hoodoo-Pywell-Wrencoe, which is a very deep poorly drained soil and subject to long periods of standing water.

2. Pollutant Source Inventory

Point Source Discharges

Previous to 1999, there were periodic unauthorized discharges to Johnson Creek and Cocolalla Lake of untreated sewage from the Sandy Beach Resort sewage lagoon. The lagoon has been in use since the early 1970's. In May of 1999, the lagoon was drained and the new community drainfield was fully operational.

Nonpoint Source Discharges

Historically, there have been numerous severe land disturbing activities which contributed large amounts of sediment and associated nutrients, as well as direct nutrient inputs, to the lake. These human caused sources of pollution included dairies located along tributaries, heavy logging activity, failed sewage systems, urban development, heavy grazing and feedlots in bottom lands, and creek channelization.

Currently, nutrient transport to the lake has been reduced by better land use practices and infrastructure improvements. There are now two systems used for sewage disposal, individual septic systems and two community drainfields. The community drainfields have replaced some of the failed septic systems found along the lake. Grazing pressure has been reduced in some areas, and dairies and feedlots are no longer present. Nutrient contributions to the lake from livestock are now primarily from bank destabilization along tributaries. Forest harvesting practices have improved, however, harvesting pressure remains high. Urban growth is a new and increasingly significant factor in nutrient contribution to the lake. Relatively unregulated development and lack of enforcement for the existing county stormwater ordinance results in stream and lake sedimentation. An extensive network of poorly constructed roads also contribute to this sediment loading.

In the Phase I Diagnostic Study, Rothrock concluded that 23% of the phosphorus loading was internally generated from anoxic and aerobic sediments, and macrophyte decay. Reduction of internal phosphorus loads would greatly reduce the growth of algae which would in-turn, reduce or eliminate the formation of anoxic conditions. To break this nutrient recycling, would likely involve an in-lake chemical treatment, combined with a concentrated effort to reduce external nutrient sources to provide a lasting benefit.

2.a. Summary of Past and Present Pollution Control Efforts

In the 1950s the lake was managed as a cutthroat fishery. In 1957 the Cocolalla drainage system received a rotenone treatment to eliminate spiny ray and trash fish, and then was planted with cutthroat. Since then however, competition from warm water fish, decreasing water quality, and degradation of stream segments causing low salmonid spawning success has made the lake marginal for natural trout production. Current management by the Idaho Fish and Game includes maintaining the trout fishery by stocking catchable rainbow trout or fingerlings, and stocking channel catfish. Warm water fish spawn successfully in the lake.

In the falls of 1978 and 1983 the development of a dense blue-green algae blooms led to a heightened awareness of the public concerning the water quality of Cocolalla Lake. In 1983 a public notice was issued advising against using the lake for drinking water or primary contact recreation due to potential blue-green algae toxins. As a result the Cocolalla Lake Association was formed in 1985, with the goal of reversing the lake eutrophication process and preserving its beneficial uses. With over 100 members this group became very strong advocates of pollution reduction and prevention, and successful in their efforts to educate the public.

In 1990, the lake and Cocolalla Creek were designated as Stream Segments of Concern under Idaho's Antidegradation Program. A committee made up of local groups and resource agencies, identified issues significant to water quality degradation in the watershed. Three site specific best management practices for timber harvesting were recommended by the committee and implemented by Idaho Department of Lands.

In 1994 the Bonner Soil Conservation District was awarded a State Agricultural Water Quality Program (SAWQP) grant to pursue measures to reverse the accelerated eutrophication of Cocolalla Lake and its tributaries. Tasks accomplished were:

1. Publish and distribute four newsletters.
2. Distribute information packets at public events.
3. Conduct four educational workshops that address watershed pollution issues.
4. Provide a water awareness educational program for school children.
5. Purchase a sign which identifies the SAWQP project area.
6. Purchase an environmental educational program for use by students and adults.
7. Construct fire pits and signs.
8. Provided fish passage on Fish Creek through the culvert to Cocolalla Lake.

A feasibility study examining alternatives for controlling nutrient loading into Cocolalla Lake was developed by Montgomery Engineers (JMM, 1993). From this list, the Cocolalla Lake Watershed Management Plan was developed by the Bonner Soil Conservation District in 1996. Goals of this plan were:

1. Reduce phosphorus loading from existing septic systems.
2. Restrict increased phosphorus loading from future development
3. Minimize nonpoint source pollution associated with urban and residential land use

runoff entering the tributaries and lake.

4. Minimize nonpoint source pollution associated with pasture and hayland uses.
5. Minimize nonpoint source pollution associated with forest land uses.

Restoration projects completed in 1996-'97 by the Cocolalla Lake Association were:

1. Road improvements on Cocolalla Loop Road at Fish Creek, implementation of Bonner County's Stormwater Ordinance, and the development of a stormwater and erosion control plan for Fish Creek Road and Cocolalla Loop Road.
2. Fence construction and repair along the Idaho Fish and Game property.
3. Training of a Streamwalk Team and their annual public education efforts.

3. Water Quality Concerns and Status

Nutrient pollution in Cocolalla Lake causes periodic blooms of blue-green algae. These blooms curtail recreational use in the late summer and cause the dissolved oxygen levels to fall below minimum standards set by Idaho.

3.a. Applicable Water Quality Standards

Cocolalla Lake was listed as impaired due to unspecified "pollutants", nutrients and dissolved oxygen in the 1996 303(d) list. It has designated beneficial uses of agricultural and domestic water supply, cold water biota, primary and secondary contact recreation, and is designated as a Special Resource Water.

Idaho's water quality standard for excess nutrients is as follows, "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses."

Idaho's water quality standard for dissolved oxygen is that the concentration must exceed 5mg/L at all times. This standard does not apply to (1) the bottom 20% of water depth, where depths are 115 feet (35 meters) or less, or (2) waters of the hypolimnion (deepest water) in stratified lakes.

3.b. Summary and Analysis of Existing Water Quality Data

Cocolalla Lake has had several water quality studies conducted over the last twenty years. In the mid-1970s IDEQ (Johann 1974 and Trial 1976) assessed the lake's trophic status. The conclusion was that the lake was either meso-eutrophic or eutrophic, with secchi disk transparency measurements around 5 feet (1.5 m) and hypolimnion oxygen depletion. Nutrient input was identified to be from heavy grazing and haying along tributaries, and septic tank leaching from lakeshore homes.

In 1986 a one year lake study (Falter and Good 1987) determined that the lake was phosphorus limited and meso-eutrophic. Falter also provided a table of phosphorus export coefficients selected for the characteristics of the Cocolalla watershed.

Cocolalla Creek and Cocolalla Lake were also designated as Stream Segments of Concern under

Idaho's Antidegradation Program in 1989. The resulting report established site specific best management practices for Cocolalla Creek. These included pre-operational inspections for Class I stream crossings and for those operations that will involve road construction or major reconstruction.

From 1990 to 1992 IDEQ conducted a diagnostic monitoring program of the Cocolalla Lake watershed. Rothrock found that the lake trophic status was between meso-eutrophic and eutrophic, similar to the mid-1970s finding (Rothrock 1995). Low dissolved oxygen (<1.0 mg/l) began at 23 feet (7 meters) which comprises 24% of the total lake volume. The anoxic layer did not develop in the winter months. From approximately 31 feet (9.5 m) to maximum lake depth, low oxygen levels allowed phosphate to be released from bottom sediments. This high layer of phosphate comprised 7% of the total lake volume. This internal nutrient cycling accounted for 23% of the estimated annual phosphorus load in the lake from October 1990 through September 1991. Even though in theory, if phosphorus is reduced over a period of years internal nutrient cycling will eventually disappear, modeling shows that this might not be achievable for Cocolalla Lake. Therefore, a treatment, such as alum, may be necessary to stop the internal nutrient cycling, and the phosphorus inputs to the lake reduced to maintain the benefits of the alum treatment.

Rothrock found that the five lake tributaries contributed 63% of the estimated total annual phosphorus loading to the lake, which is high compared to other north Idaho lakes. Cocolalla Creek (inlet) accounted for 40% of the tributary loading. Two main factors that contribute to this condition are grazing animals and septic tank leachate from homes along the stream.

A 1995 survey of streams in the Cocolalla watershed showed only minor problems related to phosphorus contributions from agricultural activities (Blew 1995). This information is contrary to data collected by Rothrock in 1990-91 which indicated that 15% of the phosphorus load is in the form of orthophosphate. This indicates that at least 15% of the load is animal in origin. Blew also reported that stream channelization increased bank erosion but most of these areas have healed and no longer represent significant erosion problems. Some localized streambank damage due to grazing was found. Blew described these as small and localized and not considered a significant problem to water quality.

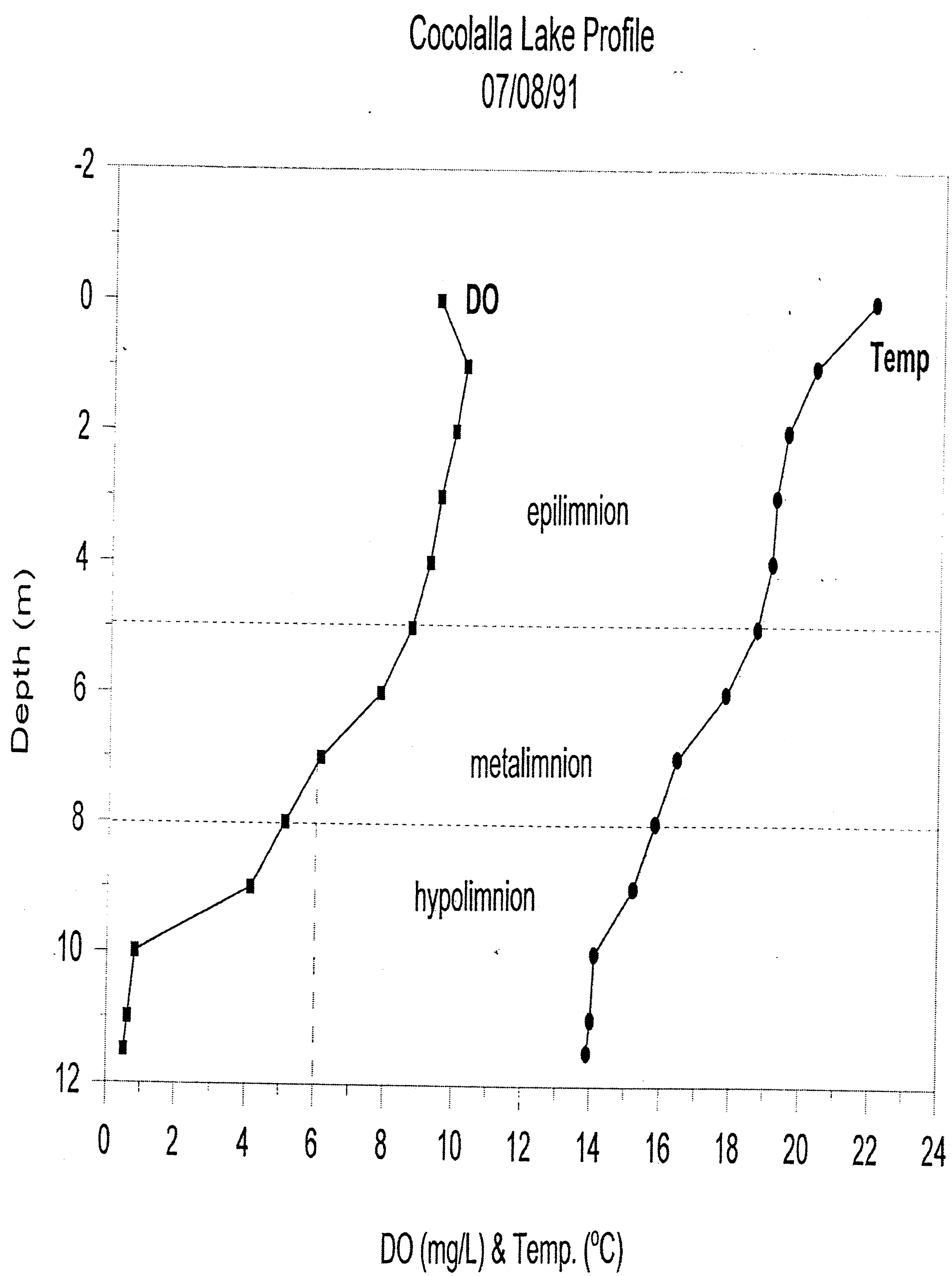
Results of shoreline lake water sampling did not indicate bacterial contamination problems. However, the northern public swimming area may be threatened due to high summer bacterial counts entering from Westmond Creek (Rothrock 1995). Rooted aquatic plants do not appear to interfere with recreational use. Less than 4% of the lake is covered by macrophytes, primarily in the southern bay.

3.c. Data Gaps for Determination of Support Status

DEQ's new Large Waterbody Assessment Guidance was not available for use in this TMDL. Data for this beneficial use support status work was collected in 1998.

4. Conclusion of Problem Assessment

<u>Dissolved Oxygen</u>



Cocolalla Lake Profile
07/08/91
DO
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metalimnion
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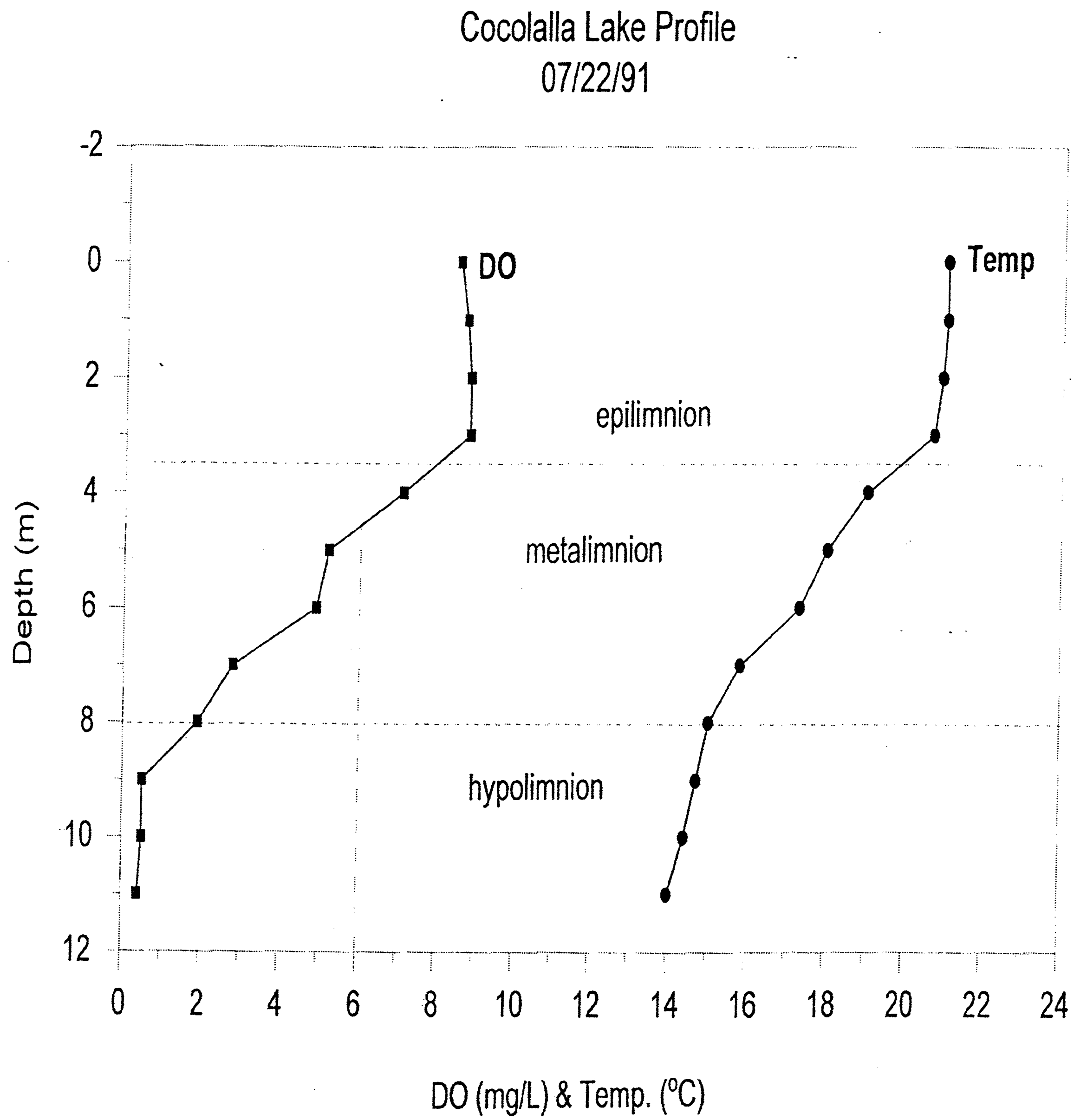
DO (mg/L) & Temp. (°C)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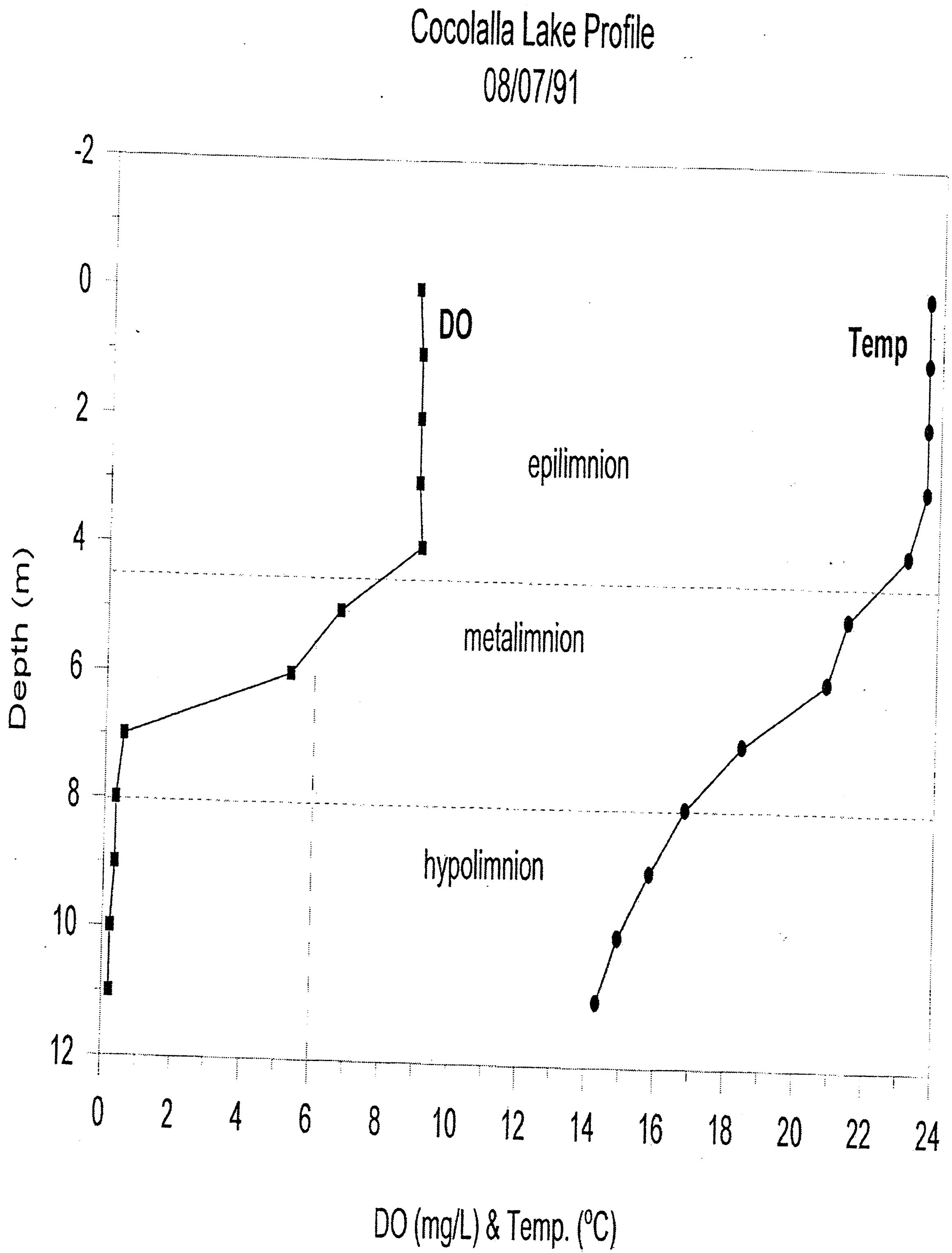

Cocolalla Lake Profile
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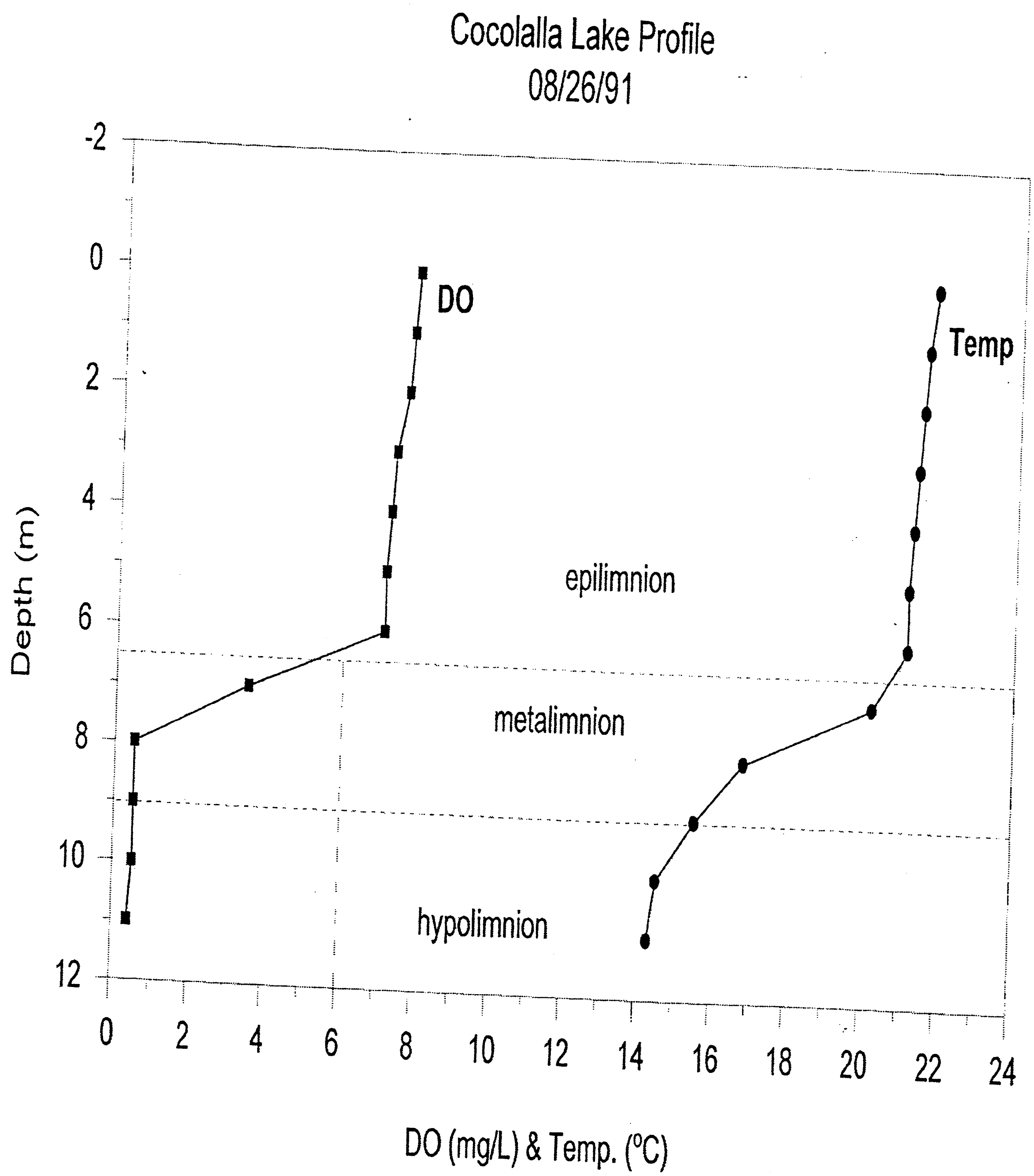

Cocolalla Lake Profile
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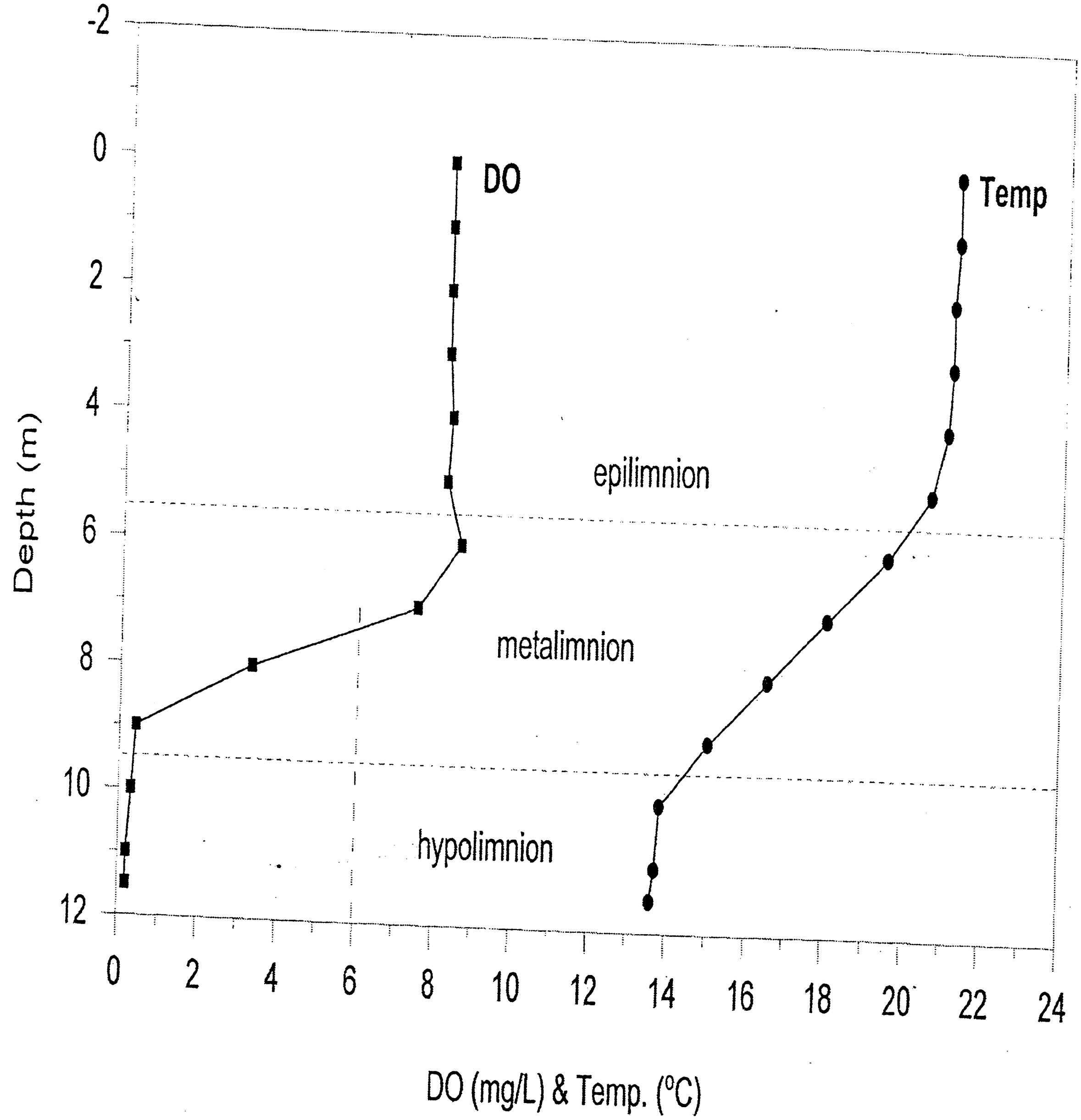
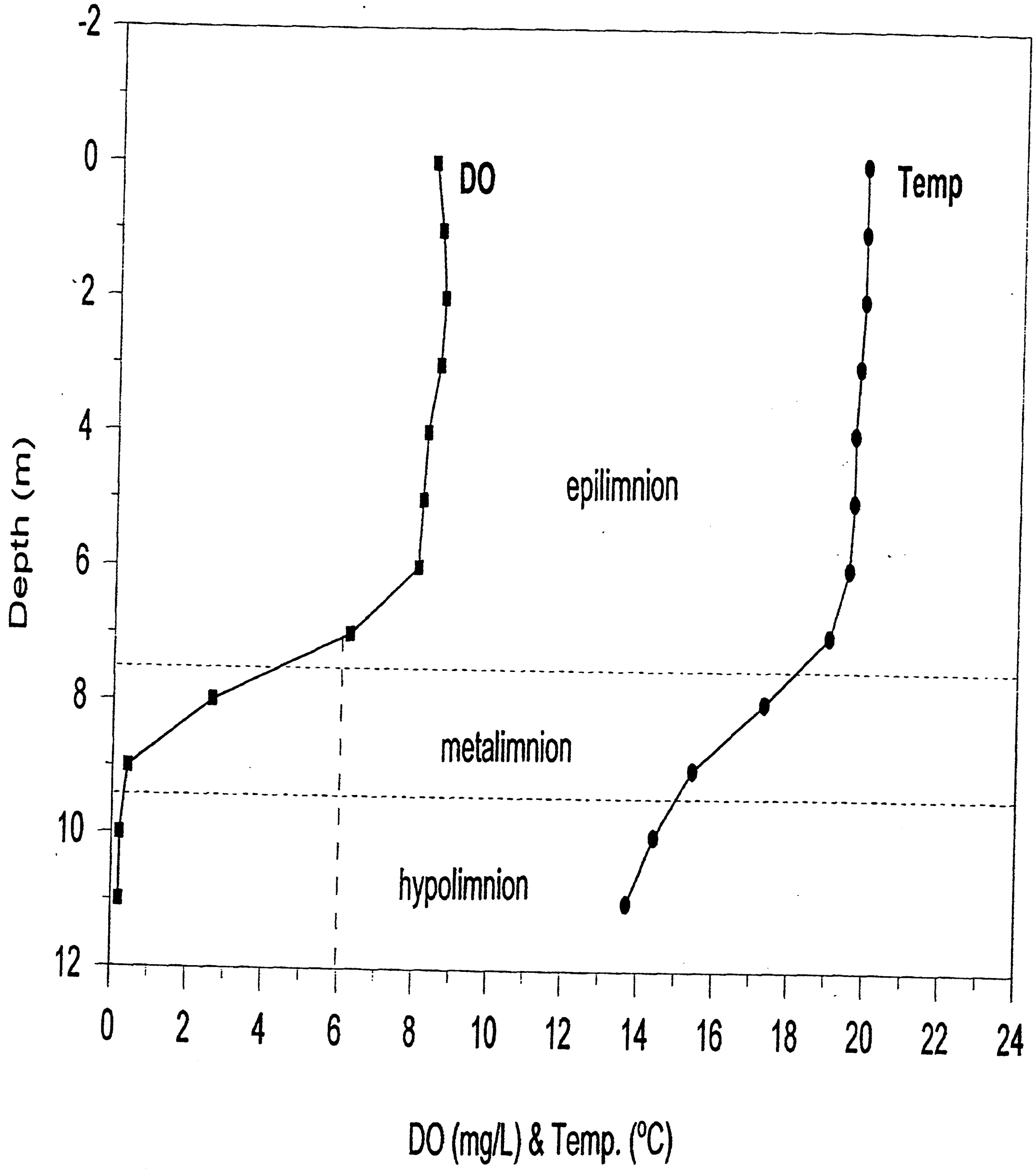
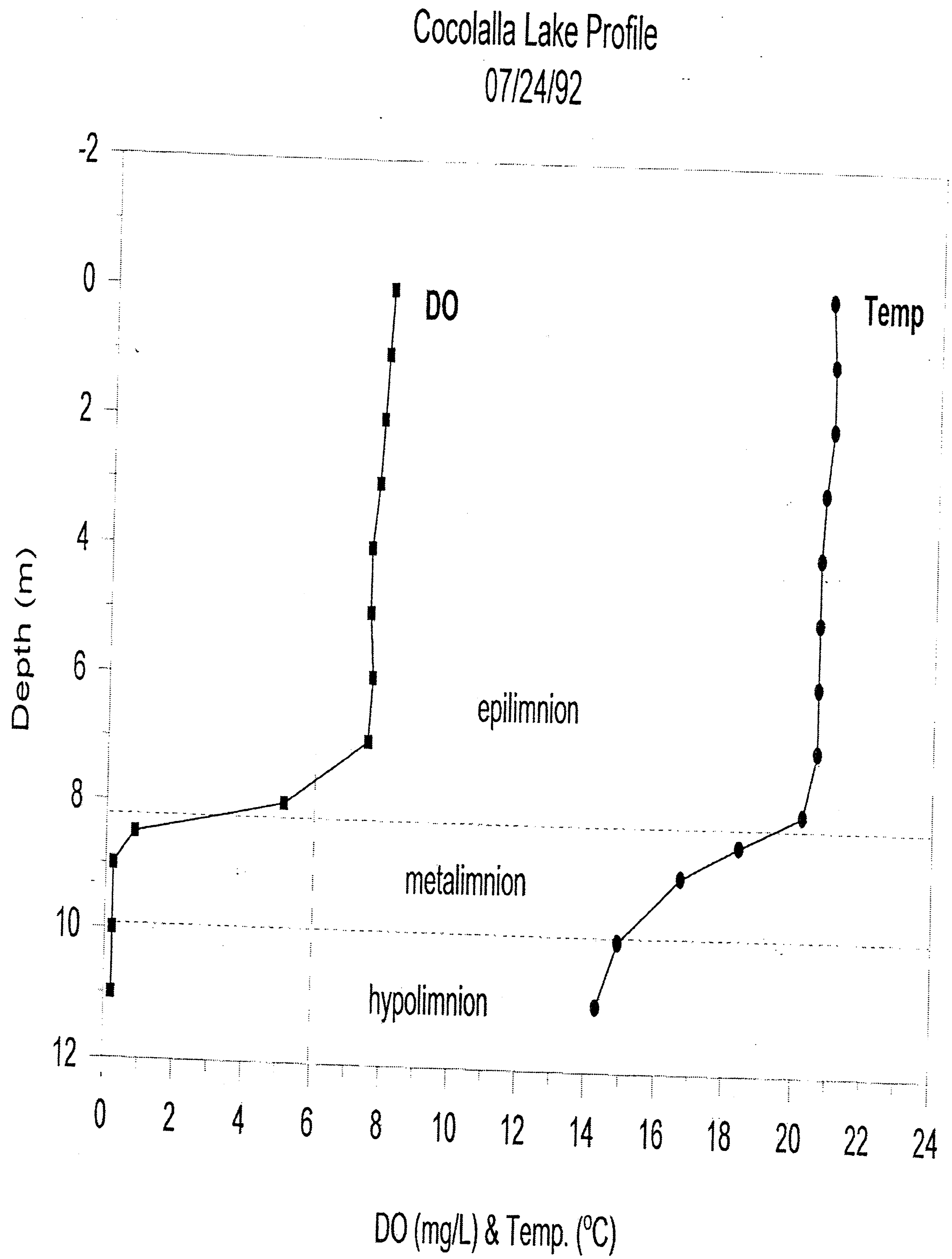
DO (mg/L) & Temp. (°C)

