Little Lost River Subbasin TMDL

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An Allocation of Nonpoint Source Pollutants in the Water Quality Limited Watersheds of the Little Lost River Valley

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Acknowledgements

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Executive Summary

Water quality, native fish populations and riparian habitat conditions have been an issue of concern in the Little Lost River watershed since the combined effects of flooding, wildfires, warm season grazing, introduction of exotic species and man-caused channelization and diversion have combined to alter sediment deposition, fish populations, and riparian vegetation along Sawmill Creek, Wet Creek and the Little Lost River. These surface waters are identified within the watershed as not supporting the beneficial uses of salmonid spawning and coldwater biota, and as important components of the Little Lost River bull trout recovery unit.

Assessments by the Idaho Department of Environmental Quality (DEQ) have identified that water quality has been limited by deposition of sediment and elevated stream temperature due to streambank erosion and reduction of riparian vegetation. Previous assessments by the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) have also identified the problems associated with water quality in the Little Lost River watershed.

BLM and USFS management practices have been altered since the early 1980s to improve water quality and habitat conditions along the major streams in the watershed. Water quality and habitat conditions have shown improvement and it is expected that with continued riparian management beneficial uses will continue to be supported in Sawmill Creek and Wet Creek, and will ultimately be fully supported in the Little Lost River.

The Clean Water Act requires that the state of Idaho identify water quality limited surface waters and develop a plan to restore beneficial use support to these waters. The Endangered Species Act requires that conservation plans be developed and implemented to restore bull trout populations to levels that insure their persistence in the Little Lost River Watershed.

DEQ has developed recommendations for the reduction of streambank erosion that would ultimately result in beneficial use support through improving streambank stability and subsequently riparian vegetation to reduce temperature. Sediment load reductions are quantified through streambank erosion inventories that estimate streambank erosion based on streambank conditions documented along several reaches of each stream. Instream sediment targets have been identified from literature values that are supportive of salmonid spawning and coldwater biota. These target values will be used to track the progress of streambank recovery and determine the need for additional management practices to improve water quality.

Streambank erosion must be reduced by an average of 61%, 62%, and 80% on the Little Lost River, Wet Creek and Sawmill Creek. This reduction of streambank erosion should result in a reduction of streambed fine sediment smaller than 6.35 mm (0.25 in) to the target level of 28% in areas suitable for salmonid spawning. These reductions incorporate an implicit margin of safety to assure restoration of beneficial uses and

equate to streambank erosion rates expected at 80% streambank stability, which is considered natural background erosion within this TMDL. Monitoring will be conducted by land management agencies to determine the adequacy of reductions and management practices.

Heat load reductions are quantified through use of temperature data loggers on water quality limited streams and identifying the reduction necessary to comply with state water quality standards. Site reach percent reductions and statements about implicit Margins of Safety are built into state water quality standards for temperature.

Table 1 Little Lost River TMDL load reduction summary for §303(d) streams.

Water Body	**Estimated Existing Total Sediment Load from Streambank Erosion**	**% Sediment Reduction from Streambank Erosion**	**Average % Temperature Reduction of Daily Average**
Little Lost River	231 tons/year	61	43
Sawmill Creek	671 tons/year	80	35
Wet Creek	224 tons/year	62	44

Water Body	Pollutants Addressed
Little Lost River	*Sediment, Temperature*
Sawmill Creek	*Sediment, Temperature*
Wet Creek	*Sediment, Temperature*

Little Lost River Subbasin at a Glance:

Hydrologic Unit Code	17040217
1998 Water Quality Limited Segments	Little Lost River, Sawmill Creek Wet Creek
Beneficial Uses Affected	Cold Water Biota Salmonid Spawning
Pollutants of Concern	Sediment, Temperature
Major Land Uses	Forestry, Agriculture
Sources Considered	Streambank/Road Erosion, Direct Solar Radiation
Area	963 sq. miles
Population (1990)	325

1.0 Introduction

Total Maximum Daily Load
The Total Maximum Daily Load (TMDL) process is described in Section (§) 303(d) of the Clean Water Act (CWA) (40 CFR 130.7). TMDLs are plans designed to direct management actions so that polluted water bodies are restored to a level that achieves state water quality standards. A TMDL is a mechanism for determining how much pollutant a water body can safely assimilate (the loading capacity) without violating state water quality standards. An essential component of a TMDL is identifying the current volume or mass and sources of pollutants discharged to the water body. Thereafter, a determination can be made identifying the amount of pollutants each source may discharge (the allocations). Point sources of pollution, those discharges from discrete pipes or conveyances, will receive a wasteload allocation (WLA) that specifies how much of the pollutant each point source can release to the water body. There are no point sources within the Little Lost Watershed, therefore the WLA=0. Nonpoint sources of pollution will receive a load allocation (LA), which specifies how much pollutant can be released to a water body.