Cocolalla Lake Profile
06/29/92



Cocolalla Lake Profile
07/10/92





Cocolalla Lake Profile
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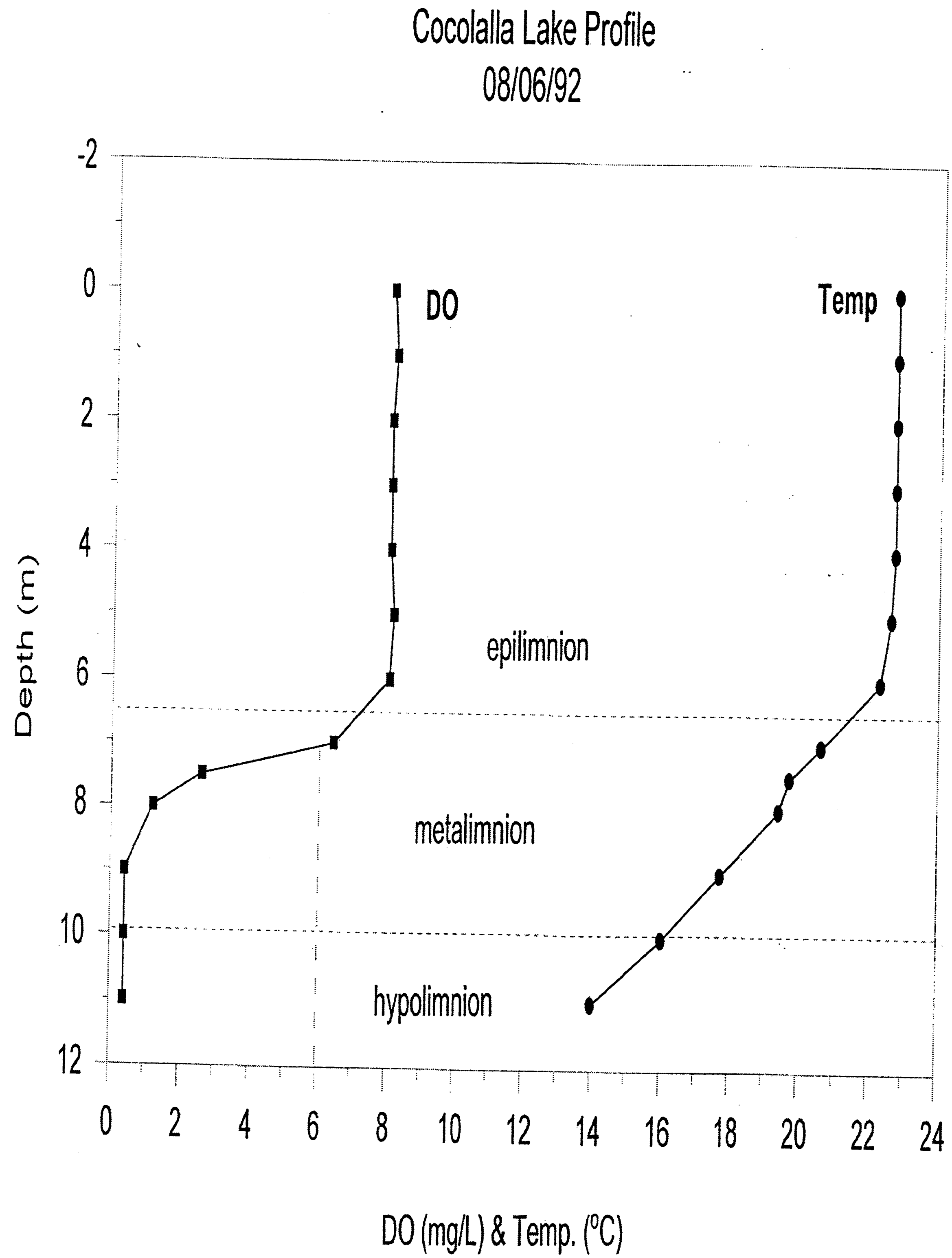
DO (mg/L) & Temp. (°C)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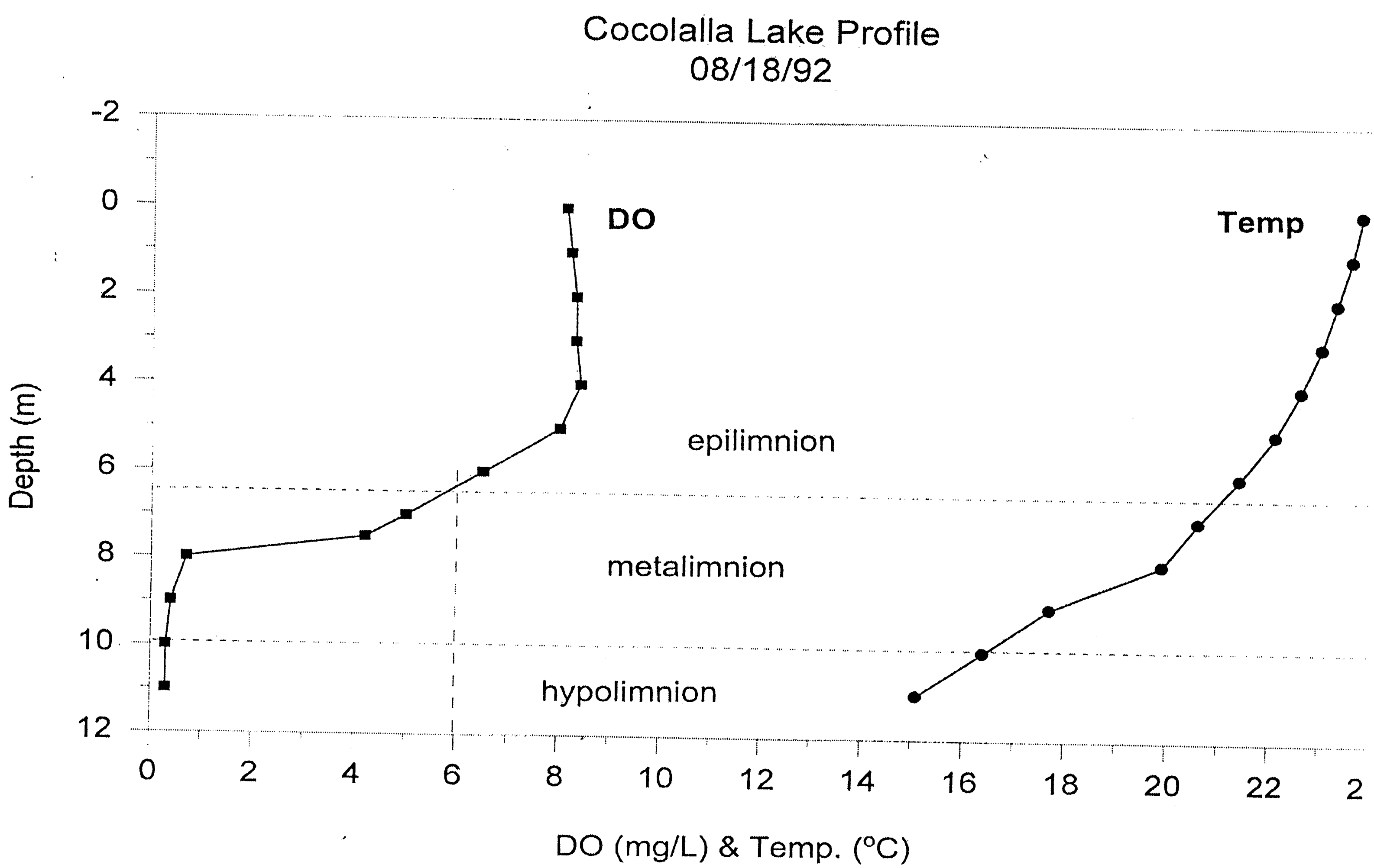
DO (mg/L) & Temp. (°C)


Cocolalla Lake Profile
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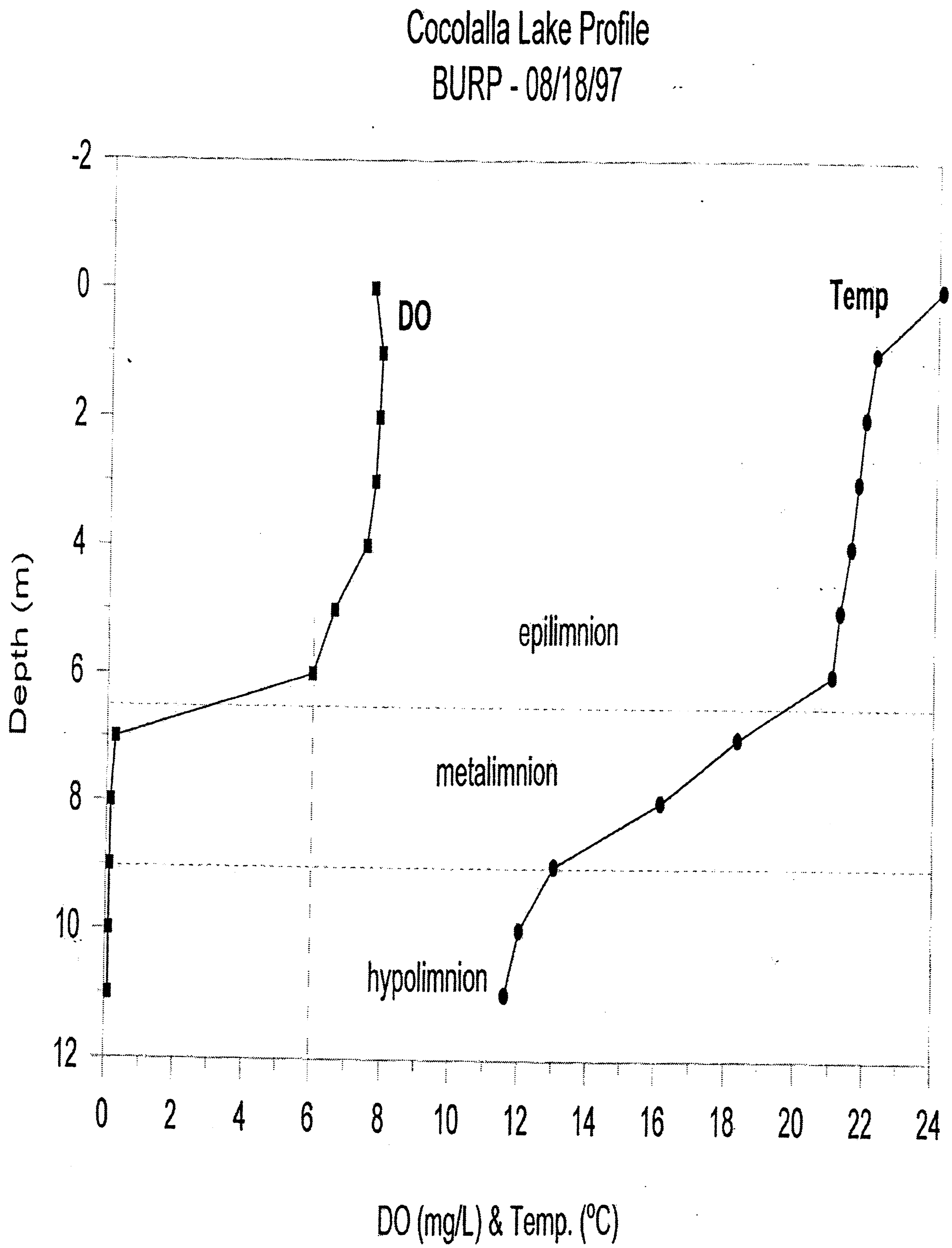
DO (mg/L) & Temp. (°C)



Cocolalla Lake Profile
BURP - 08/18/97
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DO (mg/L) & Temp. (°C)

Data shows that Cocolalla Lake does not meet Idaho's dissolved oxygen standard for cold water biota, a designated use. In 1992, waters 23 feet (7 m) and deeper fell below the 5 mg/l standard and comprised greater than the bottom 20% of water depth in the lake (24% < 1.0mg/l). The area of low dissolved oxygen was above the hypolimnion in all samples for both years of the study, 1991 and 1992. In conclusion, Cocolalla Lake will require a TMDL that achieves compliance with Idaho's dissolved oxygen standard.

Nutrients

Newspaper articles from the early 1980s describe recreational use impairment due to excess nutrients in Cocolalla Lake. In 1991 a blue-green algae bloom was noted by Rothrock, however, it was not as severe as those seen in years 1986, 1988, 1989 and 1993. Based upon this evidence, the lake appears to substantially and chronically violate Idaho's narrative nutrient standard. Achieving compliance with the dissolved oxygen standard should also remove the impairment due to excess nutrients.

5. TMDL- Loading Analysis and Allocation

Problem Statement: Cocolalla Lake does not meet the water quality standards for dissolved oxygen and nutrients.

5.a. Numeric Targets

Dissolved oxygen must reach or exceed 5 mg/l in the upper 80% of the lake water depth and above the hypolimnion and excess nutrients cannot impair beneficial uses.

Nutrients

The WERM modeling (JMM 1993) demonstrated that a phosphorus reduction of 39% resulted in an epilimnetic phosphorus concentration of 16 *u*g/l, a chlorophyll *a* value around 8.5*u*g/l and a secchi depth of 10 feet (3.1 m). These conditions roughly equate to conditions present in the lake in 1992. Based upon the opinion of the Cocolalla Lake Steering Committee this level of water quality achieves full support of recreational uses, thus, in compliance with Idaho's nutrient standard. The year 1992 was marked by low spring flow conditions and low nutrient loading from tributaries. The 39% reduction in total phosphorus equates to a load reduction of 1,265 kg/yr, based upon the model's estimated load of 3,244 kg/yr. The margin of error for this model is unknown. Allowing for an approximated 20% error, the target reduction to achieve full support of recreational uses is 1,518 kg/yr (1,265 X 20%).

Dissolved Oxygen

Studies done in the Cocolalla Lake watershed focused on meeting the nutrient standard, not the dissolved oxygen standard. Consequently there was no link between nutrient reduction and dissolved oxygen levels. Data shows that meeting the nutrient target reduction of total phosphorus (1,518 kg/yr) will not achieve the desired oxygen levels in the lake.
Using the JMM model, a reduction of in-lake total phosphorus from 22 to 16 ug/l moves the lake trophic level to a borderline mesotrophic-eutrophic lake (JMM 1993). An additional reduction to 10μg/l may, in theory, move the trophic level of the lake to a state where there is no internal nutrient cycling (mesotrophic). A target of 10 μg/l total phosphorus requires a load reduction of 2,244 kg/yr, a 69% load reduction from existing conditions. This target is the low end of the recommended range of phosphorus concentrations (10-30μg/l) that the U.S. EPA *Water Quality*

Criteria 1972 (blue book) provides for lakes which are found to be relatively uncontaminated. This nutrient target should be sufficiently conservative to insure compliance with the dissolved oxygen standard. Including a 20% margin of safety makes the final target **8µg/l** total phosphorus with a reduction of **2,693 kg/yr**, an 89% load reduction from existing conditions.

5.b. Source Analysis

Based upon Rothrock's investigation, total phosphorus load to the lake from October 1990 thru September 1991 was 2,209 kg. Tributaries contributed 63% of the total phosphorus load and internal nutrient cycling accounted for 23%. These estimated values are compared to the Watershed Eutrophication Reduction Management modeled values of phosphorus loading to Cocolalla Lake in Table 1.

Table 1. WERRM Phosphorus Load Modeling Compared to IDEQ Estimates, 1991 (Rothrock 1995).

Source	*IDEQ (kg/yr)	WERM (kg/yr)
Tributaries		
Cocolalla Creek	552	883
Fish Creek	283	334
Westmond Creek	273	353
Butler Creek	155	114
Johnson Creek	124	100
	--------	-------
Subtotal	1,387	1,784
Septic Systems	54	118
Atmosphere (dryfall and precipitation)	111	242
Internal Loading	500	1,100
Total	2,052	3,244

*The IDEQ estimates for phosphorus loading do not include loads for groundwater of 50 kg/yr and surface overflow into the lake of 107 kg/yr. There were no estimates for these parameters in the WERM model.

IDEQ loading estimates correspond to the measured seasonal average concentrations of the following parameters: euphotic zone total phosphorus of 20 µg/l; secchi disk reading of 2.1 meters; a concentration of chlorophyll *a* of 12.9 *ug*/l, and observed persistent blooms of blue-green algae.

The WERRM model loading estimates correspond to an in-lake total phosphorus concentration of 22 μg/l and a chlorophyll a of 12 μg/l. At this phosphorus level the lake was classified as eutrophic. By reducing the epilimnetic phosphorus concentration to 16 μg/l, the predictive chlorophyll *a* value was around 8.5 *u*g/l and an associated secchi depth of 3.1 meter. This equated to a 39% reduction of annual phosphorus loading. Again, this model did not examine conditions which would meet the dissolved oxygen standard.

5.c. Linkage Analysis

Monitoring will be of dissolved oxygen, the parameter that is directly impaired.

5.d. Allocations

Tributary phosphorus loading accounted for 55% of the total load to the lake. Septic systems contributed 3.6% of the load, atmospheric load was 7.5% and internal loading accounted for 34% of the total load (Table 2.). Allocations for each of these sources is found in Table 3.

Table 2. Tributary Phosphorus Loading To Cocolalla Lake

Tributary	Modeled Load (kg/yr)	Measured Load (kg/yr)	% of Load
Fish	334	283	10
Johnson	100	124	3
Westmond	353	273	11
Butler	114	155	4
Cocolalla	883	552	27
Subtotal	**1784**	1387	**55%**
Septic Systems	118	54	4
Atmosphere	242	111	7
Internal loading	1100	500	34%
Total	**3244**	2052	100%

Table 3. Load Allocations by Source

Source	Load Reduction (kg/yr)
Fish Ck	269
Johnson	81
Westmond	296
Butler	108
Cocolalla	727
Septic Systems	108
Atmosphere	188
Internal Loading	916
Total Load Reduction	**2693**

5.e. Monitoring Plan

The Citizen Volunteer Monitoring Program collects dissolved oxygen data on Cocolalla Lake monthly from May to September. The most critical time to measure dissolved oxygen would be in late August and September when oxygen levels would be at their lowest concentration. The DEQ's beneficial use reconnaissance surveys are to be conducted once every five years. Due to the variable nature of nutrient loading to the lake, two concurrent surveys showing full support status should be obtained before de-listing is considered. During those ten years there also should not be a significant algae bloom in the lake.

5.f. Margin of Safety

A 20% margin of error was added to the dissolved oxygen target, reducing it from 10µg/l to 8µg/l (see section 5.a.). An additional margin of safety also exists in the monitoring plan of this TMDL (see section 5.e.).

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Rothrock, G. 1995. Phase I Diagnostic and Feasibility Analysis Cocolalla Lake. Bonner County, Idaho, 1990-1992. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

Trial, W.T., Jr. 1976. Water Quality Summary: Cocolalla Lake, Idaho. Idaho Department of Health and Welfare, Division of Environment. Boise, Idaho.

T. **UPPER COCOLALLA CREEK**

(tributary to Cocolalla Lake)

Waterbody Type:	stream
Ecoregion:	Northern Rockies
Designated Uses:	None; Existing uses are domestic and agricultural water supply, primary and secondary contact recreation and cold water biota
Size of Waterbody:	15.5 miles
Size of Watershed:	16,980 acres
Indicators:	

Summary: Cocolalla Creek was determined to be impaired for sediment and temperature pollution. Sediment load target was set at 673.5 tons/yr from the existing load of 5,745.9 tons/yr. Temperature will not be addressed at this time pending an anticipated change to this standard.

1. Physical and Biological Characteristics

Upper Cocolalla Creek is the largest tributary to Cocolalla Lake. The creek contributes the highest proportion of inflow and phosphorus loading to the lake. Upper Cocolalla Creek drains approximately 16,980 acres of mixed land uses, including pasture and hayland (15%), forest land (83%) and residential use, including roads (2%). It flows from the headwaters southwest toward Careywood, Idaho, then turns north and flows into Cocolalla Lake. Elevation ranges from 2080 feet (634 m) at the mouth to 2460 feet (750 m) at the headwaters. Due to the mixed geology and the effect of the Lake Missoula floods, Cocolalla Creek exhibits an irregular drainage pattern, with numerous ponds, sinks, and wet areas. The creek is perennial with the flow regimen dominated by snowmelt runoff. It is approximately 15.5 miles long from the headwaters to the mouth with many small intermittent tributaries throughout its length. Cocolalla Creek originates at Little Blacktail Mountain (elevation 3800 ft), and eventually drains into the south end of Cocolalla Lake (Gilmore 1996).

Cool, dry summers and moderately cold winters characterize the area. Average annual precipitation ranges from 25 to 30 inches (63.5 to 76.2 cm). The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events.

The headwaters originate at the eastern edge of the watershed at an elevation of 3800 ft. For the first 4.5 miles the creek drains forested land of greater than 25% slopes, and falls at an average 6% gradient until it reaches elevation 2440 ft, which is the beginning of the first valley floor. There are about 2 stream miles through this valley which at one time had substantial grazing activity, but this has lessened in recent years. In some stretches the creek becomes braided, and there are also pools due to beaver activity. At the end of the valley Cocolalla Creek receives Kreiger Creek and Three Sisters Creek, which drain the southeastern corner of the watershed (Rothrock 1995).

The watershed is heavily forested with foothill and mountainous terrain up to 4500 ft elevation and slopes ranging from 15-50%. There has been considerable logging activity and most timbered areas are second growth. The lower portion of the Cocolalla Creek watershed is characterized by pasture and hay ground and cattle and sheep grazing, with free access to riparian areas.

Geology. Most of the Cocolalla Creek watershed is the Belt series. Cocolalla Lake is bordered by batholith granites near Black Pine Mountain. The bedrock consists mainly of the Selkirk Crest quartz monzonite (Tertiary) and metamorphic rocks (Precambrian). The valleys are filled with sediments from current erosion of the mountains, lake deposits, glacial till and outwash. The combination of highly erodible soils, steep slopes, and large drainage area relative to the capacity of the streams makes these streams highly susceptible to sediment overload.

Soils. The predominant soils of the Cocolalla Creek watershed can be grouped into the following three general soil mapping units:

Pend Oreille-Rock Outcrop-Treble:
Very deep, well drained , rolling to very steep soils, and rock outcrop. Moderate permeability, rapid to very rapid runoff, high to very high erosion hazard. Unit is considered poorly suited to roads, dwellings, and recreational development due to slope, erosion hazard, and rock outcrop.

Bonner-Kootenai:
Very deep, well drained, level to hilly soils, slow runoff, slight erosion hazard. Unit is suited to hay, pasture, and livestock grazing.

Hoodoo-Pywell-Wrencoe:
Very deep, level to nearly level, poorly drained to very poorly drained on low stream terraces, flood plains, and bottomlands. Very slow runoff, subject to very long periods of flooding. Unit is well suited for hay, pasture, and livestock grazing.

Land Use. A large portion of the watershed is comprised of dense canopy conifer forest. Open canopy forests have been selectively logged as a forest management practice. Currently, the watershed, as with other areas of Bonner County, is experiencing tremendous rural development. Some of the selective logging (and clear-cuts) is occurring on 20 acre parcels using erosion control measures under the Idaho Forest Practices Act, followed by private development of homesites, roads, and driveways in which there is a lack of erosion control practices (Gilmore 1996).

Agricultural cover is mainly pasture and hayland. Pasturelands are used primarily for livestock grazing and the majority of acres are located along lower Cocolalla Creek bottomland subject to flooding. Some of the larger fields are harvested for one cutting of hay and then utilized as pasture during the summer and fall months. Open meadow cover type includes upland grass areas used for summer pasture land. This land is generally located on upland soils with up to 20% slopes (Rothrock 1995).

2. Pollutant Source Inventory

The factors currently found to be impairing Beneficial Uses and water quality in Upper Cocolalla Creek are sediment and thermal modification. Current boundaries for the water quality limited segment are from the confluence with Cocolalla Lake to its headwaters.

Point Source Discharges.
There are no known point source discharges to Upper Cocolalla Creek or its tributaries.

Nonpoint Source Discharges
Many non-point sources of pollution were identified and noted in the Final Report of the Cocolalla Creek Local Working Committee as prepared by Clark (1991). These sources included the following in order of relative importance:

Silviculture. There are approximately 14,407 acres of forest land within the Cocolalla Creek watershed. Much of this watershed is covered with densely forested areas, consisting of conifers including Douglas fir, grand fir, ponderosa pine, and lodgepole pine. A significant portion is covered with open forest land which has been selectively logged. Some large blocks of forested land are managed by the U.S. Forest Service. Other public lands are managed by the U.S. Bureau of Land Management, and the Idaho Department of Lands. Most of the land is under private ownership.

Harvest activity occurred throughout the watershed at a brisk rate in the early 1990's. In 1994, the Idaho Department of Lands office in Sandpoint, Idaho issued 148 Certificates of Compliance-Fire Management Agreement/Notification of Forest Practice within the Cocolalla Lake watershed (Gilmore 1995).

Agriculture and Grazing.
Pasture condition was rated on forage quality, grazing management levels, soil condition, and erosion potential. Results of this survey was that approximately 80% of the pastures are in good condition, 10% in fair condition, and 10% in poor condition (Gilmore 1995).

Stream zones associated with grazing were rated according to the quality of riparian vegetation, streambank stability, and streambank erosion potential. Estimates indicate approximately 80% of the streambanks are in good condition, 10% in fair condition, and 10% in poor condition (Blew 1995).

Cocolalla creek flows from forest land through hay and pastureland. Many of the channels have been physically altered or straightened. This has impacted the hydrology of the system by changing the timing and volume of stream flows. Riparian vegetation on the straightened sections is in poor condition, with the woody component completely lacking or decadent. This increases the potential for channel erosion during spring runoff flows. This also increases the vulnerability and erosion potential of the banks when exposed to mechanical impacts from livestock. Sediment from sheet and rill erosion on the pasture and hayland is insignificant, since most fields are flat 0-3% slopes, and have 70-95% vegetative cover.

Roads. An estimated 2% of the watershed are included in roadways. This does not include the miles of active and inactive forest roads. When inactive roads are factored in, road densities in the watershed exceed 5 to 6 miles per section, which can significantly affect the drainage patterns and overall hydrology of the system, including sediment transport (Gilmore 1995).

Sediment is generated by roads because drainage facilities and other sediment control measures have not been installed in many areas. The roads generally have shallow side ditches but very few relief or cross culverts. As the runoff water drains from the road surface, it is collected in the roadside ditches and then continues to grow in terms of flow, velocity, and sediment transport. The discharge points for most of these ditches is directly to the stream.

Road surfaces are often observed to encourage rill and gully erosion. Cut slopes are often steep and have little chance for revegetation, leaving exposed soil surfaces. Fill slopes also are often too steep to become revegetated and they continue to contribute sediments to down slope areas or directly into the streams (Gilmore 1995).

Unsurfaced roads contribute sediment at a greatly accelerated rate. The roads which have the greatest impact are associated with those near the stream and improperly maintained or abandoned logging roads in the forested areas. Erosion rates have been estimated as high as 7 tons per acre/year for road surfaces and side slopes (Stevenson 1996).

Residential development (urban wildland interface). The Cocolalla Creek watershed is experiencing tremendous development. An estimated 300 acres per year are subdivided with the majority of the development occurring on 20 acre parcels following forest land harvest activities. Erosion control practices, installed on the forest land under the Forest Practice Act, are destroyed and removed during construction. Opportunities for erosion increases as contractors and developers excavate for home sites and driveways during the critical erosion periods. Rural land divisions creating parcels 20 acres or larger are currently exempt from the county subdivision ordinance. There is a lack of enforcement on these larger developments and contractors and developers are generally not planning or implementing erosion control or storm water management plans. Erosion control plans or storm water management plans for residential construction are required as a condition of building permit issuance by Bonner county, but lack enforcement.

2.a. Summary of Past and Present Pollution Control Efforts

The Cocolalla Lake Association was formed in 1985 with a stated goal of "reversing the lake eutrophication process and preserving its beneficial uses. The Association has developed contacts with and promoted actions from federal, state, and county agencies to encourage surveys and regulations for reducing nonpoint nutrients and sediment into the lake. Various formats have been used to educate local residents and visitors in using practices which lessen pollution. Association members have also conducted a watershed inventory and mapping.

In 1986 the Cocolalla Lake Association contracted with Dr. Michael Falter of the University of Idaho to conduct a one-year study with the objectives of describing current lake conditions (determined to be phosphorus limited meso-eutrophic), estimate nutrient loading, and provide a computer model for predicting lake response to watershed management options (Falter and Good, 1987). A very useful result from that study was an extensive literature search on phosphorus export coefficients from various watersheds and nonpoint sources. By defining the hydrology, dimensions, and land uses within the Cocolalla Lake watershed, a table of phosphorus export coefficients was selected as best estimates for the particular characteristics of the Cocolalla watershed.

In August 1990, DEQ was awarded funding of an Environmental Protection Agency Clean Lakes Phase 1 grant. A diagnostic monitoring program of the Cocolalla Lake watershed was conducted by DEQ from October 1990 through September 1991. An extension of the program provided some further site specific sampling from December 1991 to September 1992. Also in 1990, Upper and Lower Cocolalla Creeks and Cocolalla Lake were designated as Stream Segments of Concern under the Idaho Antidegradation Program. A Local Working Committee was formed which developed water quality objectives and site specific Best Management Practices for these areas (USDA-SCS 1992).

In 1993, the Cocolalla Lake Steering Committee selected James M. Montgomery Consulting Engineers, Inc. to conduct a feasibility analysis of watershed and lake restoration options, and to help formulate a lake management plan. It was completed in 1996 with five targets identified to reduce cultural eutrophication of Cocolalla Lake.

3. Water Quality Concerns and Status

The 1992 Idaho Water Quality Status Report (IDEQ 1992) reported that cold water biota and salmonid spawning were partially impaired in Upper Cocolalla Creek. This was confirmed based upon evaluations of the stream segment using the Beneficial Use Reconnaissance Project data gathered in 1995 and 1998. In addition to this listing, Cocolalla Creek is under scrutiny as a major contributor of nutrients to Cocolalla Lake. This Lake is impaired due to nutrients and dissolved oxygen.

3.a. Applicable Water Quality Standards

Upper Cocolalla Creek was listed for sediment and thermal pollution in the 1996 303(d) list. The Idaho Water Quality Standards narrative criteria (IDAPA16.01.02.200) states that sediment shall not exceed, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Such impairment is determined through water quality monitoring. Monitoring conducted in 1991 showed that sediment was limiting beneficial use attainment (Rothrock 1995).

Temperatures for cold water biota and salmonid spawning (IDAPA 16.01.02.250) must be 22°C or less with a maximum daily average of no greater than 19° C. During spawning periods and incubation for particular species of salmonid, water temperature must be 13° C or less with a maximum daily average no greater than 9°C. Temperature exceedances will not be addressed until proposed new temperature standards have been finalized.

3.b. Summary and Analysis of Existing Water Quality Data

Streambank Erosion Rates. Isolated, short sections along the channels are eroding at moderate rates. This is generally associated with livestock crossings, urban development, and hydrologic impacts. Streambank erosion rates on the remaining stream section are nearly "background" or geologic rather than accelerated (Stevenson 1996).

According to Stevenson (1996), the riparian and pasture condition inventories estimated 80% of the streambanks in good condition, with 10% in fair and 10% in poor condition. The good condition areas were considered "background" erosion rates. The areas in good condition are estimated to contribute .0098 tons/year/linear foot of channel while the areas in poor condition contribute .0315 tons/year/linear foot of channel.

Flow. An account of monthly average discharge and flow volume for two stream sampling sites were recorded for Upper Cocolalla Creek from October 1990 through September 1991. This hydrograph showed three short duration high flow peaks of greater than 100 cfs between late winter and spring. The highest flow months of February through April had monthly volumes around 3,400 ac-ft. Over the study year the lower stream site recorded 5,000 acre-feet more than upper stream site. This is a 40% increase over five stream miles and drains about 25% of the total Cocolalla Creek watershed. An account of monthly average discharge and flow volume for sampling sites CC1 and CC2 are summarized in Table 3.

Table 3. Average Flow Velocity and Volume - Upper Cocolalla Creek
Oct. 1990-Sept. 1991

Station	Mean Discharge (cfs)	Max. Discharge (cfs)	Total Flow Volume (acre-feet)	% of total lake inflow
Cocolalla Creek CC1 (upper)	17.2	110	12,418	----
Cocolalla Creek CC2 (lower)	24.0	159	17,389	52%

Flow volumes in the watershed are significantly related to precipitation. The period of October 1991 through May 1992 was far below normal in precipitation and snowpack in north Idaho, and winter temperatures were quite mild. Peak flow on the lower Cocolalla Creek hydrograph was in late February with a maximum of only 47 cfs. From December through May the combined flow volume of Cocolalla Creek plus Fish Creek in 1992 was 65% less than 1991 (Rothrock 1995).

Phosphorus. Cocolalla Creek provides about 40% of the total Cocolalla Lake inflow and is the single highest phosphorus importer to the lake (25% of the total phosphorus budget). Phosphorus loading increases substantially over the last seven miles of the creek with an apparent influence from grazing lands (Rothrock 1995).

Sampling done on Cocolalla Creek from October 1990 to September 1991 measured nutrients at two sites (CC1 - upper, CC2 - lower). Three samples at the lower site in February and early March produced above average TP values (0.031mg/L). These samples were on the upward slopes of hydrograph peaks. Sampling in rainy periods in October and November also produced above average phosphorus values. This likely reflects initial wet season nutrient runoff from summer accumulation of animal wastes on the grazing lands. Dissolved ortho-phosphate concentrations ranged between 0.001 - 0.004 mg/L (Rothrock 1995).

Suspended Sediment. Similar to the trend in phosphorus values, Cocolalla Creek did not exhibit a high February total suspended sediment peak. Mean suspended sediment in the high runoff period of mid-February to May at the lower site (CC2) did average about 3mg/L more than the low runoff period of fall and early winter. During high flow, mean suspended sediment was nearly the same at both CC2 and upstream at CC1, indicating either low stream bank erosion in the flatland stretch between the stations, or rapid sediment settling (Rothrock 1995).

Nitrogen. Data analysis of total nitrogen concentrations are made with caution because of the poor quality assurance results for ammonia and TKN.

Cocolalla Creek site CC1 had the higher nitrate mean (0.208 mg/L), surprisingly slightly greater than the lower station CC2. Nitrate values were above the yearly mean in fall months, and then declined to around 0.20 mg/L and below in winter and spring. This was unlike total phosphorus which increased above the mean in February and March. Mean nitrate at CC1 and CC2 were nearly the same up to the June samples, while TP concentrations were consistently higher at the downstream site. Nitrate increased each month at the low flow period June through September, and concentrations were less at the downstream site. This may have been due to nitrate assimilation by attached algal growth and macrophytes which were abundant (particularly periphyton) in the lower stretch of the creek (Rothrock 1995).

Bacteria. Rothrock reported that on Cocolalla Creek at CC2 there was a high fecal strep count in the November 1991 sample, coinciding with high phosphorus and nitrogen values. In winter months there was only one sample with above average fecal strep and fecal coliform. During the low flow period of June through September coliform counts increased, reaching a high of 200 colonies/100 ml. In Cocolalla Valley there is livestock grazing in summer months, and observed direct animal contact in the stream. Over the year station CC2 was slightly higher in mean bacteria counts than CC1 (1995).

Physical Characteristics. At station CC2, electrical conductivity (EC) values in the summer and fall months at low flow ran between 100 - 150 *u*mhos, and then dropped to 45 - 70 *u*mho in winter and spring. In late summer on Cocolalla Creek the pH reached 8.0 units.

Summer downstream temperature measurements on upper Cocolalla Creek were 11 - 12°C, while downstream at CC2 the water had warmed to 13 - 14°C in the 1991 monitoring (Rothrock 1995). Beneficial Use Reconnaissance Project data collected August 1, 1995 in the lower portion of Cocolalla Creek reported an in-stream temperature of 21°C.

Dissolved oxygen maintained sufficient levels for salmonid fisheries in summer months. The lowest summer oxygen level recorded at CC1 and CC2 was in early August at 7.6 mg/L.

Antidegradation Reconnaissance - Habitat, Macroinvertebrates, Fisheries

A reconnaissance level monitoring under the Antidegradation Program was undertaken in the summer of 1991 by DEQ (DEQ, 1991). Both upper and lower stream segments were surveyed on Cocolalla Creek. The lower reach showed beneficial use impairment with unstable banks, pools and riffles sedimented, and substrate dominated by sand and silt. Macroinvertebrates were dominated by black fly larva. Mayflies and stoneflies were rare and there were no caddisflies found in lower Cocolalla Creek. Upper Cocolalla Creek above the first agricultural valley had an abundant and diverse macroinvertebrate community. The stream had good shade cover and an abundance of pools formed by large organic debris.

Beneficial Use Reconnaissance Project (BURP) data collected in 1994 showed an unimpaired macroinvertebrate community in the lower portion of Cocolalla Creek, with a combined Macroinvertebrate Index (MBI) value of 4.26 collected 500 meters upstream from the confluence with Cocolalla Lake. In the upper reaches, BURP data recorded an MBI of 3.89, which also provides for full support status. 1995 BURP data in the lower reaches between these two sites showed an impaired community, with an MBI reported at 2.90.

USDA Preliminary Investigation.
Aquatic Habitat: Aquatic habitat was inventoried in Cocolalla Creek using an evaluation method patterned after the USFS "COWFISH" Model. Parameters inventoried include undercut banks, stream shading, vegetative overhang, streambank stability, cobble embeddedness, and width/depth ratio.

The evaluation of the lower reaches of the creek indicate that the fish habitat is in poor condition. The habitat is currently at approximately 40 percent of its potential. Parameters limiting fish populations include: high percent cobble embeddedness, low percent of overhanging vegetation, low percent of undercut banks, and low percent of stream shading.

Water Quality problems associated with this section of the creek were siltation and reduced diversity and prevalence of tolerant bottom dwelling aquatic organisms. The section was rated as poor to fair based upon evaluation for indicators of sediment, animal wastes, and nutrients. (USDA-SCS 1992).

Fish. In the 1950's, Cocolalla Lake was managed as a cutthroat trout fishery. In 1957 the Cocolalla drainage system received a rotenone treatment to eliminate spiny ray and trash fish, and then was planted with cutthroat. Since then, competition from warm water fish, decreasing water quality, and degradation of stream segments (including Cocolalla Creek) leading to spawning areas has made the lake marginal for natural trout production (Rothrock 1995).

A July 1987 survey of upper Cocolalla Creek by the Idaho Department of Fish and Game (Horner, 1988) was also summarized in the antidegradation report. Game fish species found were brown trout, rainbow trout, brook trout. Brook trout were the most numerous of the three salmonid species. The best salmonid habitat type was found in the upper reaches of Cocolalla Creek.

Snorkeling was conducted by DEQ personnel on July 29, 1993 at two sites in Cocolalla Creek. At the upper site, 17 brook trout and 2 sculpins were counted. Brook trout density was estimated at $17.4/100m^2$. Most fish observed in the lower reach were cutthroat trout. Brook trout were also observed (Corsi 1995).

Electrofishing data collected by the IDEQ in 1997 approximately 500 meters upstream from the confluence with Cocolalla Lake showed four species of salmonids (Brook, Brown, Cutthroat, and Rainbow) and four other fish species (minnow, Bullhead, Sculpin, and Dace). The data was inconclusive for support status of salmonid spawning.

Historical Sampling. Nutrient loading calculations were made from stream monitoring in 1975. Cocolalla creek was identified as contributing the greatest amount of nutrients to Cocolalla lake. Reference was also made to stream impairment in Cocolalla Creek associated with heavy grazing and haying.

3.c. Data Gaps for Determination of Support Status

Bacteria sampling of Upper Cocolalla is needed to determine if there is an impairment of primary contact recreation use. Additional temperature recordings are also required.

4. Problem Assessment Conclusions

Upper Cocolalla Creek was determined to be a water quality limited segment by DEQ's waterbody assessment process. It was determined that the primary factors of concern are sediment and thermal modification. These pollutants are considered to be impairing cold water biota and salmonid spawning based upon beneficial use reconnaissance data and other data. The impairment determination was based upon a 1995 low macroinvertebrate index score of 2.90 and information from other macroinvertebrate community evaluations. Sediment data on Cocolalla Creek reflect a high percentage of cobble embeddedness, which impairs both the cold water biota and salmonid spawning beneficial uses. Temperature data indicated that in-stream temperatures may be to high to fully support salmonid spawning.

While the beneficial use reconnaissance data does not suggest primary contact recreation is an appropriate use for this stream, historical flow data does. High bacteria counts in November of 1991 and other dates indicate that the possibility of this occurring again should warrant further investigation into support status of this beneficial use.

5. TMDL - Loading Analysis and Allocation

Problem Statement: Impairment of cold water biota and salmonid spawning beneficial uses due to excess sediment.

5.a. Numeric Targets
(See attached spreadsheet)
5.b. Source Analysis
(see attached spreadsheet)
5.c. Linkage Analysis
(See below)
5.d. Allocations
(see attached spreadsheet.)

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. Explanations of some of the values have not been detailed as yet on the spreadsheets pending their revision. Background loading from land uses and stream bank erosion coefficients are being revised to be specific to the Pend Oreille watershed. Once the revised values are received the "Sediment Yield" portion of the spreadsheet will more fully explain the source of the values. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition.

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Upper Cocolalla Creek: Land Use Information

Land Use		
Sub-watershed	Upper Cocolalla Ck	*Explanation/Comments*
Pasture (ac)	**2869**	
Forest Land (ac)	**14407**	
Unstocked Forest (ac)	**1109**	Includes once burned areas
Highway (ac)	**80**	State or County Paved Highways
Double Fires (ac)	**448**	Areas which have been burned over twice

Road Data		
Sub-Watershed	Upper Cocolalla Ck	
1. Forest roads (total miles)	**92.1**	
CWE road score (av)	17.2	
*Sediment export coefficient (tons/mi/yr)	**3.8**	
#Total Forest Rd Failures (cubic yds delivered)	**0**	*Cumulative Watershed Effects data*
2. Unpaved Co.& priv. roads (total miles)	**126**	
Paved Co.&priv. roads (total miles)	7.4	
**Sediment export coefficient (tons/mi/yr)	**25.5**	
Total C&P Rd Failures (cubic yds delivered)	0	*Based on weighted average of forest road failures.*
##Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**6.3**	*166.3 tons/yr/mi*
good condition	**7.8**	*51.7 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1996. Recommends 7 tons/ac/yr for unsurfaced roads X 3.64 ac/mi road = 25.5 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an ever-estimate of sediment delivered to the stream since failures can continue to deliver to the stream for a number of years after they occur, however, in a much reduced quantity. One much also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a specialist in this field, makes these estimates a close approximation of actual conditions. To further refine the mass failure estimates one could assign a once in ten year occurrence to the largest failures which probably occurred during the floods of 1996.
##Source of data from 1996 aerial photos.

Upper Cocolalla Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments
Watershed:	Upper Cocolalla Ck	Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr; Yield Coeff. (tons/ac/yr)
Pasture (tons/yr)	157.8	0.055
Forest Land (tons/yr)	547.5	0.038
Unstocked Forest (tons/yr)	18.8	0.017 (this acreage is a subset of Forest Land acreage)
Highway (tons/yr)	2.7	0.034
Double Fires (tons/yr)	7.6	0.017 (this acreage is a subset of Forest Land acreage)
Total Yield (tons/yr)	**734.4**	(Values taken from WATSED and RUSLE models see below explanation [#])

*Sediment Yield From Roads		
Watershed:	Upper Cocolalla Ck	
Forest Roads (tons/yr)	**350.0**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**0**	***Assumes soil density of 1.5 g/cc and a conversion factor of 2.189.*
County and Private Roads (tons/yr)	**3,210.50**	
Co. and Private Road Failure (tons/yr)	0	*Based on weighted average of forest road failures.*

*Percent fines and percent cobble of the Vay/Pend Oreile/Bonner/Hoodoo series B&C soil horizons is 90% fines, 10% cobble (Bonner Co. Soil Survey).
**"Guide For Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.055) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support praactices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landype and years since harvest.
Highways (0.034) obtained from WATSED witht he following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Upper Cocolalla Creek Watershed: Sediment Exported To Stream

	Upper Cocolalla Ck
Land use export (tons/yr)	734.4
Road export (tons/yr)	3560.5
Road failure (tons/yr)	0
Bank export (tons/yr)	
poor condition	1047.7
good condition	403.3
Total export (tons/yr)	**5745.9**
*Natural Background Mass Failure (tons/yr)	0

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure contributed by roads.

Upper Cocolalla Creek Watershed

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	17,276			
Presently Forested	14,407			
Estimated Historically Forested	16,276	0.038		618.5
Estimated Historically Pasture	1,000	0.55		55
Natural Mass Failure (tons/yr)				0
Background Load = Target Load			**Target Load**	**673.5**
			Existing Load	**5745.9**
			Load Reduction	**5072.4**

U.

FISH CREEK
(tributary to upper Cocolalla Creek)

Summary:
Fish Creek was placed on the 1996 303(d) list of water quality impaired streams for sediment and thermal modification. The 1996 Waterbody Assessment Guidance methodology using the 1994 Beneficial Use Reconnaissance Project data concluded that Fish Creek was fully supportive of all beneficial uses. Fish Creek was recommended for delisted based upon this data, however, remained on the 1998 303(d) list as impaired due to sediment, pathogen and thermal pollution. The 1996 methodology was later discounted, and in April 2000, removed from the water quality standards. We currently do not have an approved method of determining support status. Since the standards change, new data became available and it was determined that Fish Creek was impaired due to sediment and temperature. The target sediment load is 278 tons/yr, a 65 percent reduction over existing conditions. Temperature will not be addressed at this time pending an anticipated change to this standard. Limited data indicates that there is no impairment due to pathogens, however additional data should be collected to confirm this conclusion.

1. Physical and Biological Characteristics

Fish Creek drains into Cocolalla Creek ½ mile south of Cocolalla Lake at the junction of U.S. Highway 95 and the Fish Creek Road, 4 ½ miles north of Careywood, Bonner County, Idaho. The Fish Creek drainage contains 6,430 acres used primarily for forestry with small areas of rural residential. Land ownership is distributed among the Bureau of Land Management, Panhandle National Forest, the Idaho Department Lands, industrial timber companies, and small private owners.

The Fish Creek watershed is underlain in the western headwaters by Cretaceous plutons of granodiorite and diorite of the Kaniksu Batholith. Precambrian metasediments of various composition occur along the southeast side of the watershed. The lower elevations were affected by the Lake Missoula floods and exhibit scouring and mixed deposits.

Fish Creek is a third order tributary to Cocolalla Creek. The drainage is oriented in a easterly direction. It drains the west side of the Cocolalla watershed and is the second largest subwatershed within this drainage. Elevation ranges from 2,118 feet at the confluence to near 4,558 feet on Long Mountain.

Cool, dry summers and cold, wet winters characterize the area. Average annual precipitation is relatively low for north Idaho ranging from 25 inches at the lower elevations to 30 inches at the highest elevations. The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snow melt and major rain-on-snow events.

Vegetation varies with elevation, aspect and drainage. Lower elevations generally support Cedar-Hemlock habitat types. Uplands support a mixed conifer forest of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine, with the more xeric species dominating south to west facing aspects. Higher elevations include subalpine fir, spruce, alder, alpine meadows and brush fields. Very wet areas especially along riparian zones support alder, willow, and other water loving species.

Fish Creek consists of two main forks, a dendritic patterned south fork begins around elevation 4000 feet. For 2.7 stream miles the stream drops at an average 11% gradient to elevation 2486 feet where it meets with a north fork. The north fork is similar to the south fork in character and length. The soils in this upper drainage are highly erodible because of their granitic origin. There has been considerable silviculture activity over the years, particularly in the north fork sub-watershed. In most years the forks of Fish Creek are perennial, dominated by snow melt runoff (Rothrock 1995).

From the confluence of the south and north forks, Fish Creek Road parallels Fish Creek for 1.4 stream miles at a 3% gradient. The stream substrate is cobbles, gravel, and sand. Large amounts sediment enters the stream during storm events from this road surface and embankments. There also has been considerable residential development with private timber clearing and construction of access roads and driveways.

Fish Creek downstream from Cocolalla Loop Road has a gentle gradient where it passes through pasture land and approaches the southern end of the lake. The channel has been straightened in this stretch. At a point beginning 0.4 miles downstream from Cocolalla Loop Road, Fish Creek has become severely degraded. Upstream sediment runoff and bedload movement have settled and completely filled the stream channel. There also has been stream bank damage by cattle and horses. The result is a sediment delta which dams the creek and forces water to flow out over pasture land. A dendritic pattern of small channels flows north through the pasture and then converge into a main grassy waterway. This waterway enters Cocolalla Creek just upstream from the lake. The surrounding flatland east of lower Fish Creek is a combination of grazing land and wetland. Soil drainage is poor and in the spring there is considerable pooling of water.

2. Pollutant Source Inventory

Point Source Discharges

There are no known point sources of pollution discharging to Fish Creek.

Nonpoint Source Discharges

Fish Creek contributes 20% of the phosphorus load and 24% of the sediment entering Cocolalla Lake from tributaries. The upper Fish Creek watershed has had more logging activity over recent years than other areas throughout the Cocolalla Lake watershed. Sampling done in 1991 and 1992 show high peaks of total suspended solids and total phosphorus during storm events (FC1 sampling station). Samples comparing amounts of phosphorus from the headwaters versus downstream just above the pasture lands show an increase of 80% (Rothrock 1995).

2.a. Summary of Past and Present Pollution Control Efforts

Cocolalla Lake and its tributaries (including Fish Creek) have received considerable private and public attention over the last 20 years with efforts concentrated on reversing the eutrophication of the lake.

Cocolalla Lake is listed as a Special Resource Water under the Idaho Water Quality Standards and Wastewater Treatment Requirements. Cocolalla Lake and Cocolalla Creek were designated Stream Segments of Concern under the Idaho Antidegradation Program in 1990. After the Stream Segment of Concern designations, an Antidegradation Local Working Committee was formed which developed water quality objectives and site specific best management practices (BMPs) for forest land activities within the watershed. A Fish Creek Stream Assessment, sponsored by the Cocolalla Lake Association and the Idaho Division of Environmental Quality was conducted in 1995.

In light of the water quality problems in Cocolalla Lake, the Bonner Soil Conservation District made Cocolalla Lake a priority area and sought funding to develop corrective and preventative actions. The District received funding to develop a watershed management plan in late 1994. The resource inventory began in 1994 and continued through early summer of 1995. The funds to develop a management plan were granted to the District through the Idaho State Agricultural Water Quality Program (SAWQP). The SAWQP is administered by the IDEQ and the Idaho Soil Conservation Commission. The resource inventory includes an identification of the water quality problems, defining critical areas and development of a watershed management plan. The planning efforts were directed by a focus group. The focus group, comprised of ranchers, Cocolalla Lake Association members, and agency representatives met frequently to discuss previous and current findings related to the watershed.

A Phase 1 Diagnostic and Feasibility Analysis of Cocolalla Lake was performed by Glen Rothrock of the IDEQ in 1995 based upon water quality data collected from 1990 - 1992. In 1996, A Cocolalla Lake Watershed Management Plan was developed by Resource Planning Unlimited and the Bonner County Soil Conservation District.

3. Water Quality Concerns and Status

Fish Creek was listed for sediment, pathogens and thermal pollution in the 1994 305(b) Report. It was placed on the 1996 303(d) list for sediment and thermal pollution. In 1998 it remained on the 303(d) list with the addition of pathogen pollution. The presence of pathogens was checked in 1999 and determined not to be impairing the recreation beneficial use existing for this stream.

Fish Creek is also under scrutiny as a major tributary and consequently a pollutant supply to Cocolalla Lake. Particular pollutants of concern include nutrients, sediment, and thermal modification (high temperatures), all of which have been found to be impairing beneficial uses of Cocolalla Lake.

3.a. Applicable Water Quality Standards

Existing beneficial uses for Fish Creek include agricultural water supply, cold water biota and secondary contact recreation. The support status for salmonid spawning is undetermined. Fish Creek was listed as impaired due to sediment, pathogens and thermal modification. Idaho's water quality standard for sediment is narrative, and states that, "Sediment shall not exceed quantities...which impair designated beneficial uses." Standards protecting secondary contact recreation require that a single E.coli sample contain no more than 576 organisms/100 ml or no more than 126 organisms/100 ml based on a minimum of five samples taken every three to five days over a thirty day period. The temperature standard for salmonid spawning may also apply.

3.b. Summary and Analysis of Existing Water Quality Data

Water quality data was collected in 1991 and 1992 by the IDEQ as part of the Phase 1 Diagnostic and Feasibility Analysis for the Cocolalla Lake Watershed. This study was conducted to identify sources of pollution within the watershed. As part of this watershed, Fish Creek was evaluated for several water quality parameters at two stations along its length. These stations are identified in the literature as FC1 and FC2.

1991 Stream Sampling Data
The lower Fish Creek Station (FC2) was found to have a mean annual discharge of 8.5 cubic feet per second (cfs). There were two short duration high flows, one in February at 118 cfs and one in April reaching 150 cfs. The increase of water volume at FC2 over upper Fish Creek FC1 was 15% in 1991. Fish Creek was found to account for 20% of total Cocolalla Lake inflow (Rothrock 1995).

At lower Fish Creek a high peak phosphorus concentration (0.092 mg/L TP) was recorded on February 20th. This sample was associated with a heavy rain on snow event. This also coincided with an extreme peak value of TSS (65 mg/l). Other than single peak values, concentrations of phosphorus were within a range of 0.006-0.020 mg/L TP at both sites. Stream samples taken below the pasture area were three times higher than upstream values for both total phosphorus and dissolved orthophosphorus (Rothrock 1995).

Lower Fish Creek had a high TSS peak on the February 20th sample of 65 mg/L, while the peak at FC1 a day earlier was only 18 mg/L. Other than these extremes all of the TSS values but one were 4 mg/L or less at both stations (Rothrock 1995).

Bacteria counts taken at both of the Fish Creek stations were mostly low, except for a 190 fecal coliform organisms/100 ml at FC2 in early March. The two samples in July and August below the pasture flooding on lower Fish Creek had coliform counts averaging 500 fecal coliform/100 ml (Rothrock 1995). This was assumed to be related to a herd of horses which roamed freely through the pasture channels.