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

Loading capacity is established taking into account seasonal variations and a margin of safety, which accounts for lack of knowledge concerning the relationship between pollution control mechanisms and water quality or beneficial use support. Calculating the exact pollutant load for pollutants running off the land or eroding directly into the stream (nonpoint sources) is difficult or, in some cases not possible. It can be dependent on natural conditions that are not fully understood or very site specific. Therefore, an adaptive management or phased TMDL is necessary which identifies interim load allocations, with further monitoring to gauge the success of management actions in achieving load reduction goals and/or the affect of actual load reductions on the water quality or beneficial use support in the Little Lost River.

The purpose of the Little Lost River TMDL is to establish an approach to achieve beneficial use support in the Little Lost River, and support water quality standards in Sawmill Creek and Wet Creek within the Little Lost River Watershed. These water bodies have been identified as water quality limited because they do not fully support beneficial uses for salmonid spawning and coldwater biota. These streams have been identified as water quality limited in the Little Lost River Subbasin Assessment (IDEQ 1998). The Subbasin Assessment is a characterization of all of the water quality data available on the streams within the subbasin or watershed.

The cause of these existing conditions has been identified as excessive sediment loading to the streams from streambank erosion and the associated elevation of stream temperature on each of the listed streams. The water quality of Wet Creek, Sawmill Creek, and the Little Lost River has been identified as impaired as specified under Section (§) 303(d) of the Clean Water Act (CWA). Section 303(d) requires each state to submit a biennial list to the Environmental Protection Agency (EPA) which identifies those waters throughout the state that are not achieving state water quality standards in spite of the application of technology-based controls in Best Management Practices (BMPs) for nonpoint source pollution. Such water bodies are known as "water quality-limited." There are no point sources such as municipal or industrial discharge into the Little Lost River or its tributaries. After identification of water quality limited segments in the Subbasin Assessment, the state must then develop a total maximum daily load for the pollutants that are impairing protected uses. Once the pollutant quantity or load has been determined controls can be implemented to reduce the load of pollutants until the water quality is restored to a level that is in compliance with state water quality standards. After completion and public review, TMDLs are submitted to the EPA for approval. Congress mandated that the EPA identify water quality limited segments and develop TMDLs if the state does not fulfill its responsibilities under §303(d) of the CWA. The Idaho Department of Environmental Quality (DEQ) is directed by state statute (see Idaho Code Section 39-3601 et seq.) to develop TMDLs.

History

The water quality, hydrology, fisheries and habitat conditions of streams within the Little Lost River have been monitored over the past twenty years (Mundorff, Crosthwaite, & Kilburn, 1964; Andrews, 1972; Corsi & Elle, 1989; Rose & Gallogly, 1996; USFS, 1997; Gamett, 1998; IDEQ, 1998; Koelsch, 2000; Gamett, 2000). Past events such as wildfire and heavy grazing have resulted in increased sedimentation and channel instability on Sawmill Creek. Wet Creek and the Little Lost River have been impacted by streambank erosion, and hydrologic modification related to grazing and diversion of surface waters. The 1996 listing of several water bodies within the Little Lost River watershed and the

1997 listing of the only native fish within the Little Lost River watershed, the bull trout (*Salvelinus confluentus)* as threatened under the Endangered Species Act, has heightened concern about water quality.