The highest temperature recorded in 1991 at FC2 was 13°C. Below the pasture flooding, Fish Creek temperature was 19°C. Continuous temperature measurements were collected on Fish Creek in 1997. Peak temperatures were recorded in early August at an average of 15°C for almost one week.

The low dissolved oxygen reading taken in 1991 at FC1 and FC2 was in August at 9.7 mg/L. Below the pasture flooding, there was a reading of 6.4 mg/L. The pH ranged between 6.5 to 7.5 units (Rothrock 1995).

1992 Fish Creek Sampling Data
Sampling results in 1992 began with a January rain-on-snow event. Sampling at FC2 showed that phosphorus levels climbed from 0.025 mg/l TP to 0.087 mg/l over a period of four days. Total suspended solids also climbed from 6 mg/l to 59 mg/l in the same time period. Upstream

at FC1 total suspended sediment samples from the north fork were 45 mg/l and from the south fork 21 mg/l. Sampling in February showed levels for both parameters back to their previous baseline values.

Samples were also taken downstream of station FC2 and the results compared to FC2. Total phosphorus and suspended sediment were both slightly greater than upstream of the pastureland (TSS by 2 mg/l and TP by 0.010 mg/l). This indicates that the braided section of stream bottom is a source of sediments and nutrients entering the lake. Peak discharge occurred in February at 30 cubic feet per second.

Antidegradation Reconnaissance - Habitat, Macroinvertebrates, Fisheries. A reconnaissance level monitoring under the Antidegradation Program was undertaken in the summer of 1991 by IDEQ (IDHW-DEQ, 1991). Stream segments that were surveyed included lower Fish Creek. The reach sampled showed beneficial use impairment with unstable banks, pools and riffles sedimented, and substrate dominated sand and silt. Macroinvertebrates were dominated by black fly larvae, while mayflies and stoneflies were rare.

BURP Data. Beneficial Use Reconnaissance data was collected 1994. Results of this investigation were a macrobiotic index of 4.69, a habitat index of 83, and a substrate consisting of 37.4% fines (particles <6mm diameter). This data was collected near the confluence of Fish and Cocolalla Creeks. One bacteria sample was taken in late July 1999 showing E. coli levels at 14 organisms per 100 ml, well below the 576 organisms/100 ml standard for secondary contact recreation.

Cumulative Watershed Effects Data

The Idaho Department of Lands conducted a Cumulative Watershed Effects analysis in this watershed in 1998. They found an adverse condition existed due to temperature by examining canopy cover. Channel stability rating was high due to bank sloughing, lack of vegetative bank protection and bank rock content, bank cutting, lack of large organic debris, and channel bottom movement. Surface erosion also received a high rating due to geological conditions (landtype associations #14, 50 and 51). The conclusion of the analysis was that site-specific best management practices must be developed for this watershed.

3.c. Data Gaps For Determination of Support Status

There has been no fish data recorded by the IDEQ for Fish Creek that could be used to determine support status of the salmonid spawning beneficial use in this watershed. Additional monitoring of bacteria in this stream would be valuable to more confidently determine the status of recreational uses.

4. Problem Assessment Conclusions

Stream channel instability and movement and bank and road erosion are causing excessive stream sedimentation. This sedimentation impairs cold water biota and contributes excessive amounts of nutrients to a lake impaired due to nutrients. Loss of canopy cover in the watershed is causing thermal pollution. Pending the outcome of the change to the state's temperature standard, this pollutant will be addressed at a later date. A TMDL for sediment is indicated by the above information and in support of the Cocolalla Lake TMDL.

5. TMDL

See attached spreadsheet.

5.a. Numeric Targets

See attached spreadsheet.

5.b. Source Analysis

See attached spreadsheet.

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five-year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three-part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may

show impairment of fisheries or macroinvertebrate life and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients, which estimate sedimentation rates over time based upon land use, have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.d. Allocations

Load allocations are based upon land use as shown in the attached spreadsheet. Roads and stream banks are often the source of excess sediment.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition. Natural background is used as the target load, which is the most conservative assumption available.

References

Gilmore, Shelly. 1996. Cocolalla Lake Watershed Management Plan. Bonner County Soil Conservation District. Sandpoint, Idaho.

Idaho Department of Health and Welfare, Division of Environmental Quality. 1991. Panhandle Basin Status Report. Boise, Idaho. 72pp.

Rothrock, G. 1995. Phase I Diagnostic and Feasibility Analysis Cocolalla Lake. Bonner County, Idaho, 1990-1992. Idaho Department of Health and Welfare, Division of Environmental Quality. Coeur d'Alene, Idaho.

Fish Creek: Land Use Information

Land Use		***Explanation/Comments***
Sub-watershed	Fish Creek	
Pasture (ac)	**429**	
Forest Land (ac)	**6,001**	
Unstocked Forest (ac)	**851**	Includes once burned areas
Highway (ac)	0	State or County Paved Highways
Double Fires (ac)	0	Areas which have been burned over twice

Road Data		
Sub-Watershed	Fish Creek	
1. Forest roads (total miles)	**39**	
CWE road score (av)	21	
*Sediment export coefficient (tons/mi/yr)	**5.1**	
#Total Forest Rd Failures (cubic yds delivered)	**0**	*Cumulative Watershed Effects Data*
##2. Unpaved Co.& priv. roads (total miles)	3.9	
Paved Co.&priv. roads (total miles)	0	
Total C&P Rd Failures (cubic yds delivered)	0	*Based on weighted average of forest road failures.*
###Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**1.5**	*95 tons/yr/mi*
good condition	**3.0**	*47.5 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1999. Good Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1ton/2000lbs = 47.5 tons/yr/mi
Poor Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1ton/2000lbs = 95 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##County and private road erosion derived from using the same method as forest roads. Since the method used for foest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.
###Source of data from DEQ 2000 bank inventory survey.

Fish Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments
		Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr
Watershed:	Fish Creek	*Yield Coeff. (tons/ac/yr)*
Pasture (tons/yr)	60.1	*0.14*
Forest Land (tons/yr)	228.0	*0.038*
Unstocked Forest (tons/yr)	14.5	*0.017 (this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0	*0.034*
Double Fires (tons/yr)	0	*0.017 (this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**302.6**	*(Values taken from WATSED and RUSLE models see below explanation [#])*

*Sediment Yield From Roads		
Watershed:	Fish Creek	
Forest Roads (tons/yr)	**198.9**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**0**	***Assumes soil density of 1.7 g/cc and a conversion factor of 1.431.*
County and Private Roads (tons/yr)	**19.9**	
Co. and Private Road Failure (tons/yr)	0	

*Percent fines and percent cobble of the Pend Oreille - Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.14) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.034) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Fish Creek: Sediment Exported To Stream

	Fish Creek
Land use export (tons/yr)	302.6
Road export (tons/yr)	218.8
Road failure (tons/yr)	0.0
Bank export (tons/yr)	
poor condition	142.5
good condition	142.5
Total export (tons/yr)	**806.4**
*Natural Background Mass Failure (tons/yr)	0

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure associated with roads.

Fish Creek

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	6,430			
Presently Forested	6,001			
Estimated Historically Forested	6,100	0.038		231.8
Estimated Historically Pasture	330	0.14		46.2
Natural Mass Failure (tons/yr)	0			
Background Load = Target Load			**Target Load**	**278**
			Existing Load	**806.4**
			Load Reduction	**528.4**

V. **LOWER COCOLALLA CREEK**

(tributary to Pend Oreille River)

Waterbody Type:	stream
Ecoregion:	Northern Rockies
Designated Uses:	domestic and agricultural water supply, cold water biota, primary and secondary contact recreation and Special Resource Water.
Size of Waterbody:	7.3 miles stream; 376 acres water
Size of Watershed:	16,234 acres

Summary:
The Lower Cocolalla Creek was listed in 1996 as water quality impaired due to sediment and thermal modification. This problem assessment concluded that the stream is impaired due to excess sediment. Sediment load target was set at 1,202.5 tons/yr from the existing load of 4,685.7 tons/yr. Temperature will not be addressed at this time pending an anticipated change to this standard.

1. Physical and Biological Characteristics

Lower Cocolalla Creek is the singular outlet flowing out of Cocolalla Lake at the northwest corner. The stream receives some drainage from the northwest tip of the watershed, which does not enter the lake. Cocolalla Creek enters Round Lake about 3 stream miles from Cocolalla Lake. The outlet of Round Lake, still called Cocolalla Creek, flows about 3.5 miles east where it enters the Pend Oreille River.

The watershed, which drains into Cocolalla Lake and ultimately into the outlet stream, has been outlined and measured in different sources to be between 55 to 64 square miles. The watershed is heavily forested with foothill and mountainous terrain up to 4500 ft elevation and slopes ranging from 15-50%. There has been considerable logging activity and most timbered areas are second growth. There are also flatland valleys with commercial and hobby grazing and cropping of hay.

Land cover types in the Lower Cocolalla Creek watershed from the outlet to Round Lake are primarily forest, with open forest types dominating 58% of the watershed and dense forest accounting for 36%. The total acreage of this subwatershed is 1,032 acres, which makes up only 2.8% of the total Cocolalla Lake watershed. Roads make up 2.7% of the outlet watershed and agriculture/grazing account for 3% of the total acreage from the outlet to Round Lake (Rothrock 1995).

Geology. The bedrock consists mainly of the Selkirk Crest quartz monzonite (Tertiary) and metamorphic rocks (Precambrian). The valleys are filled with sediments from current erosion of the mountains, lake deposits, glacial till, and outwash. Cocolalla Lake is bordered by batholith granites near the Black Pine Mountain.

Soils. There are three general soil map units that are common throughout the watershed. In the foothills and mountains the general soil unit is Pend Oreille-Rock outcrop-Treble on 5-65% slopes with very deep and well-detailed soil units. In general these soils are classified as moderate to very deep and well drained. They were formed in glacial till derived from granite, gneiss, and schist and have a mantle of volcanic ash and loess. Permeability is rated moderate, runoff rapid to very rapid, and the hazard of water erosion high to very high. This unit is considered poorly suited to roads, dwellings, and recreational development because of slope, a hazard of erosion, and the areas of Rock outcrop.

Also common is the Bonner-Kootenai soil unit. This is a very deep, well-drained soil found in the flatlands and terraces of 0-4% slope. It formed in glacial outwash derived from granite, gneiss, and schist and has a mantle of volcanic ash and loess. Runoff is slow and the hazard of water erosion slight. This unit is suited to hay, pasture and livestock grazing.

The third unit is intermixed in the flatlands with the Bonner soil and is known as the Hoodoo-Pywell-Wrencoe unit. The most common detailed unit is Hoodoo silt loam, a very deep, poorly drained soil on 0-1% slopes. It formed in alluvium derived mainly from volcanic ash. Runoff is very slow and the soil is subject to very long periods of flooding late in winter and spring. The soil is well suited for hay, pasture, and livestock grazing. A second detailed unit is the Pywell-Hoodoo complex with the Pywell soil formed in organic material derived predominantly from herbaceous plants. The soil is poorly drained and subject to long periods of standing water.

Groundwater Hydrology. Cocolalla Lake and portions of the south, east, and north watershed overlie the Southside Aquifer, which covers approximately 46 sq mi (Rothrock 1995). In an analysis of static water levels from 127 well logs within the aquifer, depth to ground water varied from zero to 250 ft with an average depth of 51ft. Ground water movement of the aquifer was found to be north from the town of Granite through the Cocolalla Valley toward the south end of Cocolalla Lake, and continuing north from the lake toward the Pend Oreille River. The water level profile around Cocolalla Lake was found to have a relatively flat gradient.

Land ownership.

Table 1. Land Ownership - Lower Cocolalla Creek

Ownership	Acres
Private	12,873
Federal, State	3379
Water	376
Total	**16,628**

Land Use.

Table 2. Land Use - Lower Cocolalla Creek

Land Use	Acres
Forest Land	5,547
Pasture & Hayland	10,705
Water	376
Total	**16,628**

Population and Economic Conditions. There is and estimated year-around population of 1,400 residents in the watershed. More than 450,000 people live within a two hour drive of Cocolalla Lake and the area within this driving range is experiencing dramatic population growth.

The Cocolalla Lake Watershed is rural, consisting of numerous 5 to 20 acre residential properties, many with hobby farms. There is no industrial activity in the watershed.

2. Pollutant Source Inventory

Point Source Discharges

There are no known point source pollution discharges to Lower Cocolalla Creek or its tributaries.

Nonpoint Source Discharges

Many non-point sources of pollution were identified and noted in the Final Report of the Cocolalla Creek Local Working Committee as prepared by Clark (1991) and in the Cocolalla Lake Watershed Management Plan prepared by Gilmore (1996). Although not specific to Lower Cocolalla Creek, these sources for the entire Cocolalla Lake watershed were:

Silviculture. There are approximately 14,130 acres of forestland within the Cocolalla Creek watershed. Much of this watershed is covered with densely forested areas, consisting of conifers including Douglas fir, grand fir, ponderosa pine, and lodgepole pine. A significant portion is covered with open forestland that has been selectively logged. Logging clear-cuts in the watershed comprise only about 1 percent of the area (Gilmore 1995). Some large blocks of forested land are managed by the U.S. Forest Service, Panhandle National Forest. Other public lands are managed by the U.S. Bureau of Land Management and the Idaho Department of Lands. Most of the land is under private ownership, with some owned by corporations.

Harvest activity occurred throughout the watershed at a brisk rate in the early 1990's. In 1994, the Idaho Department of Lands office in Sandpoint, Idaho issued 148 Certificates of Compliance-Fire Management Agreement/Notification of Forest Practice within the Cocolalla Lake watershed (Gilmore 1995).

Erosion on forest land typically occurs only during harvest activities and is associated mainly with improper road and skid trail design and construction. Forest harvest activities within the riparian area can damage the stream if tractor or skidding activities occur across the creek channel. Excessive organic debris can contribute to nutrient loadings, and skid trails through the creek may result in a direct channelization of water from the uplands to the creek during the following spring run-off events. Silvicultural activities are the only nonpoint source activities that are currently subject to regulations protecting water quality in the Cocolalla Creek watershed.

Agriculture and Grazing.
Pasture condition rated on forage quality, grazing management levels, soil condition, and erosion potential estimates approximately 80% of the pastures are in good condition, 10% in fair condition, and 10% in poor condition (Gilmore 1995).

Stream zones associated with grazing were rated according to the quality of riparian vegetation, streambank stability, and streambank erosion potential. Estimates indicate approximately 80% of the streambanks are in good condition, 10% in fair condition, and 10% in poor condition (Blew 1995).

Cocolalla creek flows from forest land through hay and pastureland. Many of the channels have been physically altered or straightened. This has impacted the hydrology of the system by changing the timing and volume of stream flows. Riparian vegetation on the straightened sections is in poor condition, with the woody component completely lacking or decadent. This increases the potential for channel erosion during spring runoff flows. This also increases the vulnerability and erosion potential of the banks when exposed to mechanical impacts from livestock.

Sediment from sheet and rill erosion on the pasture and hayland is insignificant, since most fields are flat 0-3% slopes, and have 70-95% vegetative cover.

Roads. An estimated 2% of the watershed acres are included as roadways. This does not include the miles of active and inactive forest roads. When inactive roads are factored in, road densities in the watershed exceed 5 to 6 miles per section, which can significantly affect the drainage patterns and overall hydrology of the system, including sediment transport (Gilmore 1995).

Sediment is generated by roads because drainage facilities and other sediment control measures have not been implemented in many areas. The roads generally have shallow side ditches but very few relief or cross culverts. As the runoff water drains from the road surface, it is collected in the roadside ditches and then continues to grow in terms of flow, velocity, and sediment transport. The discharge points for most of these ditches are directly to the stream.

Road surfaces are often observed to encourage rill and gully erosion. Cut slopes are often steep and have little chance for revegetation, leaving exposed soil surfaces. Fill slopes also are often too steep to become revegetated and they continue to contribute sediments to down slope areas or directly into the streams (Gilmore 1995).

Unsurfaced roads contribute sediment at a greatly accelerated rate. The roads which have the greatest impact are associated with those near the stream and improperly maintained or abandoned logging roads in the forested areas. Erosion rates have been estimated as high as 7 tons per acre/year for road surfaces and side slopes.

Residential development (urban wildland interface). The Cocolalla Creek watershed is experiencing tremendous development. An estimated 300 acres per year are subdivided with the majority of the development occurring on 20 acre parcels following forest land harvest activities. Erosion control practices, installed on the forest land under the Forest Practice Act, are destroyed and removed during construction. Opportunities for erosion increases as contractors and developers excavate for home sites and driveways during the critical erosion periods. Rural land divisions creating parcels 20 acres or larger are currently exempt from the county subdivision ordinance. There is a lack of enforcement on these larger developments and contractors and developers are generally not planning or implementing erosion control or storm water management plans. Erosion control plans or storm water management plans for residential construction are required as a condition of building permit issuance by Bonner county, but lack enforcement.

2a. Summary of Past and Present Pollution Control Efforts

In 1990, Upper and Lower Cocolalla Creeks and Cocolalla Lake were designated as Stream Segments of Concern under the Idaho Antidegradation Program. A Local Working Committee was formed which developed water quality objectives and site specific Best Management Practices for these areas (USDA-SCS 1992).

In September 1992, a grant application was made for EPA Phase II funding for Fiscal Year 1993 to install several site specific phosphorus reduction demonstration projects.

The Cocolalla Lake Clean Lakes Phase I Diagnostic report was completed in 1995. This report, coupled with the feasibility analysis completed by the Montgomery Engineering firm, were used as the basis for the comprehensive Cocolalla Lake Watershed Management Plan published by the Bonner Soil Conservation District in June 1996. This management plan sets out 5 targets, or project goals, to minimize further degradation and improve water quality in the Cocolalla Creek watershed (these are narrative, not numeric, goals). These goals address the reduction of pollution from specific nonpoint sources within the watershed. The plan includes a cost analysis of implementation and addresses sources of potential funding.

3. Water Quality Concerns and Status

Designated beneficial uses of Lower Cocolalla Creek are domestic and agricultural water supply, primary and secondary contact recreation, cold water biota, and Special Resource Water. As a Special Resource Water the stream has been found to require intensive protection to preserve outstanding characteristics or to maintain current beneficial uses. In 1994 the creek was identified as impaired for sediment and thermal pollution.

3a. Applicable Water Quality Standards

Lower Cocolalla Creek was listed for sediment and thermal pollution in the 1996 303(d) list. The Idaho Water Quality Standards narrative criteria (IDAPA16.01.02.200) states that sediment shall not exceed, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Such impairment is determined through water quality monitoring. Monitoring conducted in 1991 showed that sediment was limiting beneficial use attainment (Rothrock 1995).

The numeric criteria (IDAPA 16.01.02.250) for temperature to protect cold water biota, must be 22°C or less with a maximum daily average of no greater than 19°C. Temperature exceedances will not be addressed until proposed new temperature standards have been finalized.

3b. Summary and Analysis of Existing Water Quality Data

In August 1990, DEQ received a U.S. Environmental Protection Agency (EPA) Clean Lakes Phase I grant. A diagnostic monitoring program was conducted by DEQ from October 1990 to September 1992. A summary and analysis of that monitoring and other data collected from the Beneficial Use Reconnaissance Project are presented here.

Flow. An account of monthly average discharge and flow volume was collected from October 1991 through September 1991. This data was collected at the Lake Outlet (Lower Cocolalla Creek) and several stations on tributary streams above the lake. Data at the outlet can be summarized as: 1) mean discharge (cfs) - 58.2; 2) maximum discharge (cfs) - 377; 3) total flow volume (acre-feet) - 42,127. This station exhibited peaks in its continuous hydrograph representing three short duration high flow peaks (3 to 7 days) between late winter and spring, coinciding with similar peaks on main tributary streams (Upper Cocolalla and Fish Creeks). The highest peak was in early April with discharge approaching 380 cfs. Monthly volume was at its greatest in April, 11,000 acre-feet (Rothrock 1995).

Phosphorus. On Lower Cocolalla Creek, extreme total phosphorus peaks were absent but the February 20th sample of 0.028mg/L was the highest of the study year, coinciding with similar seasonally high concentrations from Cocolalla Lake tributary streams. The seasonal average was 0.018 mg/L total phosphorus compared to the combined flow weighted mean from the five inflow tributary stations of 0.034 mg/L. This would indicate a high phosphorus retention within the lake. The majority of dissolved orthophosphate values at this station were below the detection level of <0.002mg/L (Rothrock 1995).

Physical Characteristics. Lower Cocolalla Creek, due to its source being the lake, August temperatures reached 22° C. Hobo temperature graphs from 1997 showed similar high temperatures in July and August. In early August 1991, dissolved oxygen had dropped to 4.6 mg/L.

BURP Data. In 1995 BURP data taken at a sight approximately 100 meters downstream from Round Lake recorded a temperature of 24°C on July 31. A current meter discharge measurement recorded a flow value of 3.42 cfs. A Wolmann pebble count at the site reported 13.37% fine particles (<6mm diameter). The Macroinvertebrate Index (MBI) was recorded at 2.99, which requires verification for support status.

Fish. A July 1987 survey of Cocolalla Creek by the Idaho Department of Fish and Game found brown trout, rainbow trout, brook trout, and largemouth bass. Rainbow trout and brown trout were generally distributed upstream from Cocolalla Lake. Brook trout, the most numerous of the three salmonid species, was distributed both upstream and downstream of the lake. Largemouth bass were only sighted near the confluence with the Pend Oreille River (Rothrock 1995).

Summary. The data presented here would tend to suggest that this stream segment, while listed for the same factors as the upper segment above Cocolalla Lake, has inherently different and unique characteristics. This is due to the effects wrought by the lake. Nutrient and sediment loads are relieved somewhat by the absorption of these pollutants by the biological and physical characteristics of the lake. Tributary sediment loads are dropped into the lake, and consequent uptake of nutrients by biological organisms and the settling of sediments reduce outgoing concentrations.

Meanwhile, the effects of pollutants such as elevated temperature and low dissolved oxygen values are magnified. Water flowing out of the lake has been subject to irradiation and is much warmer than tributary inflow. Dissolved oxygen values reflect the extremely low values typically found in mesotrophic-eutrophic lakes such as Cocolalla.

3c. Data Gaps for Determination of Support Status

Although there is a significant amount of temperature data on current conditions that has been obtained from monitoring done by the IDEQ since 1991, further investigation is needed concerning the watershed's natural and background temperature regime and biological support status. Data results show that late summer temperatures regularly exceed water quality criteria of temperature for full support of cold water biota and salmonid life cycles. There is no readily available information, however, on historical or background temperature regimes within the stream outlet or its source, Cocolalla Lake. Collections in the mid-1970's show that Cocolalla Lake was already mesotrophic to eutrophic, which would indicate high summer water temperatures entering the outlet stream at that time.

More in depth analysis of BURP surface fines data and additional sampling of surface fines would be valuable to confidently establish a suitable sediment target for this stream. The current listing of this segment for sediment seems to be based upon data collected on reaches above Cocolalla Lake. The BURP data on the lower segment below Round Lake indicates a low percentage of fines. There is a good possibility that the lakes (Cocolalla and Round) are filtering a large quantity of the sediment load in the mid-section of the Cocolalla Creeks. Further investigation and sampling of various areas of the lower outlet reach would be valuable to gain a better understanding of ultimate sediment destination from upstream pollution. This would also provide information as to the extent of nonpoint source pollution in the watershed from Cocolalla Lake to the Pend Oreille River.

The 1991 results at the outlet stream indicate a need for further investigation into dissolved oxygen values at different points in the stream to determine if levels may be low consistently enough to impair cold water biota.

Even though there is considerable information available on the water quality of the watershed above the outlet stream, data on the lower watershed and Round Lake is limited. Upstream pollution treatments should improve the conditions downstream, although more in depth analysis of the lower watershed may turn up other subwatershed specific problems.

There is no information currently available on what particular values for sediment loads would be adequate to support beneficial uses in Cocolalla Creek. Because there was no Cumulative Watershed Effects analysis done on the Lower Cocolalla Creek there is inadequate data on what actions taken within the watershed will significantly reduce sediment loading.

4. Problem Assessment Conclusions

Lower Cocolalla Creek has been determined to be a water quality limited segment as determined by DEQ's waterbody assessment process. It was determined that the primary factors of concern are sediment and thermal modification. These pollutants are considered to be impairing cold water biota based upon available beneficial use reconnaissance data and other data. The impairment determination was based upon a low macroinvertebrate index score of 2.99 and temperatures exceeding 22°C. Warm water temperatures limit the survival of low temperature organisms and excess sediment limits their habitat diversity.

5. TMDL - Loading Analysis and Allocation

See attached spreadsheet.

Problem Statement:
Excess sediment is impairing the beneficial uses of cold water biota and salmonid spawning in Lower Cocolalla Creek.

5.a. Numeric Targets
(See attached spreadsheet)

5.b. Source Analysis
(see attached spreadsheet)
5.c. Linkage Analysis
(See below)
5.d. Allocations
(see attached spreadsheet)

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem.

So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients, which estimate sedimentation rates over time based upon land use, have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. Explanations of some of the values have not been detailed as yet on the spreadsheets pending their revision. Background loading from land uses and stream bank erosion coefficients are being revised to be specific to the Pend Oreille watershed. Once the revised values are received the "Sediment Yield" portion of the spreadsheet will more fully explain the source of the values. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition. Because Lower Cocolalla Creek was overlooked during data collection for this project, the Cumulative Effects data had to be estimated using other watersheds in the sub-basin with a similar geologic type.

References

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Lower Cocolalla Creek: Land Use Information

Land Use		***Explanation/Comments***
Sub-watershed	Lower Cocolalla Ck	
Pasture (ac)	**10705**	
Forest Land (ac)	**19864**	
Unstocked Forest (ac)	**3974**	Includes once burned areas
Highway (ac)	**10.9**	State or County Paved Highways
Double Fires (ac)	0	Areas which have been burned over twice

Road Data	
Sub-Watershed	Lower Cocolalla Ck
1. Forest roads (total miles)	**115**
#CWE road score (av)	20
*Sediment export coefficient (tons/mi/yr)	**4.8**
#Total Forest Rd Failures (cubic yds delivered)	**76**
2. Unpaved Co.& priv. roads (total miles)	**68**
**Sediment export coefficient (tons/mi/yr)	**25.5**
Paved Co.&priv. roads (total miles)	7.5
#Total C&P Rd Failures (cubic yds delivered)	**44.9**

##Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**3.2**	*166.3 tons/yr/mi*
good condition	**5.8**	*51.7 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1996. Recomends 7 tons/ac/yr for unsurfaced roads X 3.64 ac/mi road = 25.5 tons/yr/mi
#Presumed CWE score for roads and road failures derived from a weighted average of CWE scores by geologic type from watersheds assessed by CWE in the Pend Oreille watershed.
##Source of data from 1996 aerial photos.

Lower Cocolalla Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments	
		Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr	
Watershed:	Lower Cocolalla Ck	*Yield Coeff. (tons/ac/yr)*	
Pasture (tons/yr)	588.8	*0.055*	
Forest Land (tons/yr)	754.8	*0.038*	
Unstocked Forest (tons/yr)	67.6	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	4	*0.034*	
Double Fires (tons/yr)	0	*0.017*	*(this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**1415.2**	*(Values taken from WATSED and RUSLE models see below explanation [#])*	

*Sediment Yield From Roads		
Watershed:	Lower Cocolalla Ck	
Forest Roads (tons/yr)	**552.0**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**95.8**	***Assumes soil density of 1.5 g/cc and a conversion factor of 1.26.*
County and Private Roads (tons/yr)	**1734**	
Co. and Private Road Failure (tons/yr)	**56.6**	

*Percent fines and percent cobble of the Bonner-Kootenai and Pend Oreille-Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide For Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.055) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and watershed size
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.34) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Lower Cocolalla Creek Watershed: Sediment Exported To Stream

	Lower Cocolalla Ck Watershed
Land use export (tons/yr)	1415.2
Road export (tons/yr)	2286.0
Road failure (tons/yr)	152.4
Bank export (tons/yr)	
poor condition	532.2
good condition	299.9
Total export (tons/yr)	**4685.7**
*Natural Background Mass Failure (tons/yr)	23.9

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure contributed by roads.

Lower Cocolalla Creek Watershed

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	30,569			
Presently Forested	19,864			
Estimated Historically Forested	29,569	0.038		1123.6
Estimated Historically Pasture	1,000	0.055		55
*Natural Mass Failure (tons/yr)				23.9
Background Load = Target Load			**Target Load**	**1202.5**
			Existing Load	**4685.7**
			Load Reduction	**3483.2**

W. **HOODOO CREEK**

(tributary to Hoodoo Lake)

Waterbody Type:	stream
Ecoregion:	Northern Rockies
Designated Uses:	none; existing uses are agricultural water supply, primary and secondary contact recreation, cold water biota and salmonid spawning.
Size of Waterbody:	10.6 miles of stream
Size of Watershed:	26,900 acres

Summary: Hoodoo Creek is a third order stream draining into the Pend Oreille River above the Albeni Falls dam of north Idaho. In 1996, Hoodoo Creek was placed on the 303(d) listed due to sediment and thermal pollution. The results of DEQ's waterbody assessment process indicate that the stream is not fully supporting its designated beneficial uses. A target load for sediment was established at 1,012.7 tons/yr from the existing load of 6,150.9 tons/yr. Temperature will not be addressed at this time due to anticipated change in Idaho's temperature standard.

1. Physical and Biological Characteristics

Approximately 12 miles above Albeni Falls Dam and nine miles southwest of Sandpoint, Idaho, Hoodoo Creek flows into the Pend Oreille River. The Hoodoo Creek drainage contains 26, 900 acres (106 km^2) used primarily for forestry, agriculture, and small acreage rural residences. The watershed is underlain by alluvial and glacial deposits, granitics of the Kaniksu Batholith, and a minor outcropping of Precambrian metasedimentary rocks. The landforms in Hoodoo Creek are strongly influenced by the glacial Lake Missoula floods. Lower elevation landforms are glacial flood terraces with some fluvial erosion patterns imposed. Alluvium and glacial flood deposits dominate a wide band along the creek. The uplands in the eastern half of the watershed are eroded and rounded irregularly as a result of the Lake Missoula flood.