Issues of Concern

Increased erosion of streambanks has resulted in elevated levels of turbidity, deposition of fine sediment within spawning gravel, and loss of habitat diversity within the streams listed as water quality impaired. Streambank erosion has also resulted in loss of stream shading from riparian vegetation that has led to elevated stream temperatures during the warmest seasons of the year. These conditions have been further exacerbated by human and natural caused fires in the Sawmill Creek watershed that have increased peak flows that have resulted in severe channel modification in areas and further increased sediment deposition. The loss of riparian vegetation that provided thermal buffering to the stream has likely contributed to ice damming of the lower Little Lost that has resulted in past flooding of the town of Howe. Flooding was subsequently alleviated by diverting the Little Lost River into infiltration trenches above the town of Howe that completely dewater the Little Lost River during times of high flooding risk. The impact of dewatering the Little Lost River during winter months was mitigated by implementing BMPs on Sawmill Creek to improve streambank stability and riparian habitat conditions. Additionally, BMPs have been implemented on Wet Creek to improve streambank stability and riparian habitat conditions to recover the effect of historic heavy grazing. Streambank erosion on Wet Creek has also been increased from a hydropower project that diverts the flow of Dry Creek, to the North, into a pipeline that discharges into Wet Creek. Wet Creek and Sawmill Creek are also a source of sediment to the Little Lost River.

2.0 Watershed Assessment

2.1 Watershed Description

A complete characterization of the Little Lost River subbasin can be found in the Little Lost River Subbasin Assessment (IDEQ, 1998), available from the Idaho Falls Regional Office of the DEQ. This watershed description is intended to serve as a succinct background to frame the issues within the following sections for the individual TMDLs for the Little Lost River and its §303(d) listed tributaries. More localized watershed descriptions are included in the individual TMDL sections.

The Little Lost River subbasin is located in eastern Idaho on the northern margin of the Snake River plain. The watershed is approximately 50 miles long by 20 miles wide (963 square miles). The valley floor averages seven miles in width, and is fairly consistent in width from the head of the valley to the mouth. Shaped like a long rectangle, it contains a high elevation valley flanked by the Lost River Range to the west and the Lemhi Range to the east.

The spine of the Lost River Range near the subbasin is predominately 10,000 feet in elevation, varying from 12,000 feet (Mount Breitenbach) in the north to 8,500 feet (Howe Peak) in the south. Most of the Lemhi Range is close to 11,000 feet in elevation with the ridge line ranging from 12,200 feet (Diamond Peak) to 10,800 feet (Saddle Mountain). The northwestern portion of the subbasin broadens a bit with several mountains and hills in the valley located between the Lost River Range and the Little Lost River.

Sawmill Creek elevation reaches 7,200 feet near Timber Creek at the head of Sawmill Canyon with surrounding mountains varying in elevation from 9,000 to 10,900 feet. Sawmill Creek joins Summit Creek at 6,200 feet in elevation. The valley bottom ranges in elevation from 6,600 feet near the source of Summit Creek in the north to 4,800 feet near the Little Lost River Sinks, resulting in an approximate average valley gradient of 38 feet/mile (the gradient is steeper in the upper reaches of the valley).

Climate

The valley bottom of the Little Lost River basin can be characterized as a high desert. Average annual precipitation is less than 10 inches per year over much of the valley. Winters are long and cold while summers are brief and hot. Precipitation rises in the flanking mountains to 35 inches or more, falling mostly as snow.

Hydrology

The Little Lost River, the largest stream in the subbasin, flows southeastward between the Lost River and Lemhi Ranges. The headwaters of the river are located in the far northern corner of the subbasin in Sawmill Canyon. Several tributaries join the river in the canyon before it meets Summit Creek in the valley.

Some maps of the area, such as the Challis National Forest Map, refer to this upper portion above Summit Creek as the Little Lost River, while United States Geological Survey (USGS) maps and the Geographic Names Information System refer to the mainstem above Summit Creek as Sawmill Creek. The later is the convention used here. Thus the Little Lost River begins at the confluence of Sawmill and Summit Creeks about four miles northwest of Clyde. The river then flows almost directly down the middle of a large rectangular valley filled with glacial alluvium.

Sawmill Creek rises in the Lemhi Range and flows initially on consolidated rock for 12 to 14 miles. Sawmill then loses up to 50% of its water by percolation to underlying alluvial sediments from the point it enters the valley floor to its confluence with Summit Creek (Andrews 1972). Summit Creek rises in numerous springs and seeps at the northwest end of the basin. Other major tributaries to the Little Lost River include Dry Creek and Wet Creek from the northwestern corner of the subbasin.

Below Clyde a number of spring-fed tributaries enter the Little Lost River including Williams Creek and Badger Creek from the Lemhi range, and Deer Creek from the Lost River range. The remainder of the mountain tributaries are short and flow steeply off the flanking mountains producing large alluvial fans (up to 900 m deep) extending more than halfway across the valley in places. Except during times of high runoff, most of these creeks entering the valley from side canyons disappear into their alluvium before reaching the river. Consequently, most of the runoff to the Little Lost River below badger Creek is through subsurface flow and spring-fed valley streams such as Big Springs and Fallert Springs Creeks arising in the valley rather than the mountains.

Mundorf and others (1963) reported that the valley bottom aquifer rises to the surface for 2-3 miles below the confluence of Summit and Sawmill Creeks creating a natural swampy area and feeding flow in the river. For the next 7-8 miles the water table is within 15-20 feet of the surface and rises to the surface again below the mouth of Badger Creek contributing flow to the Little Lost through several springs. The water table then dips only to rise to the surface one more time for 3-4 miles around Fallert Springs Creeks before diving to 200 feet or more below ground in the vicinity of Howe.

Total discharge has been reported to be greater below Badger Creek due to the inflow of spring-fed creeks upstream and a large ridge extending from the Lemhi Range that forces the water table to the surface at Fallert Springs Creeks (Andrews 1972). The significant spring-dominated flow regime in the lower valley has made this valley more resistant to drought than the Big Lost valley to the west. The river disappears into an ephemeral playa, the Little Lost River Sink, just south of Howe on the margin of the Snake River Plain. The river sometimes drains into the Big Lost River Sinks during times of extremely high runoff (Bartholomay 1990).

Annual hydrographs of the Little Lost River show a late-spring early summer snowmelt peak. There is less than a ten-fold range in mean monthly discharge and minimum flows typically occur in mid-winter. Overall run-off is less than 1.7 inches, discounting diversions for irrigation of about 4000 acres.

Geology

The geologic description of the Little Lost River subbasin was compiled from Stearns and others (1938), Mundorf and others (1964), and Alt and Hyndman (1989). Geologically complex, the bounding mountain ranges are for the most part formed of Paleozoic sedimentary rocks, including folded and faulted limestones, quartzites and shales. Local occurrences of Tertiary volcanic rocks of the Challis formation, chiefly andesitic or silicic in composition, constitute a portion of these mountains also. Both ranges terminate at their southeastern margin in the Eastern Snake River Plain where basalt is the predominant lithology. The Little Lost River valley is apparently formed in a down-faulted block of consolidated rocks, similar to those in the uplands. The river flows on alluvium, resulting from erosion of the flanks of the mountains, that has partially filled the valley.

These bordering mountain ranges began to take form by the middle Cenozoic, prior to the subsidence of the Snake River Plain, which began in Late Cenozoic time. These ranges are a result of a northeastern extension of the underlying continental crust, and the consequent block-faulted Basin and Range topography characteristic of this part of the West. Uplift, tilting, faulting and the concurrent subsidence of the Little Lost River basin (and watershed) has continued to the present.

A significant factor in terms of the surficial geology of the basin is the work of glaciers during the Pleistocene. These glaciers added debris, in the form of terraces and outwash deposits, to the valley. Since Quaternary time tributary streams have filled the valley with alluvium to considerable depth, perhaps as much as 3000 feet. An obvious feature of the valley today is a series of coalescing alluvial fans consisting of poorly sorted materials eroded form the flanking mountains. Toward the center of the valley the Little Lost River has reworked, somewhat leveled, and better sorted the alluvial deposits. This alluvium hosts a large reservoir of groundwater, which feeds the many springs in the subbasin. Soils formed on this alluvium are for the most part thin, stony and well drained.

Soils

The types of soils in the subbasin affect many aspects of surface water, particularly the quantity and texture of sediment in the water bodies. In the Little Lost River subbasin, the surface soil texture is predominately gravelly loam throughout the valley and along the mountain ranges. Gravelly loam is not as erodible as other soil textures, but it is difficult for vegetation to grow in this coarse soil and provide cohesiveness. There is some loam, sandy loam, clay loam and silt loam in small portions of the valley. In the mountain ranges toward the ridge line, stony loam, cobbly loam, unweathered bedrock and fragmented material cover the slopes.