The Hoodoo Creek watershed drainage is oriented in a northerly direction with the creek generally flowing from the south to the north. Elevation ranges from 2080 feet (634 m) at the mouth to 2460 feet (750 m) at the headwaters. Due to the effects of the Lake Missoula flood the Hoodoo Creek watershed has a poorly developed drainage system with most of the tributaries running subsurface before entering the main channel.

Moderately cold winters and cool, dry summers characterize the area. Average annual precipitation ranges from 25 to 30 inches (63.5 to 76.2 cm). The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation. Lower elevations are dominated by Lodgepole flats and wetland meadows. The uplands are mostly cedar hemlock vegetative types. Very wet areas support alder, willow, and other water loving species. Forestry is currently being practiced on 21,457 acres (86.8 km^2) or about 82% of the watershed.

2. Pollutant Source Inventory

Point Source Discharges

There are no permitted point source discharges in the Hoodoo watershed.

Nonpoint Source Discharges

Sediment generated from roads, skid trails, and mass wasting was evaluated for delivery to streams. The Hoodoo Creek drainage contains approximately 245 miles of roads. Based on the weighted average score for the forestry portion of the watershed, the sediment delivery rating from FPA roads is low, reflecting mostly road surface and inside ditch erosion but little delivery to stream channels.

2a. Summary of Past and Present Pollution Control Efforts

Unknown.

3. Water Quality Concerns and Status

The Hoodoo Creek beneficial uses are agricultural water supply, primary (Sue Ahlers, personal communication, 1994) and secondary contact recreation, cold water biota and salmonid spawning (John Hollister, personal communication 1999).

3.a. Applicable Water Quality Standards

Hoodoo Creek was listed for sediment and thermal pollution in the 1996 303(d) list. The Idaho Water Quality Standards narrative criteria (IDAPA16.01.02.200) states that sediment shall not exceed, in the absence of specific sediment criteria, quantities which impair designated beneficial uses.

The numeric criteria (IDAPA 16.01.02.250) for temperature to protect salmonid spawning shall be 13°C or less with a maximum daily average no greater than 9°C. Temperature exceedances will not be addressed until proposed new temperature standards have been finalized.

3.b. Summary and Analysis of Existing Water Quality Data

See the Cumulative Watershed Effects Summary Report found in Appendix B. Results of the 1998 Beneficial Use Reconnaissance monitoring was an Macrobiotic Index score of 2.6, a Habitat Index score of 52 and electrofishing which found no salmonid species. The determination was that it does not fully support beneficial uses.

3.c. Data Gaps for Determination of Support Status

None.

4. Conclusion of Problem Assessment

Hoodoo Creek is impaired due to excess sediment load in the stream. A TMDL should be written to address this problem.

5. TMDL- Loading Analysis and Allocation

Problem Statement:
Excess sediment is impairing the beneficial uses of cold water biota and salmonid spawning in Hoodoo Creek.

5.a. Numeric Targets
(see attached spreadsheet)
5.b. Source Analysis
(see attached spreadsheet)
5.c. Linkage Analysis
(see below)
5.d. Allocations
(See attached spreadsheet.)

5.c. and 5.e. Monitoring Plan and Linkage Analysis

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced

will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three-part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients, which estimate sedimentation rates over time based upon land use, have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

5.f. Margin of Safety

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. Explanations of some of the values have not been detailed as yet on the spreadsheets pending their revision. Background loading from land uses and stream bank erosion coefficients are being revised to be specific to the Pend Oreille watershed. Once the revised values are received the "Sediment Yield" portion of the spreadsheet will more fully explain the source of the values. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho

Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition.

References

Ahlers, Sue 1994. Personal communication regarding concerns for her children playing in Hoodoo Creek. Resident of/or near Vay, Idaho.

Dechert, T., Raiha, D. and Saunders, V. 1999. Hoodoo Creek Cumulative Watershed Effects Assessment. September. Idaho Department of Lands. Coeur d'Alene, Idaho.

Hollister, John. 1999. Personal communication concerning brook and brown trout presence in Hoodoo Creek. Resident of/or near Vay, Idaho.

Hoodoo Creek: Land Use Information

Land Use		Explanation/Comments
Sub-watershed	Hoodoo Ck	
Pasture (ac)	**4744**	
Forest Land (ac)	**21457**	
Unstocked Forest (ac)	**3442**	Includes once burned areas
Highway (ac)	0	State or County Paved Highways
Double Fires (ac)	**699**	Areas which have been burned over twice
Road Data		
Sub-Watershed	Hoodoo Ck	
1. Forest roads (total miles)	**118**	
CWE road score (av)	19.5	
*Sediment export coefficient (tons/mi/yr)	**4.5**	
#Total Forest Rd Failures (cubic yds delivered)	0	*Cumulative Watershed Effects data*
2. Unpaved Co.& priv. roads (total miles)	**118**	
Paved Co.&priv. roads (total miles)	10	
**Sediment export coefficient (tons/mi/yr)	**25.5**	
##Total C&P Rd Failures (cubic yds delivered)	0	*Based on weighted average of forest road failures.*
##Stream bank erosion-both banks (mi)		*<u>**erosion coefficients</u>*
poor condition	**7.25**	*166.3 tons/yr/mi*
good condition	**5.0**	*51.7 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1996. Recommends 7 tons/ac/yr for unsurfaced roads X 3.64 ac/mi road = 25.5 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver to the stream for a number of years after they occur, however, in a much reduced quantity. One much also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##Source of data from 1996 aerial photos.

Hoodoo Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments
Watershed:	Hoodoo Ck	*Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr*
		Yield Coeff. (tons/ac/yr)
Pasture (tons/yr)	260.9	*0.055*
Forest Land (tons/yr)	815.4	*0.038*
Unstocked Forest (tons/yr)	58.5	*0.017*
Highway (tons/yr)	0	*0.034*
Double Fires (tons/yr)	11.9	*0.017*
Total Yield (tons/yr)	**1146.7**	*(Values taken from WATSED and RUSLE models see below explanation [#])*

*Sediment Yield From Roads		
Watershed:	Hoodoo Ck	
Forest Roads (tons/yr)	**531.0**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	0	***Assumes soil density of 1.5 g/cc and a conversion factor of 1.26.*
County and Private Roads (tons/yr)	**3009.0**	
Co. and Private Road Failure (tons/yr)	0	

*Percent fines and percent cobble of the Hoodoo series B & C soil horizons is 100% fines, 0% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.055) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and watershed size
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.34) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

Hoodoo Creek Watershed: Sediment Exported To Stream

	Hoodoo Watershed
Land use export (tons/yr)	1146.7
Road export (tons/yr)	3540.0
Road failure (tons/yr)	0
Bank export (tons/yr)	
poor condition	1205.7
good condition	258.5
Total export (tons/yr)	**6150.9**
*Natural Background Mass Failure (tons/yr)	0

*Background mass failure is the difference between the total mass failure by geologic type, and the mass failure attributable to roads.

Hoodoo Creek Watershed

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	26201			
Presently Forested	21,457			
Estimated Historically Forested	25,201	0.038		957.7
Estimated Historically Pasture	1,000	0.055		55
*Natural Mass Failure (tons/yr)				0
Background Load = Target Load			**Target Load**	**1012.7**
			Existing Load	**6150.9**
			Load Reduction	**5138.2**

X. PEND OREILLE RIVER

(Tributary to the Columbia River)

Summary: The Pend Oreille River was added to the 1996 303(d) list based upon a 1988 report from Idaho Fish and Game. Pollutants of concern are sediment, thermal modification and flow. Data from various studies point to the Albani Falls dam as the primary cause of: (1) sedimentation due to de-stabilization of river banks from water level fluctuations; (2) flow modifications due to the impoundment of water behind the dam; and (3) to an unknown degree, temperature increases due to the retention of water upstream of the dam and an increase in lake surface area. Preliminary findings of one study indicate that high temperatures in the Pend Oreille River are a natural condition. Short of removal of the Albani Falls dam, no scientific studies point to other more recent causes of sedimentation and temperature pollution. Idaho DEQ is not addressing flow as a pollutant. Due to the lack of a beneficial use assessment method for this type of river system it is difficult to determine its support status.

1. Physical and Biological Characteristics

The Pend Oreille River begins at the outlet of Pend Oreille Lake and drains 24,200 square miles (62,678 km^2). Flows range from 11,200 to 73,000 cubic feet per second. The basin's topography consists of river-bottom flatlands in a long and narrow trough between the Selkirk Mountains and the Okanagan Highlands. Agriculture on the lowland plains includes grain crops, hay, pasture, and livestock. Soils in the floodplain are poorly drained to excessively drained on alluvial fans, terraces and dunes. Upslope of the river, the terrain is rolling to very steep with rock outcrops, and very deep well drained soils (Weisel 1982).

Albani Falls Dam was built on the Pend Oreille River in 1952, about 26 miles downstream from where it leaves Pend Oreille Lake. The dam significantly influences water levels in the lake and Pend Oreille River. During the summer months, the dam holds the lake level artificially high, and the Pend Oreille River downstream of its mouth essentially becomes a shallow outlet arm of the lake. During the fall the gates are opened at Albani Falls and water level is drawn down for flood control storage (Corsi *et al.* 1998). Presence of the dam altered the river substrate, which historically was deep holes and runs with cobble and gravel. This type of bottom substrate provided spawning habitat for salmonids, and before the dam, the river provided good cutthroat and rainbow trout, bull trout and mountain whitefish sportfishing (DuPont, 1994). When the dam was constructed, riparian vegetation was cleared to prevent excessive debris from entering the water during flow changes. This increased erosion and deposition of silt in gravel bars.

Today, the river shorelines have gentle to moderate steepness consisting of mostly fine sediments (<4mm), while about 10% consist of boulder and rip rap. The river has an average depth of 23.3 feet (7.1 m), a maximum depth of 159 feet (48.5 m), and an average width of 2,300 feet (700 m). Much of the Pend Oreille River watershed is privately owned with a concentration of homes along the river frontage. Based upon conservation officer reports, few people fish the river and catches of salmonids (trout) and centrarchids (panfish, bass, etc.) are rare (DuPont, 1994).

2. Pollutant Source Inventory

Point Source Discharges

a. The Sandpoint Wastewater Treatment Plant discharges treated wastewater to the Pend Oreille River near Memorial Park just west of the Highway 95 "long" bridge across the lake. This plant is permitted to discharge on a weekly average: 550 lbs/day of biochemical oxygen demand, 550 lbs/day of total suspended solids, 200 colonies/100ml of fecal coliform bacteria, and a monthly average of 0.45 mg/l total residual chlorine.

   The City of Sandpoint has problems with the infiltration/inflow of stormwater into their collection system. This causes the plant to periodically discharge only primarily treated wastewater (primary clarifier plus chlorine contact chamber) to the river. They exceeded their permitted effluent limits for all years examined, 1984-1998 (DEQ Inspection Reports). In 1998, the Environmental Protection Agency fined the City of Sandpoint $27,500 for violations involving the wastewater treatment plant's discharges.

b. The City of Priest River has been discharging treated wastewater to the Pend Oreille River since 1954. In 1998, EPA conducted an inspection of the facility and outlined major and minor problems the City must address. A review of the treatment plant's discharge monitoring reports indicates that the plant has been operating within permit limits. Prior to the 1998 inspection, the Priest River treatment plant was last inspected in 1987.

   Due to growth pressures the City has begun plans to expand and upgrade their treatment plant. Upgrades will improve the reliability of the plant to meet permit effluent limits. The new system is expected to be operational by the year 2001.

c. The Albani Falls Dam has a small wastewater treatment system which serves facilities for its employees and visitors. The discharge was last permitted in 1978 and last inspected in 1983. A review of discharge monitoring reports indicates it is operating within its permit limits (DEQ NPDES files).

d. The City of Dover had requested EPA to permit a discharge of treated wastewater into the Pend Oreille River. The EPA, experiencing a backlog of NPDES permits to process, issued a "minor letter" which stated that the discharge is acceptable but must meet state water quality standards. The EPA later agreed to issue a discharge permit for the outfall sometime in the future. No public involvement process was solicited by EPA concerning this decision to permit the discharge. It is illegal to discharge wastewater in Idaho without a federal NPDES permit (Nickie Arnold, EPA, personal communication).

   The project is continuing forward and will begin discharging to the Pend Oreille River by

January, 2000. Other options in lieu of a discharge to the river were explored by the City but abandon. Land application of wastewater was one of these alternatives, but due to an objection by a resident this alternative was dropped (DEQ-Dover wastewater file).

Nonpoint Source Discharges

Due to a high population growth rate in Bonner County, the shoreline along the Pend Oreille River is now developed with primarily year around homes with shoreline riprap to prevent bank erosion. Much of the remaining native riparian vegetation left after the banks were stripped of trees for the dam operation, have been replaced with lawns and rock rip-rap for bank stabilization. Water level fluctuations of the Albani Falls dam prevent the establishment of vegetation in the flooded zone, which results in severe bank erosion along undeveloped shoreline.

2. a. Summary of Past and Present Pollution Control Efforts

Most of past research on the Pend Oreille River has been conducted downstream of the Albani Falls Dam, and primarily focused on the severe Eurasian milfoil infestation and how to get rid of it (EPA 1993). In 1998, Eurasian milfoil was first discovered in the river upstream of the Albani Falls Dam. Historically, the dam has operated as a barrier to the upward migration of this invasive non-native aquatic plant. This discovery of the plant above the dam marks the beginning of Idaho's fight to minimize milfoil's spread further upstream to the mouth of the river, and into Pend Oreille Lake, Priest River, and Priest Lake. Thus far, Bonner County's response has been swift and aggressive in treating the infested areas with herbicide.

3. Water Quality Concerns and Status

The Pend Oreille River was first listed in the 1988 Idaho Water Quality Status Report as fully supporting all beneficial uses, however, salmonid spawning, cold water biota and domestic water supply were noted to be potentially at risk. Pollutants of concern were nutrients, siltation/sedimentation, pathogens (bacteria) and other habitat alterations. The highest magnitude of pollution was attributed to flow regulation by the dam and its destabilizing effect on river banks and alteration of river hydraulics. To a lesser degree land development, wastewater discharges and septic systems were the sources of nutrients and pathogens. Forest practices and agricultural practices were of low magnitude of pollutant sources (DEQ, 1989).

Information in the 1988 report was based upon comments from Idaho Fish and Game and was transferred to the 1992 Water Quality Status Report without additional assessment. The 1992 list, in part, was then used to develop the 1996 303(d) list of impaired waters requiring TMDLs (DEQ, 1992). The pollutants of concern on the 1996 list are sediment, thermal modification and flow (DEQ, 1997).

The 1998 303(d) list adds total dissolved gas to the 1996 pollutants of concern, as a result of relicensing studies conducted by Washington Water Power (Avista). Dissolved gas in the river will be addressed at a future date after the required TMDLs are completed.

3. a. Applicable Water Quality Standards

The pollutants of concern are regulated by the following Idaho Water Quality Standards:

Sediment
Idaho's water quality standard for sediment is narrative, and states that sediment shall not exceed quantities which impair designated beneficial uses. Designated beneficial uses for the Pend Oreille River are domestic water supply, agricultural water supply, cold water biota, and primary and secondary contact recreation.

Flow
The water quality standards do not include flow as a beneficial use, nor are there criteria to protect flow in a stream. Idaho's Antidegradation Policy states that, "The existing in stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." This might imply that flow is also regulated since it is necessary for the maintenance of existing uses. The State of Idaho, Division of Environmental Quality has taken the position that Idaho does not regulate water flow and therefore, it will not be addressed in this problem assessment.

Thermal Modification (temperature)
The Pend Oreille River is not protected for salmonid spawning or bull trout spawning and rearing (EPA, 1997). Therefore, only the cold water biota temperature standard applies and limits the river to a water temperature of twenty-two (22) degrees C or less with a maximum daily average of no greater than nineteen (19) degrees C (IDAPA 16.01.02.250.02.c.).

Because the Pend Oreille River flows into Washington, Idaho must insure that water quality of the river meets Washington's water quality standards at the border. Washington has designated the Pend Oreille River at the point it leaves the state of Idaho as a Class A water with the following special condition:

> "Special condition - temperature shall not exceed 20.0°C [68°F] due to human activities. When natural conditions exceed 20.0°C [68°F], no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C [32.5°F]; nor shall such temperature increase, at any time, exceed $t=34/(T+9)$."

Class A (excellent) waters in Washington are described as having water quality that shall meet or exceed the requirements for all or substantially all uses (WAC 173-201A-030).

3. b. Summary and Analysis of Existing Water Quality Data

In 1985, in response to a complaint, DEQ conducted a water quality analysis of the Pend Oreille

River in the vicinity of Riley Creek, near the town of LaClede. Temperature data from this survey was recorded for the months of April, July, August and September in 1985 and 1986. At the depth of 16.4 feet (5 m) the maximum temperature recorded was 21.3°C (70°F). A strong thermocline was exhibited during all ten sampling runs. The instantaneous temperature standard of 22°C (72°F) was not exceeded in any of the samples (Figure 1.).

Total suspended sediment and turbidity were also recorded during this investigation. Turbidity ranged from 9.0 to 0.1 NTU, with an average of 1.8 NTU. Total suspended solids were below the detection limit of 2.0 mg/l.

In 1987, due to concerns and complaints of the growing presence of algae and water weeds in the Clark Fork-Pend Oreille basin, Congress directed EPA to conduct a comprehensive water quality study of the entire basin. In response to this directive, a number of studies were initiated. The one specific to the Pend Oreille River is described below.

The Washington Department of Ecology, in 1988 began to address these concerns by conducting a study of water quality in the Pend Oreille River between Albeni Falls and Box Canyon dams. As a part of this study, surface water temperatures were taken every three weeks at Newport. Temperatures were below Idaho standards (22°C) but above Washington standards (20°C). Results of this sampling are shown in Table 1. Turbidity and suspended sediments were also sampled. Results of this sampling were turbidity measurements of 1.2 - 2.7 NTU with an average of 1.9 NTU; and total suspended sediment ranged from 0.66 - 2.4 mg/l with an average of 1.3 mg/l (Figure 2.). Idaho does not have numeric criteria for suspended sediment, but for comparison purposes a value of <25 mg/l is considered by Montana to be a high level of protection for aquatic life. This study concluded that river water quality was generally good and well below the threshold of eutrophic conditions. Phytoplankton species were typical of oligotrophic to mesotrophic waters. Periphyton concentrations were well below nuisance levels for aesthetic impairment. Macrophytes were responsible for water quality violations (Washington) for pH and total dissolved gases during the peak of the growing season. There was no significant difference between sample stations for nutrients, suggesting macrophyte occurrence and sediments do not elevate in-stream nutrient loads (Coots and Willms, 1990).

Table 1. Turbidity, Total Suspended Solids, Flow and Sediment Transport in the Pend Oreille River at Newport (Pelletier et al., 1990).

Date	Flow (cfs)	TSS (mg/l)	*Sediment Load (tons/day)	Turbidity (NTU)
7/13/88	8,330	0.71	16.0	2.7
8/2/88	11,800	0.66	21.0	1.2
8/24/88	5,860	1.08	17.1	1.4
9/13/88	10,700	1.43	41.3	2.0
10/5/88	20,000	2.40	129.5	1.7
10/25/88	23,100	1.07	66.7	1.1
11/17/88	21,700	1.30	76.1	ND

*conversion factor = 0.002697

The 1991 study in this four year series, focused on primary productivity of the Pend Oreille River in Washington and selected tributaries. Temperature was measured over a total of five days in July and August, 1990. Average daily temperatures ranged from 21.3 to 23.8°C (70.3 to 74.8°F).

In 1993, an EPA "Summary of Findings" based on the four years of study on the Pend Oreille-Clark Fork Basin, concluded that water quality in the Pend Oreille River is generally good and in the oligo-mesotrophic range of nutrient enrichment (meaning that it has low to medium amounts of nutrients in the water), and that no violation of Washington water quality standards were found (EPA, 1993). [This conclusion concerning standards violations was contrary to the 1990 progress report information.] Other conclusions of the four year investigation were:

- The primary water quality concern on the Pend Oreille River is the proliferation of Eurasian watermilfoil, an invasive and exotic aquatic plant, downstream from Albeni Falls Dam.

- Approximately 75% of the external nitrogen and phosphorus loading to this reach of the river comes from Newport wastewater treatment plant, Calispell Creek, and Trimble Creek, all in Washington.

- Nonpoint sources of pollutants in the Pend Oreille River basin that potentially affect the river include confined animal feeding operations, agriculture, on-site sewage disposal, stormwater and highway runoff, forest practices, land development, landfills, and gravel extraction.

The recommended management objective of the plan for the Pend Oreille River was:

- Improve Pend Oreille River water quality through macrophyte management and tributary nonpoint source controls. [This management plan goal of improved tributary nonpoint source controls has not yet been realized. The Cocolalla and Hoodoo watersheds are listed as water quality impaired and scheduled for TMDL development by the end of 1999.]

During 1991 and 1992, DuPont conducted a study of fish habitat and the effects of drawdowns in the Pend Oreille River. He concluded that drawdown has negative effects on fishes that prefer low velocities and shallow depths. Drawdowns force fish into the main river channel where unfavorable conditions exist and the increased erosion due to drawdowns result in loss of gravel bars and larger substrate. Over-wintering habitat for these fishes (centrarchids) is a limiting factor for the population. As an example, only 4% of the summer largemouth bass habitat are available during winter drawdowns. DuPont concluded that, if the annual drawdown were limited to 6.6 feet (2.0 m) instead of the normal 11.5 feet (3.5 m) drawdown, habitat for largemouth bass would increase 7.5 times in area. Temperature data were also collected as a part of this study (Figure 3.). Temperatures in the main river channel reached a daily average high of 22.5°C (72.5°F) both years in August. Daily average temperatures during high pool (June-August) averaged 19°C (66°F) (DuPont, 1994).

The Pend Oreille Public Utility District is applying for a Federal Energy Relicensing Commission license to continue operation of the Box Canyon dam hydroelectric facility located on the Pend Oreille River near Metaline Falls, Washington. One study in progress is examining temperature of the river versus temperature of its source water, Lake Pend Oreille. Preliminary findings indicate that temperatures of the river from Newport to Metaline Falls are not significantly different than the temperature of Pend Oreille Lake. The conclusion is that temperature exceedences on the Pend Oreille River are due to natural causes (personal communication J. Parodi, 1999). The draft report of this study is expected by fall 1999.

Corsi et al. reported that the Albani Falls Dam significantly effects beneficial uses of the river. The dam restricts upstream movement of migratory fish, and the fluctuating lake levels restrict fish access to tributary streams. Elevated dissolved gas levels during spring high flow periods, and habitat modification as a result of the dam, impact native fish populations. Dams can also isolate fish populations and eliminate life history forms, particularly fluvial and adfluvial forms. Dams can also change water quality (temperature, sediment, and nutrients), water quantity, reduce shoreline food sources, and a direct loss of fish into water conveyance systems (turbines, spillways, or water delivery systems). The Albeni Falls dam and its operations may have negatively influenced overwintering habitat for bull trout, and the dam fragments habitat believed to be historically occupied by bull trout. Low winter water levels are hypothesized to be the primary cause for the decline of kokanee salmon in the Pend Oreille Lake since the late 1960s, because the lower lake levels forced kokanee to spawn in shoreline gravels with high levels of fine sediments (Corsi *et al.*1998). High temperatures in the Pend Oreille River preclude its use by cold water fish.

The Idaho Fish and Game requested that the Power Planning Council raise the winter lake level by four feet, on an experimental basis, to create more kokanee spawning habitat. Another benefit of the increased lake level is that warm water fish habitat in the Pend Oreille River would be increased by more than seven times the regular winter pool level. The new higher level was approved and implemented during the winters of 1996-'97, 1997-'98 and 1998-'99. Idaho Fish and Game has requested seven more years of the higher winter pool level to complete their study.

Results from other information sources concerning the Pend Oreille River were:

*The USGS monitoring station at Newport reports daily discharge amounts only, and therefore no data from this source were available.

*Idaho DEQ's Large River Waterbody Assessment Guidance was determined to be unusable for Pend Oreille River due to its reservoir characteristics and size, and therefore, data collected as a part of the Beneficial Use Reconnaissance Project's 1998 investigation cannot be used to assess the support status of this river (C. Grafe, IDEQ, personal communication 1998).

3. c. Data Gaps For Determination of Support Status

Data gaps that exist for the Pend Oreille River are as follows:

1. No data exist that describes the extent that recent urban development has had on increased sedimentation to the Pend Oreille River.

2. No studies are available concerning the effects of the Albani Falls dam and sedimentation of the river.

3. DEQ has not yet developed a method to determine the support status of the Pend Oreille River.

4. Problem Assessment Conclusions

The river was listed in the 1996 Water Quality Status Report as water quality impaired for sediment, thermal pollution (temperature) and flow.

<u>Temperature</u>
The current temperature standard for the Pend Oreille River protects cold water biota that existed in the river on or after November 28, 1975. There are no data that suggest that temperature has further impaired cold water biota after that date.

<u>Sediment</u>

Uses of the river that must be protected from sediment pollution are cold water biota, domestic water supply and agricultural water supply. The Albani Falls dam and its operation is the major cause of sedimentation in the river. Historically, the increase of bottom sediment has impaired cold water biota in the river, but there is no evidence that the level of impairment has increased since 1975. Total suspended sediment and turbidity are very low and supportive of all designated beneficial uses.

Flow

DEQ at this time does not recognize flow as a pollutant so it was not addressed in this assessment.

In summary, the findings of this problem assessment remain inconclusive until DEQ develops a method to assess the support status of cold water biota in the Pend Oreille River. No evidence was found that indicated cold water biota has been further impaired since 1975.