The soil depth is deeper in the valley bottom and shallower along the hillsides and mountain slopes. Most of the valley bottom soil is about 56 to 60 inches deep while the hillside soils range from 34 to 56 inches deep. Along the top of the mountain ridges and at the southern tip of the basin (Little Lost River Sinks) the soil is fairly shallow at about 20 to 34 inches deep.

The average soil slope provides a gauge of potential soil erosion, or erodibility risk. The slopes are low (3-9%) in the valley and gradually increase as approaching the two bordering mountain ranges. The slopes are fairly steep in the mountain ranges particularly along the Lemhi Range where average slopes were greater than 44% in places.

The K-factor is the soil erodibility factor in the Universal Soil Loss Equation. The factor is composed of four soil properties: texture, organic matter content, soil structure, and permeability. The K-factor values range from 1.0 (most erosive) to 0.01 (nearly nonerosive). The weighted average K-factors are fairly low to moderate (0.08 to 0.34) for this semi-arid subbasin comprised of mainly coarse soil textures. In comparing the factors for the subbasin, the values are lowest along the mountain ridges where unweathered bedrock and fragmented material is found. The valley and surrounding hillsides show a range of 0.08 to 0.17 except for portions in the north and a section in the south.

Geomorphic Description

Stream channels can be described by their gradient, width, depth, entrenchment and substrate type as well as other parameters described in Rosgen (1996). The Rosgen system of stream channel classification helps provide insight into the function and evolution of stream channels within the Little Lost watershed. It also provides a range of parameters that are useful to describe expected conditions and to compare with observed conditions. Relief ratio is an indication of sediment yield potential. Values are dimensionless and range between 0 and 1. Drainage Density (D) is an indication of the spacing and distribution of drainage channels within the drainage basin. High drainage density indicates numerous closely spaced channels that provide an efficient route for runoff and entrained sediment load. Depositional stream density is the ratio of the length of depositional stream (overall gradient less than 1.5%) to the length of transport stream (overall gradient greater than 1.5% but less than 3%). As the length of depositional reaches increases, the potential sediment transport decreases. Bankfull discharge is the maximum flow prior to flooding. It is the flow at which streams function at their highest efficiency to transport sediment. Bankfull flow is estimated to occur at a frequency of approximately 1.5 years (Rosgen 1996). The product of relief ratio, drainage density and bankfull discharge divided by depositional stream density (miles of stream <1.5% slope) gives sediment transport potential (P_S), which is an indication of streams tendency to transport, deposit, or deliver sediment through its coarse. Use of bankfull discharge as a variable in the calculation of P_S attempts to account for long term climatic trends within the basin and to limit the effects of annual variability in the watershed. The geomorphic risk assessment is used within this TMDL to characterize each §303(d) listed watershed with the others and to compare the potential of each watershed to move sediment through its course.

Riparian vegetation has an important effect on stream morphology and streambank stability of certain stream types. This effect is very high on C channel types (Rosgen 1994). Stream morphology also influences the presence, amount and potential for establishment of riparian vegetation communities (Rosgen 1996). This interrelationship is very important to the existing and potential conditions observed in Wet Creek. Years of unmanaged overgrazing have shifted riparian communities that previously had significant components of intermediate sized woody/shrub species to primarily grass/forb communities. Since the 1930's attempts were made to divert Dry Creek streamflows into Wet Creek to save water and produce hydroelectricity. The earliest diversion was made via Corral Creek, the second through the Dry Creek Flume, and most recently the Dry Creek Pipeline. These additional flows to Wet Creek have degraded (incised) the channel bed, in some reaches severely, and it continues to develop a floodplain. Implementation of comprehensive riparian grazing management by BLM has initiated restoration of riparian vegetation communities to Booth willow, Geyer willow/beaked sedge, Water birch, and Nebraska sedge community types (BLM 2000). In time, with continued responsible riparian management, succession will likely continue toward intermediate sized woody/shrub species from the current willow oriented community types. These successional changes will improve the temperature regime by increasing shading of the stream and reducing the surface area of the stream, as well as reduce streambank erosion and improve width to depth ratio.

Additionally, stream channels can incise, lowering the water table adjacent to the stream, removing the streams access to its flood plain, and changing how the channel functions. Much of the Proper Functioning Condition evaluation conducted by the BLM is based on this relationship. Properly functioning stream channels generally have access to their flood plain and the potential for larger woody plants is elevated as a result of this. Reestablishing the flood plain necessitates a certain amount of bank erosion to accommodate this cyclical flooding and redistribution of sediment to build a redefined bank. Ultimately, the potential for deeper rooted larger woody plants increases and they colonize available habitat. Changes in the composition, vigor, and density of riparian vegetation produce corresponding changes in rooting depth, rooting density, shading, water temperature, physical protection from bank erosion processes, terrestrial insect habitat, and contribution of detritus to the channel (Rosgen 1996). Overall, the Little Lost stream channel is incised from just above the confluence of Wet Creek to the upper Little Lost River Highway crossing at Clyde. The Sawmill Creek channel is aggraded with much lateral instability and extreme channel widening.

Biological Characteristics

The land cover in the Little Lost River subbasin is predominately forest in the mountain ranges and rangeland in the valley with some irrigated agriculture around Clyde, Fallert, and Howe. In the most northwestern corner of the subbasin, the range of elevation produces a broad spectrum of life zones ranging from semi-arid shrub lands to alpine rock/scree. Several vegetation types are present, including sagebrush and grass, mountain mahogany, spruce, subalpine fir, whitebark pine, and Douglas-fir. In the South Lost River Management Area of the Challis National Forest the vegetative types include sagebrush and grass, and mountain mahogany at the lower elevations with an abrupt transition to Douglas-fir and whitebark pine at higher elevations. A few drainages hold minor amounts of commercial timber, but the quality is poor. The area is classified as part of the western spruce/fir forest ecosystem.

In Sawmill Canyon, vegetation includes sagebrush, grass communities, lodgepole pine, Douglas-fir, subalpine, and mountain mahogany. The area is classified as a sagebrush steppe and western spruce/fir ecosystem (USFS 1987). Moving toward the mouth of Sawmill canyon, the riparian vegetation shifts to balsam poplars, river birch, willows, and crested wheat grass. As the river enters the valley near Summit Creek, the vegetation changes to a mixture of sagebrush, rabbit brush and grasses (Andrews 1972). The area to the east of Howe, the Arco Hills, is classified as a sagebrush steppe ecosystem. The higher elevations are characterized by more gentle sagebrush/grass covered slopes interspersed with stringers of Douglas-fir and whitebark pine (USFS 1987).

The Wet Creek drainage over the listed reach is primarily sagebrush, grass communities with a willow dominated riparian zone.

Few fish have had access to the Little Lost River drainage due to ancient geological formations, which limit overland connections between these streams and adjacent drainages. Some species in the basin are plainly introduced while other species may be naturally established from when the Little Lost River drainage was linked to the Salmon River and Snake River drainages. Eight species of salmonids have been reported to be native or have been introduced into the Little Lost River basin (BLM 1998, USFS 1997, Gamett 1998). These are rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), bull trout (*S. confluentus*), cutthroat trout (*O. clarki*), brown trout (*Salmo trutta*), golden trout (*O. aquabonita*), mountain whitefish (*Prosopium williamsoni*) and Arctic grayling (*Thymallus arcticus*). The subbasin also contains shorthead sculpin (*Cottus confusus*), a native species.

Fish introductions in the drainage have been considerable and date back to 1915. Some species known to have been introduced in the drainage—golden trout, mountain whitefish, and grayling—have not been documented in any streams (Gamett 1998). Other introductions are clearly exotic. According to Gamett (1998) introduced species in the Little Lost River drainage include guppy (*Poecilia reticulata*), green swordtail (*Xiphophorus helleri*), convict cichlid (*Cichlasoma nigrofasciatum*), Mozambique tilapia (*Tilapia mossambica*), and goldfish (*Carassius auratus*). All five of these have been identified in Barney Hot Springs in the Summit Creek drainage.

The Little Lost River drainage upstream of the Big Springs Creek confluence is one of 59 key watersheds identified in Governor Batt's State of Idaho Bull Trout Conservation Plan (Batt 1996). Bull trout have been reported in the upper reaches of Badger Creek and Big Creek, the lower reach of Camp Creek, Hawley Creek, Iron Creek, Jackson Creek, the mid- and upper reaches of the mainstream (including Sawmill Creek), Mill Creek, Quigley Creek, Redrock Creek, Smithie Fork, Timber Creek, Squaw Creek (Sawmill Canyon), North Fork Squaw Creek, lower Slide Creek, the upper reach of Warm Creek, Wet Creek (except the mid-section), and Williams Creek. Bull trout are thought to have been introduced to the watershed by an irrigation ditch that connected the upper Pahsimeroi with upper Summit Creek.