5. References

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Appendix A

List of Abbreviations and Acronyms

BURP	Beneficial Use Reconnaissance Project
CFR	Code of Federal Regulations
CWE	Cumulative Watershed Effects Process for Idaho
DEQ	Division of Environmental Quality
EPA	U.S. Environmental Protection Agency
HUC	Hydrologic Unit Code
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Division of Environmental Quality
IDL	Idaho Department of Lands
NPDES	National Pollution Discharge Elimination System
P.L.	Public Law
PM&E	Protection, mitigation and enhancement
TMDL	Total Maximum Daily Load

Appendix B
Pend Oreille Sub-Basin Cumulative Watershed Effects Summary Reports

POL CWE Summary Report

Berry Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0503	*HUC6 Name*	Berry Creek
Acres	6087	*303(d) Listed*	No
FPA Acres	6002	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	44	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.16	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	15 of 20		
# Segments w/High Temp Rating	5 of 20	*Canopy Closure/Temperature Rating*	High
Roads Score	46.7	*Roads Rating*	Moderate
Skid Trail Score	12	*Skid Trail Rating*	High
Mass Failure Score	92.8	*Mass Failure Rating*	High
Total Sediment Delivery Score	151.5	*Total Sediment Delivery Rating*	High
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Caribou Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0504	*HUC6 Name*	Caribou Creek
Acres	9173	*303(d) Listed*	Yes
FPA Acres	9154	*303(d) Pollutant(s)*	sediment
		303(d) Comments	305(b) appendix D

Scores / Ratings

Channel Stability Index	48	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.24	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	9 of 13		
# Segments w/High Temp Rating	4 of 13	*Canopy Closure/Temperature Rating*	High
Roads Score	35.4	*Roads Rating*	Moderate
Skid Trail Score	6	*Skid Trail Rating*	Low
Mass Failure Score	54.0	*Mass Failure Rating*	High
Total Sediment Delivery Score	95.4	*Total Sediment Delivery Rating*	Moderate
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Cascade Creek

HUC4 Number	17010213	*HUC4 Name*	Lower Clark Fork
HUC6 Number	0203	*HUC6 Name*	Cascade Creek
Acres	3849	*303(d) Listed*	No
FPA Acres	3554	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	53	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.16	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	4 of 6		
# Segments w/High Temp Rating	2 of 6	*Canopy Closure/Temperature Rating*	High
Roads Score	19.4	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	30.4	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	High
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	Moderate
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Cocolalla Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	1105	*HUC6 Name*	Cocolalla Creek
Acres	17276	*303(d) Listed*	Yes
FPA Acres	14407	*303(d) Pollutant(s)*	sediment, thermal modification
		303(d) Comments	305(b) appendix D, SSOC-"p" for CWB

Scores / Ratings

Scores		Ratings	
Channel Stability Index	50	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.24	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	3 of 8		
# Segments w/High Temp Rating	5 of 8	*Canopy Closure/Temperature Rating*	High
Roads Score	17.2	*Roads Rating*	Low
Skid Trail Score	6	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	32.2	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	35	*Nutrient Current Condition Rating*	Moderate
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Moderate
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Colburn Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0403	*HUC6 Name*	Colburn Creek
Acres	5517	*303(d) Listed*	No
FPA Acres	4453	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	67	*Channel Stability Rating*	High
Canopy Removal Index	0.15	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	0 of 3		
# Segments w/High Temp Rating	3 of 3	*Canopy Closure/Temperature Rating*	High
Roads Score	27.8	*Roads Rating*	Low
Skid Trail Score	4	*Skid Trail Rating*	Low
Mass Failure Score	101.7	*Mass Failure Rating*	High
Total Sediment Delivery Score	133.5	*Total Sediment Delivery Rating*	High
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Curtis Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	1304	*HUC6 Name*	Curtis Creek
Acres	11489	*303(d) Listed*	No
FPA Acres	10499	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	44.5	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.26	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	9 of 13		
# Segments w/High Temp Rating	4 of 13	*Canopy Closure/Temperature Rating*	High
Roads Score	18.7	*Roads Rating*	Low
Skid Trail Score	12	*Skid Trail Rating*	High
Mass Failure Score	10.1	*Mass Failure Rating*	Low
Total Sediment Delivery Score	40.8	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Low
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	Moderate
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Falls Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0311	*HUC6 Name*	Falls Creek
Acres	3065	*303(d) Listed*	No
FPA Acres	3034	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Channel Stability Index	34	*Channel Stability Rating*	Low
Canopy Removal Index	0.04	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	9 of 10		
# Segments w/High Temp Rating	1 of 10	*Canopy Closure/Temperature Rating*	High
Roads Score	28.5	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	39.5	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	29	*Nutrient Current Condition Rating*	Low
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Low
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Fish Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	1106	*HUC6 Name*	Fish Creek
Acres	6430	*303(d) Listed*	Yes
FPA Acres	6001	*303(d) Pollutant(s)*	sediment, thermal modification, pathogens
Evaluation Year	1998	*303(d) Comments*	305(b) appendix D

Scores / Ratings

Scores		Ratings	
Channel Stability Index	63	*Channel Stability Rating*	High
Canopy Removal Index	0.34	*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	3 of 7		
# Segments w/High Temp Rating	4 of 7	*Canopy Closure/Temperature Rating*	High
Roads Score	21.0	*Roads Rating*	Low
Skid Trail Score	4	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	34.0	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	36	*Nutrient Current Condition Rating*	Moderate
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Moderate
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Gold Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	1003	*HUC6 Name*	Gold Creek
Acres	6626	*303(d) Listed*	Yes
FPA Acres	6587	*303(d) Pollutant(s)*	sediment, habitat alteration
Evaluation Year	1998	*303(d) Comments*	SSOC-"s/t" for CWB and SS

Scores			Ratings	
Channel Stability Index	53.5		*Channel Stability Rating*	Moderate
Canopy Removal Index	0.29		*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	6	of 9		
# Segments w/High Temp Rating	3	of 9	*Canopy Closure/Temperature Rating*	High
Roads Score	22.8		*Roads Rating*	Low
Skid Trail Score	2		*Skid Trail Rating*	Low
Mass Failure Score	12.5		*Mass Failure Rating*	Low
Total Sediment Delivery Score	37.4		*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	25		*Nutrient Current Condition Rating*	Low
			Nutrient Hazard Rating	High
			Overall Nutrient Rating	Moderate
			CWE Surface Erosion Hazard Rating	Low
			CWE Mass Failure Hazard Rating	High
			Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Gold Creek (Pack River)

HUC4 Number	17010214	HUC4 Name	Pend Oreille Lake
HUC6 Number	0506	HUC6 Name	Gold Creek (Pack River)
Acres	7472	303(d) Listed	No
FPA Acres	6503	303(d) Pollutant(s)	N/A
Evaluation Year	1998	303(d) Comments	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	60.5	Channel Stability Rating	High
Canopy Removal Index	0.07	Hydrologic Risk Rating	Low
# Segments w/Low Temp Rating	2 of 11		
# Segments w/High Temp Rating	9 of 11	Canopy Closure/Temperature Rating	High
Roads Score	18.3	Roads Rating	Low
Skid Trail Score	2	Skid Trail Rating	Low
Mass Failure Score	9.0	Mass Failure Rating	Low
Total Sediment Delivery Score	29.3	Total Sediment Delivery Rating	Low
Nutrient Current Condition Score	0	Nutrient Current Condition Rating	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	Beneficial Use/Fine Sediment Adverse Condition	
Nutrient Adverse Condition	N/A	Hydrologic Adverse Condition	No

POL CWE Summary Report

Granite Creek

IDAHO DEPARTMENT OF LANDS

DEQ

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	1001	*HUC6 Name*	Granite Creek
Acres	16817	*303(d) Listed*	Yes
FPA Acres	16484	*303(d) Pollutant(s)*	sediment
Evaluation Year	1998	*303(d) Comments*	SSOC-"s/t" for CWB and SS

Scores		Ratings	
Channel Stability Index	56	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.09	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	8 of 16		
# Segments w/High Temp Rating	8 of 16	*Canopy Closure/Temperature Rating*	High
Roads Score	17.9	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	12.9	*Mass Failure Rating*	Low
Total Sediment Delivery Score	32.8	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	26	*Nutrient Current Condition Rating*	Low
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Low
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Grouse Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0704	*HUC6 Name*	Grouse Creek
Acres	16893	*303(d) Listed*	Yes
FPA Acres	16848	*303(d) Pollutant(s)*	sediment
Evaluation Year	1998	*303(d) Comments*	Information provided during comment period

Scores / Ratings

Scores		Ratings	
Channel Stability Index	40.5	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.10	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	21 of 27		
# Segments w/High Temp Rating	6 of 27	*Canopy Closure/Temperature Rating*	High
Roads Score	20.9	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	19.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	41.9	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Low
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Hellroaring Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0607	*HUC6 Name*	Hellroaring Creek
Acres	7728	*303(d) Listed*	No
FPA Acres	7723	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	49	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.33	*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	5 of 11		
# Segments w/High Temp Rating	6 of 11	*Canopy Closure/Temperature Rating*	High
Roads Score	59.8	*Roads Rating*	High
Skid Trail Score	12	*Skid Trail Rating*	High
Mass Failure Score	59.5	*Mass Failure Rating*	High
Total Sediment Delivery Score	131.2	*Total Sediment Delivery Rating*	High
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report
Homestead Creek (Crew 1)

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0604	*HUC6 Name*	Homestead Creek (Crew 1)
Acres	2335	*303(d) Listed*	No
FPA Acres	2335	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Channel Stability Index	54	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.64	*Hydrologic Risk Rating*	High
# Segments w/Low Temp Rating	0 of 2		
# Segments w/High Temp Rating	2 of 2	*Canopy Closure/Temperature Rating*	High
Roads Score	32.2	*Roads Rating*	Moderate
Skid Trail Score	4	*Skid Trail Rating*	Low
Mass Failure Score	39.8	*Mass Failure Rating*	Moderate
Total Sediment Delivery Score	76.0	*Total Sediment Delivery Rating*	Moderate
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	Yes

POL CWE Summary Report

Homestead Creek (Crew 2)

HUC4 Number	17010214	***HUC4 Name***	Pend Oreille Lake
HUC6 Number	0604	***HUC6 Name***	Homestead Creek (Crew 2)
Acres	2335	***303(d) Listed***	No
FPA Acres	2335	***303(d) Pollutant(s)***	N/A
Evaluation Year	1998	***303(d) Comments***	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	52	***Channel Stability Rating***	Moderate
Canopy Removal Index	0.30	***Hydrologic Risk Rating***	Moderate
# Segments w/Low Temp Rating	10 of 11		
# Segments w/High Temp Rating	1 of 11	***Canopy Closure/Temperature Rating***	High
Roads Score	32.6	***Roads Rating***	Moderate
Skid Trail Score	4	***Skid Trail Rating***	Low
Mass Failure Score	39.8	***Mass Failure Rating***	Moderate
Total Sediment Delivery Score	76.5	***Total Sediment Delivery Rating***	Moderate
Nutrient Current Condition Score	0	***Nutrient Current Condition Rating***	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	***Beneficial Use/Fine Sediment Adverse Condition***	Yes
Nutrient Adverse Condition	N/A	***Hydrologic Adverse Condition***	No

POL CWE Summary Report

Hoodoo Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	1303	*HUC6 Name*	Hoodoo Creek
Acres	26201	*303(d) Listed*	Yes
FPA Acres	21457	*303(d) Pollutant(s)*	sediment, thermal modification
Evaluation Year	1998	*303(d) Comments*	305(b) appendix D

Scores / Ratings

Scores		Ratings	
Channel Stability Index	45	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.24	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	2 of 4		
# Segments w/High Temp Rating	2 of 4	*Canopy Closure/Temperature Rating*	High
Roads Score	19.5	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	30.5	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	36	*Nutrient Current Condition Rating*	Moderate
		Nutrient Hazard Rating	High
		Overall Nutrient Rating	High
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	Yes	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Jeru Creek

HUC4 Number	17010214	**HUC4 Name**	Pend Oreille Lake
HUC6 Number	0603	**HUC6 Name**	Jeru Creek
Acres	3556	**303(d) Listed**	No
FPA Acres	3556	**303(d) Pollutant(s)**	N/A
Evaluation Year	1998	**303(d) Comments**	N/A

Scores		Ratings	
Channel Stability Index	37	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.42	*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	0 of 1		
# Segments w/High Temp Rating	1 of 1	*Canopy Closure/Temperature Rating*	High
Roads Score	16.3	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	27.3	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Lindsey Creek (Crew 1)

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0602	*HUC6 Name*	Lindsey Creek (Crew 1)
Acres	2404	*303(d) Listed*	No
FPA Acres	2402	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	59	*Channel Stability Rating*	High
Canopy Removal Index	0.19	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	1 of 3		
# Segments w/High Temp Rating	2 of 3	*Canopy Closure/Temperature Rating*	High
Roads Score	16.7	*Roads Rating*	Low
Skid Trail Score	6	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	31.7	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Lindsey Creek (Crew 2)

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0602	*HUC6 Name*	Lindsey Creek (Crew 2)
Acres	2404	*303(d) Listed*	No
FPA Acres	2401	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	42	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.30	*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	5 of 6		
# Segments w/High Temp Rating	1 of 6	*Canopy Closure/Temperature Rating*	High
Roads Score	29.2	*Roads Rating*	Low
Skid Trail Score	6	*Skid Trail Rating*	Low
Mass Failure Score	9.0	*Mass Failure Rating*	Low
Total Sediment Delivery Score	44.2	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Little Sand Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0404	*HUC6 Name*	Little Sand Creek
Acres	8047	*303(d) Listed*	No
FPA Acres	8032	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	42	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.04	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	10 of 13		
# Segments w/High Temp Rating	3 of 13	*Canopy Closure/Temperature Rating*	High
Roads Score	15.3	*Roads Rating*	Low
Skid Trail Score	8	*Skid Trail Rating*	Moderate
Mass Failure Score	11.9	*Mass Failure Rating*	Low
Total Sediment Delivery Score	35.2	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	High
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Moderate
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Martin Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0606	*HUC6 Name*	Martin Creek
Acres	2314	*303(d) Listed*	No
FPA Acres	2314	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	32	*Channel Stability Rating*	Low
Canopy Removal Index	0.03	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	0 of 2		
# Segments w/High Temp Rating	2 of 2	*Canopy Closure/Temperature Rating*	High
Roads Score	13.0	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	38.9	*Mass Failure Rating*	Moderate
Total Sediment Delivery Score	53.9	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

McCormick Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0605	*HUC6 Name*	McCormick Creek
Acres	4355	*303(d) Listed*	No
FPA Acres	4346	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	39	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.46	*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	1 of 5		
# Segments w/High Temp Rating	4 of 5	*Canopy Closure/Temperature Rating*	High
Roads Score	28.9	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	88.5	*Mass Failure Rating*	High
Total Sediment Delivery Score	119.5	*Total Sediment Delivery Rating*	High
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

North Fork Grouse Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0702	*HUC6 Name*	North Fork Grouse Creek
Acres	9537	*303(d) Listed*	Yes
FPA Acres	9529	*303(d) Pollutant(s)*	sediment
Evaluation Year	1998	*303(d) Comments*	Forest Service Information

Scores / Ratings

Scores		Ratings	
Channel Stability Index	49.5	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.41	*Hydrologic Risk Rating*	Moderate
# Segments w/Low Temp Rating	13 of 17		
# Segments w/High Temp Rating	4 of 17	*Canopy Closure/Temperature Rating*	High
Roads Score	29.6	*Roads Rating*	Low
Skid Trail Score	12	*Skid Trail Rating*	High
Mass Failure Score	41.0	*Mass Failure Rating*	Moderate
Total Sediment Delivery Score	82.5	*Total Sediment Delivery Rating*	Moderate
Nutrient Current Condition Score	0	*Nutrient Current Condition Rating*	N/A
		Nutrient Hazard Rating	Low
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	N/A	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Pack River

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0608	*HUC6 Name*	Pack River
Acres	14259	*303(d) Listed*	No
FPA Acres	14209	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	52	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.16	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	19 of 24		
# Segments w/High Temp Rating	5 of 24	*Canopy Closure/Temperature Rating*	High
Roads Score	29.9	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	47.2	*Mass Failure Rating*	High
Total Sediment Delivery Score	79.1	*Total Sediment Delivery Rating*	Moderate
Nutrient Current Condition Score	32	*Nutrient Current Condition Rating*	Moderate
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Moderate
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	Yes
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Riley Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0104	*HUC6 Name*	Riley Creek
Acres	8984	*303(d) Listed*	No
FPA Acres	8389	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores		Ratings	
Channel Stability Index	56.5	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.20	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	12 of 17		
# Segments w/High Temp Rating	5 of 17	*Canopy Closure/Temperature Rating*	High
Roads Score	25.6	*Roads Rating*	Low
Skid Trail Score	6	*Skid Trail Rating*	Low
Mass Failure Score	15.4	*Mass Failure Rating*	Low
Total Sediment Delivery Score	47.1	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	40	*Nutrient Current Condition Rating*	Moderate
		Nutrient Hazard Rating	Low
		Overall Nutrient Rating	Moderate
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	Moderate
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Sand Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0402	*HUC6 Name*	Sand Creek
Acres	13405	*303(d) Listed*	No
FPA Acres	9815	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores		Ratings	
Channel Stability Index	57	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.13	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	11 of 14		
# Segments w/High Temp Rating	3 of 14	*Canopy Closure/Temperature Rating*	High
Roads Score	22.1	*Roads Rating*	Low
Skid Trail Score	4	*Skid Trail Rating*	Low
Mass Failure Score	29.0	*Mass Failure Rating*	Moderate
Total Sediment Delivery Score	55.1	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	29	*Nutrient Current Condition Rating*	Low
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Low
		CWE Surface Erosion Hazard Rating	High
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Sand Creek (Pack River)

HUC4 Number	17010214	**HUC4 Name**	Pend Oreille Lake
HUC6 Number	0505	**HUC6 Name**	Sand Creek (Pack River)
Acres	8807	**303(d) Listed**	No
FPA Acres	7687	**303(d) Pollutant(s)**	N/A
Evaluation Year	1998	**303(d) Comments**	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	60	**Channel Stability Rating**	High
Canopy Removal Index	0.29	**Hydrologic Risk Rating**	Moderate
# Segments w/Low Temp Rating	4 of 10		
# Segments w/High Temp Rating	6 of 10	**Canopy Closure/Temperature Rating**	High
Roads Score	21.9	**Roads Rating**	Low
Skid Trail Score	12	**Skid Trail Rating**	High
Mass Failure Score	13.5	**Mass Failure Rating**	Low
Total Sediment Delivery Score	47.4	**Total Sediment Delivery Rating**	Low
Nutrient Current Condition Score	0	**Nutrient Current Condition Rating**	N/A
		Nutrient Hazard Rating	High
		Overall Nutrient Rating	N/A
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	**Beneficial Use/Fine Sediment Adverse Condition**	
Nutrient Adverse Condition	N/A	**Hydrologic Adverse Condition**	No

POL CWE Summary Report

Strong Creek

HUC4 Number	17010214	*HUC4 Name*	Pend Oreille Lake
HUC6 Number	0308	*HUC6 Name*	Strong Creek
Acres	3171	*303(d) Listed*	No
FPA Acres	3114	*303(d) Pollutant(s)*	N/A
Evaluation Year	1998	*303(d) Comments*	N/A

Scores / Ratings

Scores		Ratings	
Channel Stability Index	49	*Channel Stability Rating*	Moderate
Canopy Removal Index	0.01	*Hydrologic Risk Rating*	Low
# Segments w/Low Temp Rating	11 of 11		
# Segments w/High Temp Rating	0 of 11	*Canopy Closure/Temperature Rating*	Low
Roads Score	13.0	*Roads Rating*	Low
Skid Trail Score	2	*Skid Trail Rating*	Low
Mass Failure Score	25.6	*Mass Failure Rating*	Low
Total Sediment Delivery Score	40.6	*Total Sediment Delivery Rating*	Low
Nutrient Current Condition Score	22	*Nutrient Current Condition Rating*	Low
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Low
		CWE Surface Erosion Hazard Rating	Moderate
		CWE Mass Failure Hazard Rating	Moderate
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	No	*Beneficial Use/Fine Sediment Adverse Condition*	
Nutrient Adverse Condition	No	*Hydrologic Adverse Condition*	No

POL CWE Summary Report

Trestle Creek

HUC4 Number	17010214	***HUC4 Name***	Pend Oreille Lake
HUC6 Number	0901	***HUC6 Name***	Trestle Creek
Acres	12431	***303(d) Listed***	Yes
FPA Acres	12431	***303(d) Pollutant(s)***	none listed
Evaluation Year	1998	***303(d) Comments***	Forest Service Information

Scores / Ratings

Scores		Ratings	
Channel Stability Index	42	***Channel Stability Rating***	Moderate
Canopy Removal Index	0.05	***Hydrologic Risk Rating***	Low
# Segments w/Low Temp Rating	14 of 16		
# Segments w/High Temp Rating	2 of 16	***Canopy Closure/Temperature Rating***	High
Roads Score	17.6	***Roads Rating***	Low
Skid Trail Score	2	***Skid Trail Rating***	Low
Mass Failure Score	17.3	***Mass Failure Rating***	Low
Total Sediment Delivery Score	37.0	***Total Sediment Delivery Rating***	Low
Nutrient Current Condition Score	24	***Nutrient Current Condition Rating***	Low
		Nutrient Hazard Rating	Low
		Overall Nutrient Rating	Low
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	Low
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	***Beneficial Use/Fine Sediment Adverse Condition***	
Nutrient Adverse Condition	No	***Hydrologic Adverse Condition***	No

POL CWE Summary Report
West Gold Creek

HUC4 Number	17010214	***HUC4 Name***	Pend Oreille Lake
HUC6 Number	1004	***HUC6 Name***	West Gold Creek
Acres	4365	***303(d) Listed***	No
FPA Acres	4361	***303(d) Pollutant(s)***	N/A
Evaluation Year	1998	***303(d) Comments***	N/A

Scores / Ratings

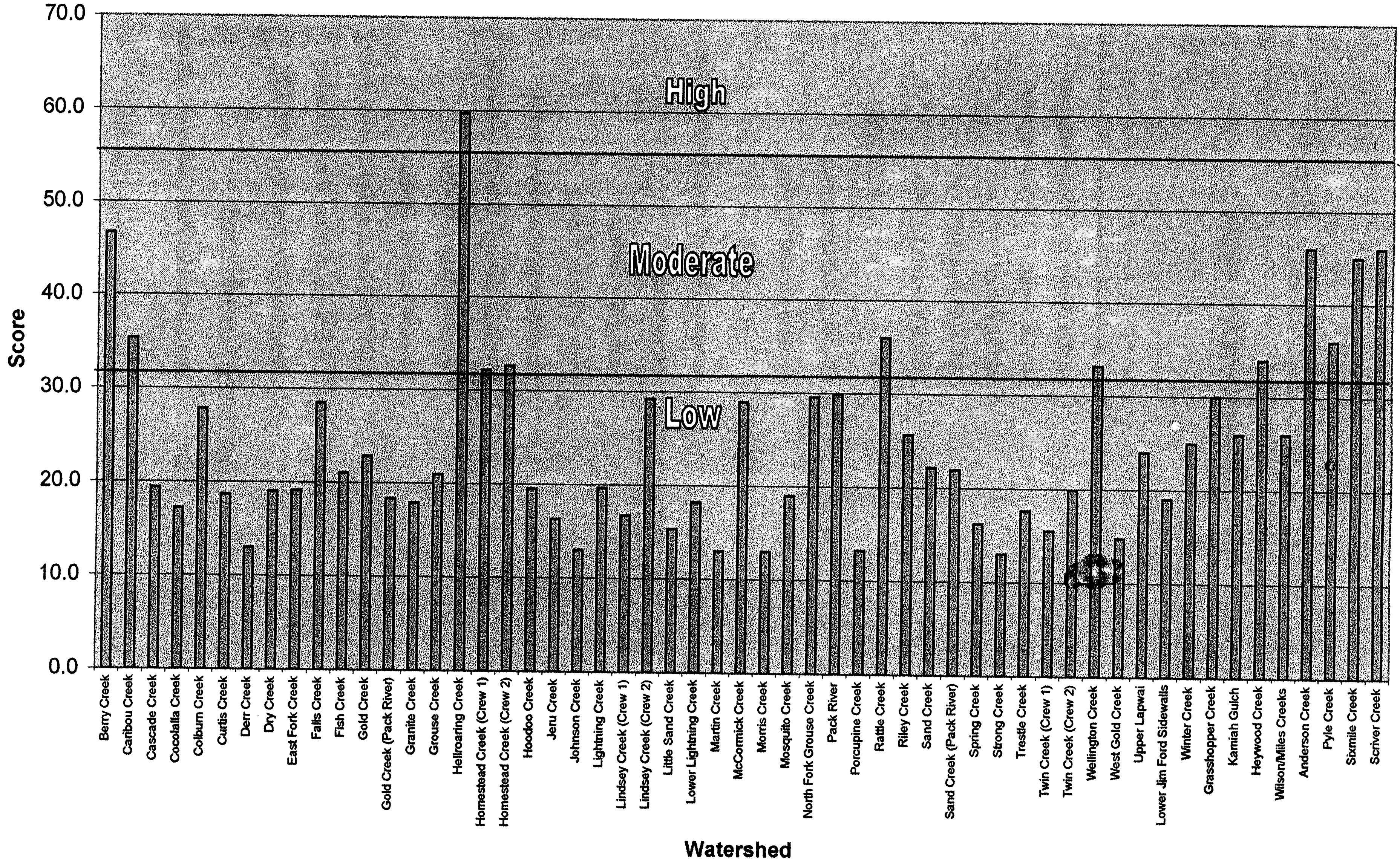
Scores		Ratings	
Channel Stability Index	30	***Channel Stability Rating***	Low
Canopy Removal Index	0.26	***Hydrologic Risk Rating***	Low
# Segments w/Low Temp Rating	7 of 11		
# Segments w/High Temp Rating	4 of 11	***Canopy Closure/Temperature Rating***	High
Roads Score	14.8	***Roads Rating***	Low
Skid Trail Score	8	***Skid Trail Rating***	Moderate
Mass Failure Score	14.3	***Mass Failure Rating***	Low
Total Sediment Delivery Score	37.1	***Total Sediment Delivery Rating***	Low
Nutrient Current Condition Score	28	***Nutrient Current Condition Rating***	Low
		Nutrient Hazard Rating	Moderate
		Overall Nutrient Rating	Low
		CWE Surface Erosion Hazard Rating	Low
		CWE Mass Failure Hazard Rating	High
		Beneficial Use Condition (BURP)	

Adverse Conditions

Temperature Adverse Condition	Yes	***Beneficial Use/Fine Sediment Adverse Condition***	
Nutrient Adverse Condition	No	***Hydrologic Adverse Condition***	No

CWE Road Scores for Assorted Watersheds
(Low-Moderate Threshold = 32; Moderate-High Threshold = 56; Minimum Score = 13)

$$\text{Total Score for Roads} = \left(\frac{\sum(\text{Segment Score} \times \text{Segment Length})}{\sum(\text{Segment Length})} \right)$$



Appendix C

Understanding the Sediment Model

Sediment is the pollutant of concern on the majority of the water quality limited streams of the Panhandle Region. Any attempt to model the sediment output of watersheds will provide, relative rather than exact, sediment yields. The model used in this sub-basin assessment attempts to identify the primary sources of stream sedimentation in a watershed. This identification of primary sources will be useful in the design of implementation plans. If additional investigation indicates sources quantified require refinement, the model input can be altered to incorporate this new information.

The model looks at five general land uses: Pasture, Forest Land, Unstocked Forest, Highway and Double Fires. Pasture land includes hay fields, grazing pastures and any low elevation treeless land. Unstocked Forest includes natural openings and 90-100% cut-over forest. Highways are paved and contribute less sediment than a gravel road and, therefore, have a lower sedimentation rate. Double Fires areareas burned by two large wildfires. Acreages for each of these land uses are shown on the "Land Use" page of the spreadsheet.

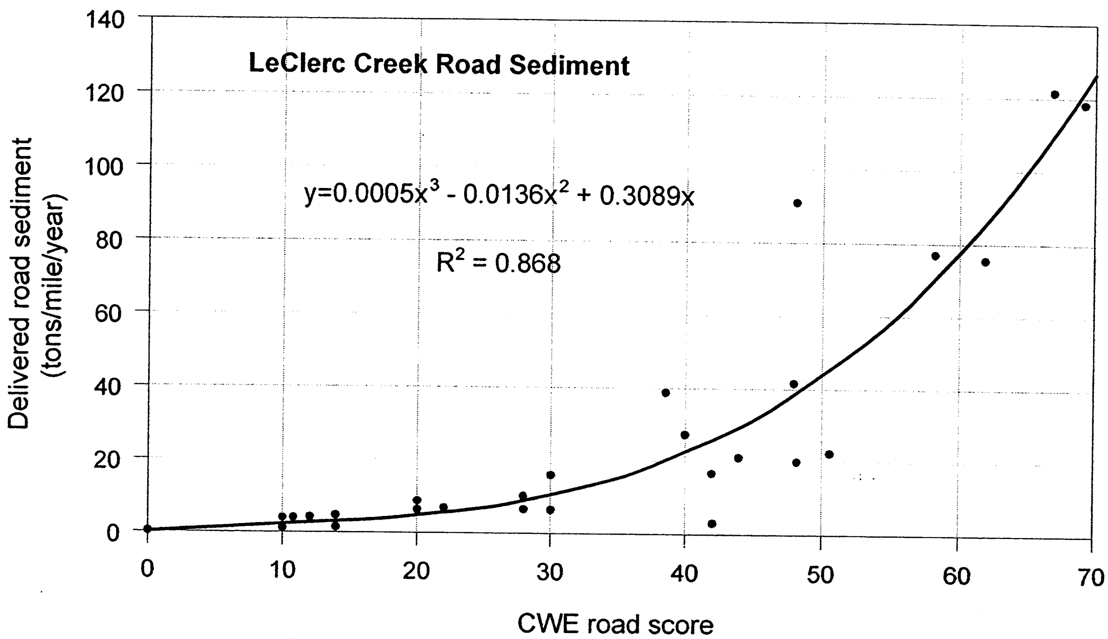
Below the "Land Use" information is the "Road Data" section. It divides roads into those used in association with the harvesting of forest tree species, and unpaved county and unpaved private roads. Road data did not separate private and county roads so they were combined even though they may have different sediment yields. This section also includes an estimate of the cubic yards of sediment delivered to the stream due to slope failures along forest and county/private roads. This data was obtained from field work done for the Cumulative Watershed Effects Analysis, a tool developed by the Idaho Department of Lands to address the cumulative effects of multiple forest practices. Because no data were available for private and county road failures, a weighted average of the forest road failures were used.

Stream bank erosion was estimated from aerial photos and on-the-ground spot checks. Better data may be available in the future and can be substituted for this estimate. The erosion coefficient for bank erosion was taken from a study by Stevenson in the Cocolalla Lake area. The calculation to obtain the bank erosion rates in tons/yr/mi is displayed in a footnote. It assumes a two foot high eroding bank and a soil weight of 90 pounds per cubic foot.

The "Sediment Yield" page of the spreadsheet shows the acreage from the previous page multiplied by the sediment yield coefficient. The basic land use coefficients were developed by using the WATSED and RUSLE models, which utilize localized information concerning landtype, acreage and other factors. The coefficients for "double fires" and "unstocked forest" were developed by taking the difference between the highest value of the coefficient for the geologic type and the median. This value, 0.017 tons/acre/year of sediment, is added to the natural background sediment yield value of 0.038 tons/ac/yr.

The sediment yield from roads is calculated by using the McGreer Model formula that equates the Cumulative Watershed Effects road scores with a corresponding sediment yield (Figure 1). In the case of roads, it was assumed that all sediment was delivered to the stream system. These are conservative estimates of actual delivery.

Figure 1: Sediment export of roads based on Cumulative Watershed Effects scores.



The "Sediment Total" spreadsheet simply totals all the sources of sediment to come up with the existing sediment load. Natural background mass failures are also calculated from data collected by the Cumulative Watershed Effects teams. Natural background for each land use historically present in the watershed is then calculated on the last page of the spreadsheet. This number becomes the target load, the difference between the target load and the existing load is the amount of reduction that may be necessary to recover beneficial uses lost due to excess sedimentation.

Appendix D

TECHNICAL GUIDANCE

Montana and Idaho Border
Nutrient Load Agreement for Pend Oreille Lake Open Water

GOAL	Protect Pend Oreille Lake open water quality
WATERS AFFECTED	Pend Oreille Lake and Clark Fork River
TARGETS	• An area-weighted euphotic-zone average concentration of 7.3 ug/l total phosphorus for Pend Oreille Lake • Total loading to Pend Oreille Lake of 328,651 kg/yr total phosphorus • 259,500 kg/yr total phosphorus from Montana (Clark Fork River at Montana/Idaho state line) • 69,151 kg/yr total phosphorus from the Pend Oreille Lake watershed in Idaho • Greater than a 15:1 total nitrogen to total phosphorus ratio
AREA PROTECTED	Open waters of the lake (waters where the maximum depth is greater than 2.5 times water transparency as measured by Secchi depth) from the mouth of the Clark Fork River to the Long Bridge (Highway 95.) See Attachment C, Map of Pend Oreille Lake.

I. Technical Guidance Summary

In September 1999, the Tri-State Water Quality Council (Council) created a Technical Team to develop technical guidance for an agreement between the states of Montana and Idaho for establishing nutrient targets and apportioning loads to Pend Oreille Lake. The impetus for developing the targets was concern over maintaining the water quality of the open waters of Pend Oreille Lake and the need to address potential impacts from the Clark Fork River in Montana and local sources in Idaho. The Technical Team's charge was to set open water nutrient concentration targets which support the lake's designated beneficial uses, and nutrient loading targets to meet those concentrations. The team reviewed and analyzed existing data on Pend Oreille Lake and the Clark Fork to establish a solid scientific foundation for technical guidance and a proposed agreement for consideration by the two states. Team members included representatives from Montana Department of Environmental Quality (MDEQ), Idaho Division of Environmental Quality (IDEQ), the University of Idaho, and the Clark Fork Coalition. The U.S. Environmental Protection Agency (EPA) Regions 8 and 10, and the U.S. Geological Survey, participated in the team in an advisory capacity. Land & Water Consulting, contractor to the Council, provided technical expertise to the team.