Cultural Description

The area in and around the Little Lost Valley is entirely rural with an economy based on agriculture. Grazing of cattle and sheep is the principal agricultural activity, including irrigated pasture and hay to support these animals through the winter. Approximately 9,000 head of cattle and 10,000 head of sheep graze in the subbasin according to recent estimates (BLM, USFS personal communication). In the lower half of the subbasin there is some irrigated cropland, principally alfalfa and small grains. Diversion of surface water for irrigation dates back to the 1870s and has been supplemented by pumping of groundwater since 1948 (IDWR 1998). Currently more acreage is sprinkler irrigated than gravity irrigated (Brennan and others 1997).

Howe, with a population estimated at 20 in 1990, is the largest community. Based on 1990 census data, the population of the subbasin is 325. There are less than 0.5 persons per square mile, making this area one of the least populated areas in Idaho, outside of designated wilderness. Over 90% of the land area is publicly owned with the USFS and BLM being two principal land management agencies.

About 70% of the subbasin is considered rangeland. The second major land use category is evergreen forested and mixed forested land at 17%. These forested areas are scattered with shrub and brush rangeland throughout the two mountain ranges. A small percentage of the land, about 6%, is used for cropland and pasture. The remaining land cover in the subbasin is principally a mixture of tundra and bare ground.

Road densities are very low in the subbasin. The Little Lost/Pahsimeroi highway is the main paved road through the valley. There are several unpaved roads, developed by BLM, that cross the valley. Most of the unpaved roads located in Sawmill Canyon were developed by the USFS.

Most of the subbasin falls within Butte County, although Custer and Lemhi Counties divide the northern section. A small percentage of the land in the subbasin is privately owned, with the majority (91%) of the land ownership being public. BLM (43%) and the USFS (43%) manage the largest portions. The federal boundaries of Idaho National Environmental Engineering Laboratory (INEEL) enter the subbasin at the southern tip. The State of Idaho (Idaho Department of Lands) manages small land parcels interspersed within BLM land.

Watershed Characteristics

The Little Lost River subbasin has seven subwatersheds or fifth field hydrologic units (Table 2). The table shows the considerable changes in elevation ranges and corresponding relief ratios. The relief ratio is the difference in elevation between the high point on a watershed divide and its pour point divided by the length of the watershed. This ratio provides a relative indication of watershed steepness and thus, the erosive power of runoff in that watershed. An entirely flat watershed has a relief ratio of zero. Drainage density provides a relative measure of transport efficiency.

Table 2 Physical attributes of 5th field HUCs in the Little Lost River subbasin.

HUC5 No.	HUC5 Name	Area (Acres)	Dominant Aspect	Elevation Range		Relief Ratio[1]	Drainage Density[2] (mi/mi^2)
				Low	High		
1	Lower Little Lost River	141,344	SE	4819	10810	.100-.125	1.19
2	Taylor Canyon	33,557	E	5085	10771	.082	1.40
3	Middle Little Lost River	109,767	SE	5292	10741	.105-.134	1.56
4	Williams Creek	78,262	W-SW	5774	12198	.131-.162	1.26
5	Wet Creek	117,124	NE-E	6171	12139	.052	1.09
6	Summit Creek	62,184	SE	6250	10745	.053	0.75
7	Sawmill Creek	74,138	S-SW	6211	10866	.045	1.13
	Total	616,375					

[1] For mainstem or composite 5th field HUC Nos. 1, 3, 4, relief ratio is calculated based on the width both to the left and right of the mainstem, rather than 'length.'
[2] Drainage density based on 1:100k GIS hydrography, excluding canals and ditches.

For comparable geology and soils, a watershed with greater relief ratio and drainage density would to have a greater natural sediment yield as well as higher potential for accelerated erosion due to land surface disturbances.