Driven by citizen concerns over Pend Oreille Lake water quality, the Council, MDEQ, IDEQ and EPA concurred that development of nutrient targets at the Montana/Idaho border would be timely to help prevent pollution of the lake's open waters. Because about 90 percent of the flow and 80 percent of the loading of total phosphorus into Pend Oreille Lake comes from the Clark Fork River, targets are established for the Clark Fork River at the border to address this predominate influence on lake water quality. By establishing these targets, a major objective of the Clark Fork-Pend Oreille Watershed Management Plan is fulfilled, which is to protect Pend Oreille Lake water quality by maintaining or reducing the rate of nutrient loading from Montana's Clark Fork River, as well as reducing nutrient loading from the lake's watershed in Idaho. The targets focus on the lake's open water and do not address the nearshore, shallow areas of the lake that are influenced predominately by sources located within one mile of the shoreline. Nearshore issues will be addressed in a future document.

Establishing targets at the interstate boundary will help apportion nutrient management responsibilities between the two states for future water quality planning and implementation activities. The targets will also provide a framework for water quality management decisions related to new sources.

The goal of the nutrient loading targets is to protect open lake water quality. To reach this goal, an area-weighted euphotic zone concentration target for Pend Oreille Lake of 7.3 ug/l total phosphorus is recommended by the Technical Team. To meet this target, a total load of 328,651 kg/yr. total phosphorus is recommended to be allocated as follows:

- 259,500 kg/yr total phosphorus from Montana (Clark Fork River at Montana/Idaho state line;) and

- 69,151 kg.yr total phosphorus from the Pend Oreille Lake watershed in Idaho.

Additionally, the team recommends maintenance of a ratio greater than 15:1 total nitrogen to total phosphorus. Set as an action level, a 15:1 ratio is a desirable lower limit to avoid the occurrence of algal blooms in Pend Oreille Lake.

II. Background

A. Clark Fork-Pend Oreille Project History

In response to citizen concerns and complaints about the growing presence of algae in the Clark Fork-Pend Oreille watershed, in 1987 U.S. Congress mandated EPA to conduct a comprehensive water quality study in the three-state basin and to report study findings and recommendations to Congress. Authorized in the Clean Water Act, this study was known as the Section 525 Clark Fork-Pend Oreille Basin Water Quality Study. Regions 8 and 10 of EPA had primary federal responsibility for implementing the study, while the states of Montana, Idaho and Washington identified research objectives within their boundaries, conducted the research, wrote reports and recommended state-specific management actions to meet the basin-wide study objectives. A steering committee consisting of representatives from EPA and the three states oversaw the study and reviewed and summarized the three state plans into a document titled: Clark Fork-Pend Oreille Basin Water Quality Study: A Summary of Findings and a Management Plan. Following a series of basin-wide pubic hearings, the management plan was finalized in 1993.

The plan focuses on the control of nutrients and eutrophication in the three-state basin, and its goal is to restore and protect designated beneficial water uses basinwide. To meet the goal, the plan establishes four objectives:

1. Control nuisance algae in the Clark Fork River by reducing nutrient concentrations.
2. Protect Pend Oreille Lake water quality by maintaining or reducing current rates of nutrient loading from the Clark Fork River.
3. Reduce nearshore eutrophication in Pend Oreille Lake by reducing nutrient loading from local sources.
4. Improve Pend Oreille River water quality through macrophyte management and tributary nonpoint source controls.

The watershed management plan is being implemented by the Council, a broad-based 28-member group established by EPA and the three states in October 1993. In addition to setting policy and direction for water quality management actions, the Council oversees the efforts of various subcommittees who are working in local communities throughout the watershed to carry out priority actions from the plan. One of the top priorities in the plan is the development of nutrient targets and nutrient reduction strategies for the Clark Fork River and Pend Oreille Lake. The Council's work to meet the four management plan objectives can be summarized as follows:

Management Plan Objective 1:
Control nuisance algae in the Clark Fork River by reducing nutrient concentrations.

Work on the Clark Fork River targets began in 1994 when a Nutrient Target subcommittee was established by the Council to forge numeric targets and a workable implementation plan for meeting those targets. The process was driven by 303(d) requirements of the federal Clean Water Act and the State of Montana's responsibility under Section 303(d) to develop a TMDL. However, in 1995 the Council decided to take a voluntary approach rather than a mandatory, permitted approach. With approval from MDEQ and EPA to proceed with development of a voluntary program, the subcommittee wrestled with the complex scientific and policy issues associated with the reduction of nutrient loading. After four years of work the group completed the Clark Fork Voluntary Nutrient Reduction Program (VNRP), which was approved by EPA Region 8 in October 1998 as a functionally equivalent TMDL for the river.

The goal of the Clark Fork VNRP is to restore beneficial uses and eliminate nuisance algae growth in the river from Warm Springs Creek to the Flathead River confluence. To meet the goal, the VNRP sets numeric targets for chlorophyll-*a*, total phosphorus, and total nitrogen1 for 200 miles of river and sets site-specific measures to meet the targets over a ten-year period. The VNRP includes commitments for specific actions to be taken by each of the four key point source dischargers (the three cities of Butte, Deer Lodge, Missoula and Smurfit-Stone Container Corporation) and calls for reductions from other point sources and key non-point sources to reach the numeric targets.

Management Plan Objective 2:
Protect Pend Oreille Lake water quality by maintaining or reducing current rates of nutrient loading from the Clark Fork River.

Having been successful in reaching consensus on goals and a strategy to significantly reduce nutrients and algae on the Clark Fork River, the Council focused its attention downstream of the VNRP to prevent pollution of Idaho's Pend Oreille Lake. Council members along with EPA and both states agreed that a nutrient loading target at the border would be instrumental in preventing increased cultural eutrophication to the lake's open water. As noted above, since about 90 percent of the flow and 80 percent of the loading of total phosphorus into Pend Oreille Lake comes from the Clark Fork River, targets are established at the border to address this predominate influence on the lake's open water. It was further agreed that targets at the border would provide the basis for a coordinated interstate management approach by apportioning responsibilities between the two states for protecting the lake. After a series of conference calls during 1999, representatives of the Council, EPA Region 8 and 10, and the states of Montana and Idaho made the decision to proceed with development of a target for the lake. A work plan was

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1 Targets for the Clark Fork mainstem are:

- 100 mg/square meter (summer mean) and 150 mg/square meter (peak) chlorophyll-*a*, at any site, for the entire Clark Fork River area of the VNRP;
- 20 ug/l total phosphorus upstream of the Reserve Street bridge at Missoula, where Cladophora is a problem and the 15:1 N:P ratio should be maintained;
- 39 ug/l total phosphorus downstream of the Reserve Street bridge at Missoula; and
- 300 ug/l total nitrogen.

developed in November 1999 and signed by MDEQ and IDEQ indicating the agencies' support of the border agreement approach. The team began its work in early 2000 and presented its technical findings and recommended targets to the Council in October 2000. At that time the team also presented a draft agreement for the states' consideration as a possible format for describing Montana and Idaho responsibilities and roles in meeting the targets. The Council presented the Technical Guidance and agreement documents to the two states in January 2001.

Management Plan Objective 3:
Reduce nearshore eutrophication in Pend Oreille Lake by reducing nutrient loading from local sources.

Once the open lake targets of the border agreement are finalized, the Council will begin work with IDEQ and local stakeholders on a nutrient management strategy to reduce impacts from nearshore nutrient sources affecting the lake's shallow bays. (See brief discussion on nearshore issues, Page 7.)

Management Plan Objective 4:
Improve Pend Oreille River water quality through macrophyte management and tributary nonpoint source controls.

Once the lake nutrient management strategy is completed, the Council will work with IDEQ and the Washington Department of Ecology (DOE) on a coordinated approach to address issues in the Pend Oreille River in Idaho and Washington. In Washington, the Council has been participating with DOE, the Pend Oreille Conservation District, the Pend Oreille Public Utility District and other entities in local watershed planning efforts already underway in Pend Oreille County.

B. Overview of the Clark Fork-Pend Oreille Watershed

The Clark Fork-Pend Oreille watershed encompasses nearly 26,000 square miles in western Montana, northern Idaho and northeastern Washington. The Clark Fork River, Pend Oreille Lake and Pend Oreille River are among the main bodies of water in the basin. The Clark Fork River begins along the west slopes of the Continental Divide and drains much of western Montana before entering Pend Oreille Lake. The lake is the source of the Pend Oreille River, which flows into northeastern Washington. The waters then enter the Columbia River. Highly valued recreational and economic resources characterize the watershed. Timber, mining, fish, wildlife, water, rangeland and croplands support a variety of human uses, ranging from logging and agriculture to recreational fishing and boating.

Concerns about environmental problems in the basin are longstanding (EPA 1993). The two greatest concerns are pollution from heavy metals from past mining and smelting activities in the headwaters of the Clark Fork River and eutrophication problems caused by excessive nutrients.2 Eutrophication manifests itself in the Clark Fork River in Montana as nuisance levels of attached and filamentous algae that impair most designated uses of the river. In Pend Oreille Lake, increasing growths of algae and other aquatic plants in nearshore areas and public perception of decreasing water clarity are the primary water quality concerns. In Washington, the Pend Oreille River is choked with heavy growth of aquatic plants that impede boat traffic and most other uses.

C. Overview of the Pend Oreille Lake Problem Assessment

Due to uncertainties about maintaining lake water quality especially in near shore areas, Pend Oreille Lake was added to the State of Idaho's 1994 Section 303(d) list –and retained on the 1996 list—as a "threatened" waterbody. Because of this listing, IDEQ prepared a problem assessment on the lake (DEQ 1999) which included the following elements, as briefly summarized here:

1. Physical and Biological Characteristics

   Pend Oreille Lake is the largest and deepest natural lake in Idaho and is recognized throughout the Inland Northwest as an extremely valuable water resource. The surface area of the lake is 91,180 acres. Lake levels are controlled by Albeni Falls dam operated by the U. S. Army Corps of Engineers near the Idaho/Washington boundary. Eighty three percent of the lake's watershed is forested (Eastern Washington University 1991). While nearly 65 percent of the lakeshore is in National Forest, almost half of all developable land in the lake's watershed is located within one mile of the lakeshore. Development pressure predicted by population growth figures will likely be concentrated fairly close to the lake because of the location of these lands (Hoelscher *et al.* 1993).

   Pend Oreille Lake's designated uses are water supply, recreation, salmonid spawning, cold-water biota, wildlife habitat and aesthetics. The lake supports a significant sport fishery [in1991, anglers expended an estimated 465,000 hours fishing the lake (Corsi *et al.* 1998) and the world record bull trout, weighing 32 pounds, was taken from the lake in 1949] and is a main water source for many homes along its shores.

2. Pollutant Source Inventory

   Point sources: Of the four point sources (Cabinet Gorge Dam, Cabinet Gorge Fish Hatchery,

2 At the beginning of the Section 525 studies, the steering committee decided to restrict the studies to nutrients because they are the primary interstate water quality issue and affect the largest portion of the watershed. The steering committee also concurred that remedial actions on metals were already well underway through the federal Superfund program. Thus, the focus of the Council's work to reduce pollution in the watershed is on nutrients.

Clark Fork Hatchery and Kootenai-Ponderay Sewer District), only one discharges directly into the lake. The sewer district of the cities of Kootenai and Ponderay each year discharges 1,432 kg. total phosphorus and 9,929 kg. total nitrogen into Boyer Slough (Hoelscher *et al.* 1993).

Non-point sources: Non-point sources that contribute nutrients to the lake are the result of land disturbing activities such as residential development, silviculture, agriculture, grazing. Atmospheric deposition, septic tanks, and urban runoff are also sources of nutrients. The areas of highest algae growth along the lakeshore are areas of higher residential development (Falter *et al.* 1992). Phosphorus and nitrogen also enter the lake from tributary streams, most notably the Pack River, Lightning Creek and Sand Creek (Frenzel 1991b).

3. Water Quality Concerns and Status

The primary water quality concerns for the lake are: nutrients, metals, gas saturation (from Cabinet Gorge and Noxon Rapids hydroelectric dams), fisheries (Endangered Species Act listed bull trout), and Eurasian Milfoil (a non-native aquatic weed that forms dense weed beds and can severely restrict beneficial uses). Due to the water level fluctuations and shoreline development, bank erosion is severe in some areas (IDEQ 1999). The problem assessment also notes that as of 1999 none of the National Pollutant Discharge Elimination System (NPDES) permits for point sources were current, and that Idaho Water Quality Standards may not be protective of the lake from the standpoint of mixing zone requirements or cumulative effects from dischargers.

The State of Idaho Water Quality Standards include a narrative description for unacceptable levels of nutrients that states: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." The lake is afforded additional protection by being designated by the State as a Special Resource Water. Because of this designation, no new point sources are allowed and existing sources are limited to their current permit capacities. The Special Resource Water designation protects the lake from discharges that would cause a measurable reduction in ambient water quality below the applicable mixing zone.

Open lake water quality—which is predominantly influenced by the Clark Fork River—has not changed statistically since the mid-1950's (Beckwith 1989, Woods 1991a). However, Hoelscher *et al.* (1993) concluded that at the projected population growth rate, the difference between existing conditions (oligotrophic) and less desirable conditions (mesotrophic) would be reduced by approximately one half in twenty years. The population growth projected (population of 35,081 in Bonner County by 2010) by Hoelscher *et al.* (1993) was actually reached in 1998. Therefore, the growth pattern around the lake has reached the potential for being a very real threat to water quality.

4. Nearshore Water Quality Concerns

Population growth and shoreline development poses potential threats to nearshore and open lake water quality. Without nutrient management planning and implementation, excessive nutrients in the nearshore could impair the lake's aesthetic qualities, recreational uses and domestic water supplies (EPA 1993). Sources of these nutrients include residential development, roads, silviculture, septic tanks, and urban runoff. These sources will be addressed as part of the Council's future effort to meet Objective 3 of the management plan (to reduce nearshore eutrophication in the lake by reducing nutrient loading from local sources) through the development of a lake nutrient management strategy.

5. Problem Assessment Conclusions

IDEQ's problem assessment recommends de-listing of the lake and EPA approved de-listing in 2000. However, the assessment recognizes that over the long term there remains concern that water quality of the lake could be degraded. The assessment therefore supports the Council in its future efforts to develop a nutrient management strategy for the lake.

D. Overview of Upstream Issues

Upper and middle Clark Fork River:
Although heavy metals pollution in the headwaters of the Clark Fork is the most acute problem in the upper basin, nutrient pollution affects the largest portion of the basin and is the primary interstate water quality issue. Excessive nutrients in the river originate from a combination of point and nonpoint sources. Ambient concentrations of phosphorus and nitrogen have led to blooms of filamentous algae in the river above Missoula and heavy growths of slime, or diatom algae, below Missoula. Algae impair beneficial uses of the river, such as irrigation and recreation, and in large concentrations can deplete dissolved oxygen needed by fish and other aquatic organisms. The 525 study showed that excessive levels of algae caused water use impairment in up to 250 miles of the Clark Fork, to its confluence with the Flathead River. This impairment was the basis for the development of the VNRP, as described on Pages 3-4. Most of the Clark Fork River, as well as its tributaries, is classified as a B-1 waterbody, which means that the river's quality shall be maintained for all beneficial uses.

Flathead River:
The Flathead River provides a large flow of water containing low concentrations of nutrients, which dilutes Clark Fork River water. The Flathead provides a source of dilution relative to the Clark Fork by contributing 67% of the water, 33% of the total phosphorus and 47% of the total nitrogen to the Clark Fork at Cabinet Gorge (based on 1984-99 record.) The 525 study showed locally important sources of nutrient loading in the Flathead watershed. Concerns about nutrient loading to Flathead Lake are being addressed through a TMDL for the lake and its watershed. Flathead Lake serves as a nutrient sink and is largely responsible for reduced downstream nutrient concentrations. Downstream of the lake, operation of Kerr Dam on the lower Flathead

River causes fluctuating stream flows that can affect water quality and nutrient loading. Nutrient levels may also be affected by local sources in tributaries below Kerr Dam.

Lower Clark Fork River:
Below the Flathead River, the Clark Fork is characterized by very large streamflows and low nutrient concentrations. Reservoirs created by dams along the river at Noxon and Cabinet Gorge act as nutrient sinks for river nutrients, but because of rapid flushing in these reservoirs the percent of total nutrient retention is small or variable (Beak 1997.)
A review of existing data by Beak concluded that the retention of total phosphorus on an annual basis is probably on the order of 10 to 20 percent, although during low flow summer conditions retention in probably more substantial. Beak further concluded that algae in the reservoirs are probably more light-limited than nutrient-limited. Mass balance calculations based on data from 1984-1999 (MDEQ and Council) suggest that total phosphorus retention over the 16 year period was on the order of 25% (Land & Water 2000).

Control strategies for curbing nutrient loading in Montana's Clark Fork River basin are being implemented through the VNRP and the Flathead TMDL. However, new proposals could increase nutrient loading, such as a new point source discharge being proposed for a mine at Rock Creek on the lower Clark Fork which would introduce metals and nutrient pollution to the lower river and Pend Oreille Lake. The proposed mine project has not yet obtained an operating or discharge permit, however the Pend Oreille Lake targets would provide a basis for addressing this and other new sources so that water quality improvements made by nutrient control strategies in the basin are not jeopardized._

III. Existing Studies and Surveys

The first important task of the border agreement Technical Team was to research and review existing data on Pend Oreille Lake. The team assembled some of the members of the Section 525 study, including technical experts from IDEQ, MDEQ, the University of Idaho and U. S. Geological Survey, to review the study data as well as other data sources. The following discussion summarizes that review.

Public interest groups, industries and businesses, universities, local governments, and state and federal agencies have investigated the resources of Pend Oreille Lake to varying extent. Most of these efforts have been summarized by the Environmental Research Laboratory (1987), Beckwith (1989), Seifert (1989), Hoelscher (1993), and Hoelscher *et al.* (1993).

Fewer of these efforts focused on more traditional measures of water quality. Kemmerer and others visited Idaho early this century (Kemmerer *et al.* 1923; as cited in Rieman 1976). More recently, investigators have classified the pelagic, open waters of the lake as oligotrophic or nutrient poor (Stross 1954, Woods 1991a) tending toward mesotrophy or moderately nutrient enriched (Rieman 1976, Milligan *et al.* 1983, Beckwith 1989). The lake's great depth has been cited as an important factor in maintaining the oligotrophic characteristics (Stross 1954, Rieman 1976, Milligan *et al.* 1983, Watson *et al.* 1987, Woods 1991a). Comparisons with previous Pend Oreille Lake limnological data (Stross 1954, Platts 1958, Rieman 1976, Beckwith 1989) indicated no apparent changes in the trophic status (Platts 1958, Rieman 1976, Beckwith 1989, Woods 1991a). Beckwith (1989) and Woods (1991a) further reported no statistical differences in traditional measures of trophic state from the early 1950's to present. These data should be interpreted with caution because of differences in analytical methods, small sample size, and temporal and spatial variability.

Pend Oreille Lake is characterized by two distinct basins. The large, deep southern basin contains most (95%) of the lake's volume and has a mean depth of about 220 m (Woods 1991b). Water flowing into the southern basin will likely reside there in excess of ten years (Falter *et al.* 1992). The northern basin is much shallower with a mean depth of 29 m (Woods 1991b). Because of the smaller volume and the large flow of the Clark Fork River, water resides in the northern basin much less than one year (Falter *et al.* 1992).

A common feature among historical investigations was the strong influence exerted by the Clark Fork River on Pend Oreille Lake water quality (Stross 1954, Platts 1958, Rieman 1976, Beckwith 1989, Woods 1991a). This would be expected as most (90%) of the inflow to the lake is accounted for by the river (Frenzel 1991a). Studies have shown that the water quality of the open waters of the lake is influenced primarily by inflow from the Clark Fork River (Woods 1991b), while the water quality of the lake's nearshore zone is influenced to a greater extent by residential development and other local land use activities (Falter *et al.* 1992).

An often-used indicator of lake water quality is water clarity. The deeper, southern lake basin was found to be clearer than the shallower, northern part of Pend Oreille Lake (Stross 1954, Rieman 1976, Beckwith 1989, Woods 1991a). The greater clarity was attributed to the southern basin's depth and distance from the Clark Fork River. Suspended sediment in the river inflow, as well as re-suspended sediment from the lake bottom and near shore areas, were the main causes of lower water clarity along the north shore (Woods 1991a).

Nitrogen and phosphorus contribute to algae growth and either of these two nutrients can be limiting depending on their ratio. Phosphorus is the nutrient most often limiting algae and aquatic plants in the Pend Oreille Lake (Rieman 1976, Greene *et al.* 1984, Gangmark and Cummins 1987, Woods 1991a). Total phosphorus concentrations have been shown to increase from south to north (Woods 1991a). The south-to-north increase has been partially attributed to the Clark Fork River's input of suspended sediment. In nature, phosphorus is adsorbed to soil particles and enters surface waters from erosion of soils in the watershed. Nutrient concentrations were higher in the mid-1970's (Rieman 1976, U.S. Geological Survey 1976) than they were in the late 1980's and early 1990's (Woods 1991a). These comparisons need to be judged critically because of analytical methods and sample size. Beckwith (1989) further cautioned conclusions from these data as it is quite likely that average annual nutrient loads to the lake truly were higher during this period because of higher stream flows.

Although nitrogen limitation is common in the Clark Fork River (especially in late summer) Pend Oreille Lake is primarily phosphorus limited, with occasional nitrogen limitation in late summer in the north lake. (Falter, see Attachment D.) According to Falter's review of data and literature, the fact that the Clark Fork River is often nitrogen limited probably has little bearing on the limiting factor in most of the south lake or mid-lake. Algal assays in Pend Oreille Lake through the fall 1984 indicated primary phosphorus limitation with secondary limitation by nitrogen at all sites (Woods 1991a). Algal assays in the lake through summer-fall 1986 indicated primary phosphorus limitation and secondary nitrogen limitation in the north and mid-lake but exclusive phosphorus limitation in the south lake (Gangmark and Cummins 1987). As with many large lakes, the growth of algae in near shore areas of Pend Oreille Lake is attributed to nutrient enrichment from shoreline and lake nearshore sources.

Chlorophyll-*a*, the primary photosynthetic pigment of algae and aquatic plants, is a widely cited and accepted indicator of trophic state (Carlson 1977, Ryding and Rast 1989). Mean chlorophyll-*a* concentrations were low and spanned a narrow range (Woods 1991a). Allowing for differences in analytical methods, it appeared current chlorophyll-*a* concentrations (1989/1990) differed little from those measured nearly twenty years ago (U.S. Geological Survey 1976.) It has been stated Pend Oreille Lake primary productivity has been inhibited by the Clark Fork River's temperature (Platts 1958), turbidity (Rieman 1976) or a combination of the two (Stross 1954). The Environmental Research Laboratory (1987) modeled chlorophyll-*a* production using the lake average total phosphorus concentration and the conclusion was that algae production was not excessive.

Several data sources exist for establishing nutrient targets for Pend Oreille Lake and the Clark Fork River at the Montana-Idaho state line. The most temporally and spatially robust data for Pend Oreille Lake was collected during 1989 and 1990. The data is comprised of about 300 water samples taken at five lake stations (Woods 1991a). Precision of the data was analyzed with duplicate samples for quality-assurance purposes. The U.S. Geological Survey streamflow and nutrient concentration sampling below Cabinet Gorge Dam during those same years is the most rigorous for the Clark Fork River for 1989/90. The most continuous long term monitoring record began in 1984 with MDEQ's Clark Fork monitoring program that included sampling at multiple river sites, including below Cabinet Gorge dam. In 1998, MDEQ's nutrient concentration data record was continued by the Council's Monitoring Committee (Land & Water 1999). The Technical Team considered all of these data sets in establishing nutrient targets for Pend Oreille Lake.

IV. Nutrient Targets, Loading Analysis and Allocation

A. Assumptions

The Technical Team developed and agreed to the following assumptions prior to development of the nutrient targets:

1. **Current lake *open water* water quality is acceptable.**
   Data supports the assumption that *open water* water quality, which is predominantly influenced by the Clark Fork River, has not changed statistically since the 1950's. Historical data show that, in general, the lake was oligotrophic (nutrient poor) during the early 1950's, mid-1970's, and late-1980's (Section 525 study3.) As noted above, the 1999 lake problem assessment concluded designated beneficial uses—water supply, recreation, salmonid spawning, cold-water biota, wildlife habitat and aesthetics—are being supported. The lake is afforded extra protection through the Special Resource Water designation whereby water quality cannot be lowered to the point that beneficial uses would be impacted. Therefore, the goal of **maintenance** of lake water quality, as recommended in the Section 525 report, is acceptable.

2. **The targets cover Pend Oreille Lake to its western boundary at the Long Bridge.**
   As delineated by USGS, the area covered by the targets includes all of Pend Oreille Lake from the mouth of the Clark Fork River inflow to the Long Bridge (Highway 95.) See map, Attachment C.

3. **The focus of the nutrient targets is protection of the quality of the lake's open water.**
   Open water and nearshore areas of the lake require separate management approaches. The targets recommended in this guidance are for open water, not for nearshore areas around the lake. Open water is defined as waters where the maximum depth is greater than 2.5 times water transparency as measured by Secchi depth. The targets address Montana and Idaho sources that contribute to nutrient loading of open water. Nearshore water quality will be addressed in the future as a separate issue.

4. **The targets are based on findings from the Section 525 water quality study and the long term MDEQ data set.** Conducted during 1989 and 1990, the 525 study comprises the most comprehensive and complete analysis for the Clark Fork River and Pend Oreille Lake to date. Studies of the lake included nutrient and hydrologic budgets, pelagic zone limnology, near shore productivity, and a nutrient load/lake response model. The Technical Team is confident in the use of the 525 data based on the quantity, quality and representativeness of the data generated. The team also utilized data from MDEQ's long-term monitoring record to develop targets that consider yearly nutrient variation.

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3 The Section 525 study concluded that extensive monitoring of the pelagic zone during the 1989 and 1990 water years indicated, on the basis of phosphorus, chlorophyll-*a* and nitrogen, Pend Oreille Lake was oligotrophic. Oligotrophy also was indicated by lakewide Secchi-disk readings; although Secchi-disk readings at the northern lake stations indicated mesotrophic or eutrophic conditions, this was due to inflow of turbid runoff delivered by the Clark Fork and not by increased biological production. (Hoelscher *et al.* 1993).

5. **The targets will be for total nutrients rather than soluble nutrients.**
Using a data base consisting of 200 rivers to relate algal densities to nutrient concentrations, Dodds and Smith (1995) concluded that total nutrients were a better predictor than soluble nutrients. In lakes, limnological studies show that total nutrients have a better correlation with algae than soluble nutrients, and that total nitrogen and total phosphorus relate better to seasonal and lakewide productivity (see discussion on nitrogen and phosphorus, Attachment D.)

6. **The targets are based on an area-weighted average.**
From the standpoint of nutrient cycling, the north and south areas of the lake are functionally distinct. The targets are protective of water quality throughout the open waters of the lake, and take into account differences between regional areas of the lake.

   Four of the pelagic monitoring stations established for the Section 525 study were located at Bayview, Granite Point, Hope, and Contest Point (Woods 1991a). Area weighted values were based on surface area of lake segments as follows: segment 1 (Bayview and Granite), 70%; segment 2 (Hope and Contest Point), 30%. Using reported mean values for segment 1 and segment 2 from Woods, the average 1989 total phosphorus was 8.40 ug/l, and the 1990 value was 6.26 ug/l, with the average of these two years being 7.33 ug/l. Segments are delineated on the Pend Oreille Lake map, Attachment C.

Table 1. Area-weighted average calculations

Woods (1991)			
	Granite Segment 1 (70%)	Hope Segment 2 (30%)	Weighted Average
1989	8.1	9.1	8.40*
1990	5.9	7.1	6.26
Average	7.0	8.1	7.33

* e.g. (0.70 x 8.1) + (0.30 x 9.1) = 8.40

Further assumptions associated with development of the total phosphorus target are included in Attachment E, Pend Oreille Lake Total Phosphorus Targets.

7. **In-lake mixing of Clark Fork River inflow is an important factor, but is highly variable from year to year.**
Although mixing is an important factor, certain highly variable conditions make it difficult to predict how mixing will occur in the lake from year to year. The nutrient load/lake response model applied during the Section 525 studies was based on an annual nutrient budget and assumed that a major portion of phosphorus input from the Clark Fork River was routed through the northern segment of the lake and did not mix with the southern segment. This assumption was calibrated by in-lake tracking of the spring run-off plume from the Clark

Fork River. Using a transmissometer to measure transparency, USGS tracked the plume as it moved across the northern segment and out through the Pend Oreille River; additionally the tracking indicated that the overflow plume was less dense than lake water and stayed on top as it moved through. The results of the tracking were verified by sampling of conductivity at Cabinet Gorge and Albeni Falls. Other factors contributing to year-to-year variability in mixing, and thus to management uncertainties, include: years of very large flows when the loading could move to the south segment and go into storage; very heavy snow years when the run-off plume is much colder and could mix more with the lake as it moves through; or an extremely turbid run-off plume that could settle into the delta. (Woods, personal communication.)

8. **In addition to mixing, certain other important variables exist for which data cannot predict at this time the potential for impacts to the lake or to the targets.**
These variables, which are the result of either (1) nutrient loading, or (2) lake expression of nutrient loading, or both, are:
    -Introduced species (2)
    -Food chain dynamics versus productivity (2)
    -Hydrology (including water yield, water rights, dam operations) (1) (2)
    -Lake internal dynamics (1) (2)
    -Nutrient dynamics (upstream impoundments, and the lake itself) (1)
    -Upstream management (Clark Fork VNRP, Flathead TMDL, new sources) (1)
    -Meteorology (temperature, sunlight) (1) (2)
    -Atmospheric deposition (1) (2)
    -Ability to detect changes in the lake year-to-year (statistical challenge, sampling method) (2)

9. **The nutrient targets for Pend Oreille Lake are protective of lake water quality over the long term, while allowing for year-to-year variability.**
Lake loading can be highly variable from year to year as a result of runoff and other controllable and uncontrollable factors. However, the lake's trophic status over the long term appears to be insensitive to small-to-moderate alterations in phosphorus and nitrogen inputs. The targets, therefore, accommodate short-term variations while affording long-term water quality protection for the open waters.

10. **The application of the targets within the State of Montana and the State of Idaho will be the responsibility of each of the states.**
Although the sources of pollution may be different, it is assumed that Montana and Idaho have equal commitment and comparable ability to achieve and maintain their respective allocations.

B. Total Phosphorus

A simple mathematical model can be used to define the relation between annual total phosphorus loading and total phosphorus concentrations in the lake euphotic zone, the well-lighted portion of the water column where photosynthesis takes place. The model used for Pend Oreille Lake was originally developed by Vollenweider (1976). A conceptual representation of the expected relationship between phosphorus loading and in-lake concentration is further illustrated in a predictive graph (Hoelscher *et al.* 1993),
Attachment F.

As stated earlier, loading of total phosphorus is likely related to hydrologic events as phosphorus is adsorbed to soil particles. Frenzel (1991a) reported precipitation at Sandpoint, Idaho in 1989 was the same as the 1913-1988 average while the Clark Fork River discharge was slightly less (93%) than the average for 1928-1988. He presumed near average conditions also likely existed for ungaged drainages surrounding the lake. In 1990, precipitation was 105% and the river discharge was 116% of the long-term averages. Frenzel (1991b) estimated the total phosphorus load to Pend Oreille Lake was 292,000 kg in 1989 with the Clark Fork River contributing 80% and 361,000 kg in 1990 with the river contributing 83% of the total phosphorus load. Therefore, these data likely represent usual hydrologic and loading conditions. Temporal variability in the annual total phosphorus load to Pend Oreille Lake was 21% as measured by the relative percent difference (APHA 1998). Frenzel (1991b) estimated overall error, inclusive of errors in the hydrologic budget and estimated errors in the collection and analysis of the nutrient samples, was about 16% of the total load to Pend Oreille Lake and River upstream from Albeni Falls Dam. Land & Water (1999) estimated the accuracy for estimates of mean annual phosphorus concentration in the Clark Fork River to be within 30% based on a sample size of 18 per year.

Woods (1991a) reported lakewide total phosphorus concentrations of 8.4ug/l in 1989 and 6.2 ug/l in 1990. Relative percent difference, inclusive of temporal variability—comprised of annual loading differences as well as in-lake nutrient cycling—and measurement error, was 32%. Measurement error was estimated at 7.2%. Total phosphorus concentrations did vary spatially with higher concentrations in the northern end of the lake in closer proximity to the Clark Fork River inflow. Separation of Pend Oreille Lake into basins based on these data is not recommended because of the uncertainty of the Clark Fork River inflow annual mixing characteristics, the overwhelming dominance of the southern lake basin volume of water, and any real basin differences in total phosphorus concentration would likely be eclipsed by temporal variability.

The average total phosphorus load (328,651 kg) to Pend Oreille Lake accurately predicted within measurement error the observed average area-weighted euphotic zone lake total phosphorus concentration (7.3 ug/l). These data are realistic as the lake as a whole has a multiple year hydraulic residence time. Combining the 1989 and 1990 hydrologic data accounted for about 85% of the water volume in Pend Oreille Lake.

Many researchers have presented trophic state classification systems. The system described by Ryding and Rast (1989) was used for these analyses. Their classification system identified trophic state boundaries for oligotrophic waters as four micrograms per liter total phosphorus and ten micrograms per liter for mesotrophic waters. For any waterbody, there is a gradation in water quality along these boundaries. Sonzogni *et al.* (1976) estimated the phosphorus residence time at about three times the hydraulic residence time. This is about ten years for Pend Oreille Lake. Assuming total phosphorus loads in the mesotrophic range occurring once in a ten year period may provide for undesirable water quality conditions, a gradation for mesotrophic characteristics was set at plus or minus ten percent of the value reported by Ryding and Rast (1989).

An euphotic total phosphorus concentration of 7.3 ug/l is recommended as a target for Pend Oreille Lake. This value should either be derived from a south-lake sampling location, due to the dominance of lake volume, or better from an area-weighted average of a south-lake and north-lake location. The latter would better represent any significant changes in the major inflow, the Clark Fork River. Assuming a combined temporal variability and measurement error of 30%, euphotic total phosphorus concentrations representative of mesotrophic conditions should be detectable.

An annual total phosphorus load of 259,500 kg/yr is recommended as a target for the Clark Fork River at the Montana-Idaho state line. This value was derived by taking the average annual total phosphorus load for the 1989-90 period reported by Frenzel (1991b). An annual total phosphorus load of 69,151 kg/yr is recommended for local sources in Idaho based on the nutrient budget developed by Frenzel. The 1989-90 record is considered to be representative based on basin water yield and precipitation, which was near normal for the period.

Independent confirmation of USGS 1989-1990 total phosphorus load estimates for the Clark Fork is provided by MDEQ monitoring data. Data collected from 1984-1999 were used to estimate 1989-1990 total phosphorus loads using the FLUX model (Walker 1996). The FLUX algorithm (Method 6) employed a regression model using all data for the period of record applied to individual daily flows to estimate annual loads. Using MDEQ data (n=166), the estimated loads for 1989-1990 were 216,400 kg and 273,904 kg, respectively (Land & Water 2000). The average of these values is 245,152 kg, which corresponds to a relative percent difference of 5.7% compared with USGS value of 259,500 kg (Frenzel 1991b). This relative difference is within measurement and estimation error for the load values, and does not represent a statistically significant difference.

The USGS value of 259,500 kg is supported by MDEQ data, and is recommended as the target value to maintain consistency with the calibrated lake model (Woods 1991b) that forms the basis for lakewide total phosphorus concentrations.

A worksheet outlining how the phosphorus load allocation was calculated is included as Attachment G.

C. Total Nitrogen

Because historical data did not show strong evidence for support of a nitrogen target for the lake's open water, the Technical Team enlisted the assistance of Dr. C. Michael Falter (University of Idaho) to conduct a literature review and recommend an approach to nitrogen for Pend Oreille Lake. The results of Dr. Falter's findings and conclusions (Nitrogen vs. Phosphorus Limitation in Pend Oreille Lake Open Water) are included in Attachment D and can be summarized as follows:

- Although nitrogen limitation has occasionally been recognized in oligotrophic systems, nitrogen limitation is generally associated with eutrophic waters.
- Nitrogen limitation is more likely to occur in aquatic environments where nitrogen loss through de-nitrification is common, such as in shallow waters. Because the lake's photic zone is far removed from sediment influence and its hypolimnion is oxygen-rich, Pend Oreille Lake would be expected to show little nitrogen limitation. This suggests that nitrogen limitation should not be a significant issue in the lake, especially in its central and southern basins.
- Based on existing data, the lake appears to be primarily phosphorus-limited with occasional nitrogen limitation in late summer in the north lake. Mid- and south-lake regions show little or no nitrogen limitation.
- The ratio of total nitrogen to total phosphorus (TN:TP) serves as an indicator of a waterbody's nutrient balance and the potential for algae growth. Low TN:TP ratios are common in eutrophic lakes and blue-green algae blooms are rare when the TN:TP ratio is higher than 29:1. Algal blooms are more likely at low ratios.
- A TN:TP ratio greater than 15:1 indicates phosphorus limitation.
- During the 525 studies, TN:TP ratios in the lake's euphotic zone averaged 18:1 throughout the lake.

Based on Falter's findings, the Technical Team agreed that a nitrogen target is not justified at this time. However, because nitrogen-to-phosphorus ratios are an important indicator of potential changes to water quality, a TN:TP ratio of 15:1 is recommended as the desirable lower limit to avoid the occurrence of algal blooms in Pend Oreille Lake.

In-lake monitoring of the TN:TP ratio is recommended and an observed ratio of 15:1 or lower would serve as a trigger for reconsideration of setting a target for nitrogen.

D. Monitoring Plan Scope of Work

Introduction

A monitoring program must be in place to evaluate if the concentration and loading targets are being met and if those targets are effective in protecting the lake's water quality. In order to develop such a program, the Technical Team considered various scenarios of target exceedances and the subsequent management actions that might follow each of these scenarios. The scenarios included **episodic** (one year above the targets,) **short term** (three consecutive years above the targets) and **long term** (a ten-year average greater than the targets.) This review led the team to the following conclusions:

1. Recognizing that annual nutrient loading is inherently variable due to natural factors, periodic short-term exceedances of the loading targets may occur. However, the lake's buffering capacity has been adequate to accommodate natural variability (see discussion, Section 4). Therefore, a one-year exceedance of the targets would not trigger a management action. Of greater concern is the need to identify and assess the longer-term trend toward lake eutrophication as evidenced by increased loading.

2. A short-term exceedance of the targets (three consecutive years of total phosphorus load increases at the border that are above the targets by greater than 10%) should serve as a "red flag," triggering concern that a trend may be developing. Actions to be taken should include:
   - A review of the data to ensure confidence;
   - A review of factors such as: annual runoff/water yield and ambient concentrations;
   - A review of lake response data;
   - An identification of causes (natural and human-induced) and sources (point and nonpoint; Montana and Idaho);
   - A determination of error factor; and
   - Consideration of development and implementation of a management strategy.

3 A long-term exceedance of the targets (a ten-year average total phosphorus concentration in the lake greater than 7.3 ug/l) will warrant the development of a management strategy to curb nutrient loading. Actions to be taken should include:
   - A review of data to ensure convincing evidence of a change in trend;
   - A review of causes (natural and human-induced) and sources (point and nonpoint; Montana and Idaho); and
   - Implementation of a management strategy

Because of the need to assess trends that are based on good science, the team recommends an annual monitoring program to build a record for the long-term. The products of the program will be an annual status report, an assessment of time trends, and an analysis of the associated causes. The objective of the program will be to detect real trends early enough so that appropriate and effective actions can be taken to protect Pend Oreille Lake water quality. Data collected during the monitoring program may potentially suggest re-definition of long-term targets and trends to protect the lake.

Monitoring Goals and Objectives

The purpose of monitoring is to generate reliable information on water quality trends and status for watershed managers. Analysis of approximately 10 years of historical nutrient data for the Clark Fork watershed provided statistical design criteria for the load monitoring program at Cabinet Gorge (Land & Water 1995).

Three principle water quality monitoring objectives are defined for Pend Oreille Lake. These include 1) estimation of annual total phosphorus loads to Pend Oreille Lake from the Clark Fork River, 2) assessment of open water, lake-wide average total phosphorus concentrations in the euphotic zone and 3) assessment of trends in Pend Oreille Lake trophic status (Carlson Index). These objectives will be coordinated with the existing Clark Fork-Pend Oreille water quality monitoring program. A future objective will be developed to evaluate attainment of phosphorus loading targets for the Idaho portion of the watershed, which will be based on a nutrient management strategy for the lake.

For the purposes of determining achievement of the states' respective loading targets, it is recommended that Montana evaluate sampling data from the Clark Fork River at the border (Cabinet Gorge) and that Idaho develop and implement a program—as noted above—that will quantify nutrient loading from point, nonpoint and atmospheric sources within the Idaho portion of the watershed.

Individual management-monitoring goals are outlined with appropriate statistical criteria in the following sections.

1.1.1 Clark Fork River, Total Phosphorus Load Targets (Montana Sources)

MANAGEMENT GOAL:	Maintain Montana phosphorus loading targets
MONITORING GOAL:	Compare annual total phosphorus loads to target
DEFINITION OF TARGET:	259,500 kg annual load of total phosphorus
STATISTICAL METHODOLOGY:	Shewhart-Cusum Control Chart
STATISTICAL HYPOTHESIS:	Ho: Estimated load within control limits, short/long term Ha: Estimated load outside control limits, short/long term
DATA ANALYSIS RESULT:	Conclusions regarding achievement of targets
INFORMATION PRODUCT:	Management goal met when estimated load is within control chart baseline values

1.1.2 Pend Oreille Lake, Total Phosphorus Concentration

MANAGEMENT GOAL:	Maintain pelagic water quality

MONITORING GOAL: Evaluate departures from baseline phosphorus concentration
DEFINITION OF WATER QUALITY: Total phosphorus, euphotic zone, area-weighted lake annual average
DEFINITION OF TARGET: Mean concentration equal to or less than baseline of 7.3 ug/l
STATISTICAL METHODOLOGY: Two sample t-test, or Mann-Kendall if non-normal distribution, 90% C.L.
STATISTICAL HYPOTHESIS: Ho: No statistical difference from baseline exists
Ha: Statistical departure from baseline exists
DATA ANALYSIS RESULT: Conclusions regarding departure of annual mean concentration from baseline conditions
INFORMATION PRODUCT: Management goal met if no statistically significant difference from baseline value exists

1.1.3 Pend Oreille Lake, Trophic Status

MANAGEMENT GOAL: Maintain pelagic water quality
MONITORING GOAL: Detect significant trends in trophic status
DEFINITION OF WATER QUALITY: Carlson index (Total P, Secchi Depth, Chl a).
DEFINITION OF TREND: Presence of statistically significant trend in 10 year period
STATISTICAL METHODOLOGY: Seasonal Kendall with Sen slope estimate
STATISTICAL HYPOTHESIS: Ho: No trend exists
Ha: Trend exists
DATA ANALYSIS RESULT: Conclusions regarding presence of trends
Provide estimate of trend magnitude
INFORMATION PRODUCT: Management goal met when no trend exists, or indicates improvement

1.1.4 Pend Oreille Lake, Total Phosphorus Load Targets (Idaho Sources)

MANAGEMENT GOAL: Maintain Idaho phosphorus loading targets
MONITORING GOAL: Compare annual total phosphorus loads to target
DEFINITION OF TARGET: 69,151 kg annual load of total phosphorus
STATISTICAL METHODOLOGY*:
STATISTICAL HYPOTHESIS*:
DATA ANALYSIS RESULT*:
INFORMATION PRODUCT*:

*To be developed upon completion of a lake nutrient management strategy.

Monitoring Stations

Monitoring stations are located at sites of historical USGS data collection, and are representative of mid lake and north lake zones.

Table 2. Monitoring Locations

Site	**Latitude**	**Longitude**	**Area Represented**
Granite Point (2.5 mi SW) USGS Station 2000257	48-04'56"	116-28'33"	South-Central Lake, 70% area; 232.2 km²
Hope (1 mile W) USGS Station 2000259	48-15'00"	116-20'30"	North Lake, 30% area; 99.9 km²

Monitoring Parameters

Water samples for total phosphorus, total nitrogen, soluble reactive phosphorus and total soluble inorganic nitrogen are collected from the euphotic zone (2.5x Secchi depth). Nitrogen variables will be monitored to evaluate N:P ratios (see discussion, Pages 16-17.) If resources allow, it is recommended that soluble phosphorus and nitrogen also be analyzed to provide a more robust data set that may help with identification of nutrient sources. Samples will be taken using a 1000 ml Kemmerer sampler, and depth integrated from the euphotic zone. Chlorophyll-*a* samples will be collected from the same two locations. Field parameters will also include Secchi depth measured at Hope, Granite and Bayview. Detailed sampling methods will be contained in a sampling and analysis plan currently being prepared by Land & Water and to be approved by Montana and Idaho.

Table 3. Sample volumes, containers, preservation and holding times for lake nutrient samples

Analyte	Sample Volume	Container	Preservation	Holding Time
Total P and N	125 ml	polyethylene	add H_2SO_4 to pH<2, cool to <4°C	28 days
Total Soluble inorganic N[4] (NO_2+NO_3+NH_4)	125 ml	polyethylene	filter, add H_2SO_4 to pH<2, cool to <4°C	28 days
Soluble Reactive Phosphorus[1]	125 ml	polyethylene	filter, cool to <4°C	48 hours
Chlorophyll-*a*	1000 ml	amber polyethylene	Filter, freeze	7 days

Monitoring and Assessment Program Costs

Funding for the following monitoring program elements will need to be covered:

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4 Optional monitoring variables

- Monitoring for the above parameters at two stations (Hope and Granite);
- Applicable data from the Council's existing Clark Fork-Pend Oreille monitoring program;
- Trend analyses and reporting; and
- Source loading analysis from Idaho

E. Targets, Loading, Allocation and Monitoring Summary

Based on a review of water quality data, the Technical Team concluded that water quality in the lake's *open water* has not changed significantly since the 1950's. The team therefore concurred with the conclusion of the Section 525 study that maintenance of current water quality is an appropriate goal. To set an in-lake target that would maintain open lake water quality, the team utilized data from the Section 525 studies and MDEQ's long-term monitoring record, along with modeling methods for calculating the correlation between oligotrophic and mesotrophic lake conditions. This target is 7.3 ug/l total phosphorus to protect and maintain open lake water quality.

To meet the in-lake concentration target of 7.3 ug/l total phosphorus, the team set a target for total loading to Pend Oreille Lake of 328,651 kg/yr total phosphorus. To address contributions to the lake's open water from both the Clark Fork River and local sources, the total load is allocated as follows: 259,500 kg/yr total phosphorus from Montana (Clark Fork River at Montana/Idaho state line) and 69,151 kg/yr total phosphorus from the Pend Oreille Lake watershed in Idaho.

Based on existing data, the lake appears to be primarily phosphorus limited, therefore the in-lake target and allocations focus on total phosphorus. However, the in-lake nitrogen to phosphorus (N:P) ratio will be monitored. An observed N:P ratio of 15:1 or lower may indicate a shift toward nitrogen limitation in the lake and will serve as a trigger to initiate the setting of a target for total nitrogen.

A water quality monitoring program is essential to determine if the goal of maintaining open lake water quality is being met. The team has developed a program that includes sampling design to evaluate annual phosphorus loading to Pend Oreille Lake from the Clark Fork River and in-lake concentrations of total phosphorus. Monitoring will also provide the means to detect long-term trends in trophic status of the lake, since it is critical to detect real trends early enough so that appropriate and effective actions can be taken to protect Pend Oreille Lake water quality.

V. Attachments

- Attachment A: Glossary

- Attachment B: Reference List
- Attachment C: Map of Pend Oreille Lake
- Attachment D: Nitrogen vs. Phosphorus Limitation in Pend Oreille Lake Open Water, C. M. Falter
- Attachment E: Pend Oreille Lake Total Phosphorus Targets, B. Anderson and B. Hoelscher
- Attachment F: Predictive Graph
- Attachment G: Phosphorus Load Allocation Worksheet, B. Anderson

APPENDIX E

RESPONSE TO COMMENTS

Years 1999 and 2000

RESPONSE TO COMMENTS

PEND OREILLE/CLARK FORK SUB-BASIN ASSESSMENT AND TOTAL MAXIMUM DAILY LOADS

December 27, 1999
Revised April 17, 2000

The public comment period for this TMDL was November 18 thru December 17, 1999. It was advertised two different times during the comment period in the Coeur d'Alene Press and the Bonner Dailey Bee. Copies of the document were distributed to the Bonner County Library and those groups and individuals who requested copies. The Panhandle Basin Advisory Group and the Tri-State Water Quality Council were kept informed of the progress of the TMDL and provided a preliminary draft of the document. Forty-nine written comments were received during the comment period.

Public comments concerning the Pend Oreille Sub-basin Assessment and TMDL focused on two topics, first commenters felt that the Pend Oreille Lake should not be de-listed, and secondly, that the Clark Fork River TMDL should not be delayed until the year 2004 for its completion. Response to these comments are as follows:

Pend Oreille Lake De-listing

The problem assessment for Pend Oreille Lake concluded that the lake does not qualify for a TMDL. EPA Region 10 requires that threatened waters must be expected to exceed water quality standards due to declining water quality within the next two years. Since DEQ could not foresee that the lake would violate water quality standards within this time frame, a TMDL was not written for the lake. It was noted in the problem assessment that the lake water quality was expected to degrade, however, over a much longer time period than two years. If EPA reverses this policy and allows a preventative TMDL to be written for waters that are not immediately threatened, DEQ will write a TMDL for the lake. DEQ supports the efforts of the Tri-State Council in establishing a voluntary nutrient target for the open water area of the lake.

Clark Fork River TMDL

The Clark Fork River problem assessment concluded that due to lack of data and conflicting data, further work on this assessment will be deferred until the year 2004. It is anticipated that more data will be available by that time to base the TMDL decision on. Commenters urged the DEQ to establish a TMDL now for the river to protect Pend Oreille Lake from further metals pollution. The urgency of establishing this TMDL is due to the proposed Rock Creek mine, which, if permitted, would discharge metal bearing water into the Clark Fork River near Noxon, Montana.

In response to the concerns over the Rock Creek mine, the Idaho DEQ has worked intensively with the Montana DEQ over the last six years in developing an EIS and discharge permit which would be protective of Idaho waters. Neither document has been finalized to date. Montana's draft discharge permit contains a reopener clause which specifically addresses any future TMDLs established by Idaho. The re-opener clause requires that Montana immediately revise the discharge permit to conform with the downstream TMDL requirements. Because of this stipulation, a metals TMDL established for the Clark Fork River in Idaho in year 2004 will have the same effect as a metals TMDL established in 1999. The added benefit is that there will be more data available in 2004 to base a TMDL decision upon.

Comments from the Rock Creek Alliance include reference to 1997 USGS metals data. DEQ is not aware of such data. The USGS stopped metals sampling in 1996 at the Cabinet Gorge station. Traditional sources of information from USGS were consulted during the preparation of the problem assessment and no metals data from 1997 was encountered. If more data are provided DEQ will include it in the problem assessment.

The Alliance also would like DEQ to pursue more frequent monitoring of the Clark Fork. DEQ has recently submitted a proposal for initiating an intensive metals monitoring study at Cabinet Gorge. If funded, DEQ would contract with USGS to do the sampling using ultra-clean methods and depth integrated, bank to bank sampling techniques. This monitoring could determine what flow regime and upstream activities cause peak metals loading at Cabinet Gorge and if this loading violates water quality standards. This study proposal is competing with other similar proposals for funding statewide. There is no assurance that it will be funded, however, DEQ will continue to seek other avenues of financial support for the study.

In another comment, the Rock Creek Alliance questions the validity of a statement presented in the problem assessment that quotes a letter from EPA Region 8. The statement made by EPA Region 8 was that the Rock Creek mine would not violate Idaho water quality standards. To read more about Idaho DEQ's remaining concerns and requests for more information concerning the Rock Creek proposal, contact our office in Coeur d'Alene for copies of the most recent correspondence.

Commenters expressed concern with the discharge of phosphorus and possibly nitrogen from the proposed Rock Creek mine and their effect on the biotic community of the lake. The draft discharge permit assumes that the Idaho state line is at the edge of the mixing zone rather than approximately 21 river miles downstream. Over this 21 miles the river's plant life will assimilate (use up) the biologically available phosphorus. Modeling this nutrient uptake in the river was one of the studies Idaho encouraged Montana to undertake for development of the EIS.

Idaho has also encouraged Montana to conduct an analysis of potential effects of increased nitrogen in the Clark Fork River and Pend Oreille Lake. In the past, it was thought that nitrogen would have no effect on the lake because it was believed to be phosphorus limited. Recently, this phosphorus limited theory was discussed at the Tri-State Council's Voluntary Nutrient Target Meeting held in December 1999. The scientists at that meeting, using all available data on the Lower Clark Fork River and Pend Oreille Lake, determined that there was a significant element of uncertainty concerning the effects of increased nitrogen discharge to the lake. The most conservative approach to protecting lake water quality would be to set a nitrogen-phosphorus ratio action level. The State would then be required to act when the ratio approaches values that are indicative of a nitrogen limiting situation.

One potential consequence of not limiting nitrogen sources might occur in the near shore areas. As the near shore areas become increasingly phosphorus rich due to land use practices and development, phosphorus would no longer be the limiting nutrient for plant growth. Instead nitrogen becomes the limiting nutrient and if it has been allowed to increase in the water column, it will be utilized to create more aquatic plant biomass. The effect of increased nitrogen on plant diversity and composition is also unknown.

Metals may also be assimilated as the water flows towards the border. Metals bound to sediments may sink to the bottom or become neutralized due to the buffering capacity of the river water. The fate of the metals from the Rock Creek discharge is not discussed in the EIS or draft discharge permit. Idaho encourages Montana to investigate the expected fate of metals as they are discharged from the Rock Creek mine.

The concerns the public has with the proposed Rock Creek mine are valid and the outcomes of these remaining issues may have an effect on any future discharges permitted by Montana. However, Idaho DEQ feels that the protection afforded by the discharge permit re-opener clause and the expectations of future metals monitoring data are sufficiently strong reasons to allow the Clark Fork River TMDL to be finished in the year 2004.

<u>General Comments</u>
1. Comment: A reference was made to EPA's "Water Quality Criteria 1972" (blue book) in the Pend Oreille Lake problem assessment. EPA is developing numeric standards for nutrients and these values should be used rather those in the blue book.

2. Comment: DEQ should be monitoring more intensively in both the lake and river.

Response
At the time the problem assessment was written, the blue book offered the most conservative values of phosphorus concentrations for lakes and reservoirs, from 10 to 30 ug/l total P. Gold book value was not to exceed 25 ug/l total P. At that time, there were no other recommendations for nutrient concentrations available from EPA. Most guidance documents and policy statements from federal and state agencies are just now being developed. New funding sources are now being developed to collect data necessary for TMDL development. Future TMDLs will benefit from these changes. In the meantime, approved policies, existing guidance documents, traditional funding sources and water quality standards will guide TMDL development.

3. Comment: The Clark Fork River and Pend Oreille Lake should be listed for dissolved gas. The Clark Fork River problem assessment should address habitat alteration, flow alteration and dissolved gas rather than just metals.

Response
Idaho's draft 1998 303(d) list includes a listing for the Clark Fork River as impaired due to dissolved gas. Pollutants being addressed in this Sub-basin Assessment are in accordance with the Idaho TMDL Development Schedule. Pollutants added to this Schedule will be dealt with

at a later time.

4. Comment: The BURP/WBAG process has not been validated by EPA and it should not be used to de-list Clark Fork HUC tributaries.

Response
The BURP/WBAG process is currently being revised by DEQ. Once the revision is final, support status calls will be made using the new WBAG. Since action on the Clark Fork River and its tributaries are being deferred until 2003 and the WBAG process is being changed, it would be premature to delist any Clark Fork tributary at this time.

5. Comment: Caribou Creek, Grouse Creek, Granite Creek, Gold Creek and Fish Creek should not have been de-listed based upon the BURP/WBAG support status conclusions.

Response
The WBAG process is DEQ's method of assessing the support status of waterbodies. Until that process is changed, it remains the approved method of determining if a stream is impaired or fully supportive of its beneficial uses. Streams may be re-assessed using the new WBAG process to determine if their support status calls have changed as a result of the new process.

6. Comment: The Pend Oreille River should have sediment and nutrient TMDLs written for it.

Response
The Pend Oreille River problem assessment summary indicated that Idaho has no method to determine the support status of cold water biota in this river. Lacking an assessment method and any data that indicate that cold water biota is impaired, a TMDL for sediment will not be written. Once DEQ develops an assessment process the river's support status will be determined. Based on research from other areas, the presence of a dam on the river may be the overriding factor in governing water quality of the Pend Oreille.

Year 2000 Response to Comments for Gold Creek (tributary to Pend Oreille Lake), Caribou Creek (tributary to Pack River) and Grouse Creek (tributary to Pack River) and Fish Creek Total Maximum Daily Loads.

One comment was received during the December 13, 2000 – January 12, 2001 public comment period.

Response to Kootenai Environmental Alliance Comments

The KEA comments focused on concerns that clearcuts and other timber harvesting practices are increasing peak flows and thereby destabilizing the streambed and banks of Caribou, Grouse and Gold Creeks. In addition, specific questions were asked about the calculations and information provided in the TMDL documents. Our response is as follows:

1. The calculation for total sediment loading includes forest and county roads, road failures, fire, unstocked forest, pasture land, highways and mass wasting (both natural and man caused), not just roads. Refer to the spreadsheets at the end of each TMDL for this information. Acreages and sediment yield calculations for each TMDL are correct. Note that sediment yield for "Unstocked Forest", "Highway" and "Double Fires" land uses are added to the basic land use sediment yield to account for these special conditions. For example Gold Creek has 6,592 acres of forested land and all of that acreage has been either burned once or is unstocked forest. Since there is an increase in sediment from unstocked or burned sites an additional 0.017 tons/acre/year is added to the 0.038 tons/acre/year background value for forested land.

2. Problems associated with flow or habitat have not been addressed since Idaho maintains that these are not pollutants as defined by §502(6) of the Clean Water Act. As you suggest, it is possible that reducing the level of regulated pollutants in these streams may not completely restore beneficial uses without addressing flow or some other parameter such as the lack of large woody debris. As yet, there is no solution proposed for this situation. Temperature TMDLs will be written when Idaho revises its temperature rules. At that time canopy cover and runoff characteristics can be evaluated. Your ideas will be added to the problem assessment portion of the TMDLs under the heading "Data Gaps For Determination of Support Status".

3. In reference to your concerns about North Gold and West Gold Creeks, they are not on the 303(d) list and therefore not addressed in the problem assessment. West Gold does flow into the lower end of Gold Creek and could influence water quality in this short section. In response to situations such as this, DEQ staff met with the Panhandle National Forest staff January 9, 2001 to inform them of the water quality rules that apply to 303(d) listed waters and their tributaries. The Forest agreed to meet with their District staff to pass along this information to insure that work proposed in impaired watersheds meets the rules contained in the Idaho water quality standards.

4. The best available data and information concerning these watersheds were solicited from the land management agencies and other sources. It would have been useful to conduct our own surveys for data we felt were outdated or incomplete, however, due to time and funding restrictions it was not possible to do so. Recent timber sales may not be reflected in USFS data.

5. The WATSED modeling work was done by the Idaho Department of Lands. For information concerning the calibration of the model you can contact Tom Dechert at (208)799-4370.

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