2.2 Water Quality Concerns and Status

Water Quality Criteria

The Little Lost River, from its origin at the confluence of Summit Creek and Sawmill Creek, to the confluence of Big Spring Creek is listed for temperature and unknown pollutants. From Big Spring Creek to its lower listed boundary at the diversion below the infiltration trenches, the Little Lost river is listed for unknown pollutants. Unknown pollutants have been determined to be temperature and sediment within this TMDL from direct observation/measurement of channel and streambank conditions and available temperature data.

Sawmill Creek and Wet Creek, were listed for sediment. The Idaho water quality standards narrative criteria (IDAPA 58.01.02.200.08) 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.

None of the 1998 §303(d) streams are listed for nutrients. The narrative criteria (IDAPA 58.01.02.200.06) for nutrients states that surface waters "shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." During streambank erosion inventories, visible slime growths or other nuisance levels of aquatic plant growths were not observed.

Wet Creek and Sawmill Creek are also listed for temperature. The numeric criteria (IDAPA 58.01.02.250) for temperature are found under cold water biota and salmonid spawning. For cold water biota, water temperatures must maintain 22° C or less with a maximum daily average of no greater than 19° C. During spawning periods and incubation periods for particular salmonid species, water temperature must maintain 13° C or less with a maximum daily average no greater than 9° C (Table 3).

The Little Lost River subbasin is also considered a key bull trout watershed. There are specific numeric temperature criteria for bull trout in the water quality standards (IDAPA 58.01.02.250). For water above 1400 m in elevation (except for 5th order rivers), water temperatures shall not exceed 12° C daily average during June, July and August for juvenile bull trout rearing, and 9° C daily average during September and October for bull trout spawning.

Wet Creek is listed for flow alteration, although no TMDL will be written for flow as flow is not a recognized pollutant by the state of Idaho or EPA. There are no Idaho water quality standards for flow, nor is it suitable for estimation of load capacity or load allocations. Because of these practical limitations, TMDLs will not be developed to address flow alteration. For many of the water quality limited waters on Idaho's §303(d) list, this position will have little effect on implementation plans. This is because concerns which resulted in a listing for flow alteration are often reflected in listed pollutants—sediment or temperature, for example. In such cases, actions taken to address these related pollutants will likely address flow as well. In other cases, alternate control strategies would be applied outside the TMDL process.

Table 3 Summary of current stream temperature water quality standards in Idaho.

Source of Standard	**Beneficial Use**	**Instantaneous (not to exceed)**	**Maximum Daily Average**	**7 Day Sliding Average of Daily Maximum**
State of Idaho	Cold Water Biota	22° C 71.6° F	19° C 66.2° F	N/A
State of Idaho (seasonal by species)	Salmonid Spawning	13° C 55.4° F	9° C 48.2° F	N/A
State of Idaho (June – August)	Bull Trout Rearing	N/A	12° C 53.6° F	N/A
State of Idaho (September – October)	Bull Trout Spawning	N/A	9° C 48.2° F	N/A
EPA (June – September)	Bull Trout Spawning and Rearing	N/A	N/A	10° C 50° F

Target Selection

Sediment

Sediment target selection for the Little Lost River, Wet Creek and Sawmill Creek TMDLs are based on subsurface fine sediment. The percentage of subsurface fine sediment <6.35 mm (0.25 in) in stream habitat that would be used for spawning is felt to be a better indicator of the capability of spawning habitat to support self sustaining salmonid populations than surface fines (McNeil and Ahnell 1964, Robert Rose USFS personal communication). The Salmon and Challis National Forest, in *The Forest Plan for the Salmon Zone* has an objective of 20% or less fine sediment <6.35 mm (0.25 in) to 6 inches depth for streams supporting anadromous fish. In streams supporting only resident salmonid fish species, 28% fine sediment <6.35 mm (0.25 in) to 4 inches depth is identified as the objective (Salmon National Forest 1988). This number reflects State of Idaho goals for fish production capabilities. Subsurface fine sediment standards are based on parent watershed geology. Quartzite streams in good condition have subsurface fine sediment <6.35 mm (0.25 in), at or below 20%, streams in fair condition have 20 to 25% fines, and streams in poor condition have fines greater than 25%. In granitic, volcanic and sedimentary drainages, streams in good, fair and poor condition will have <25%, 25-30%, and >30% subsurface fines, respectively. The Little Lost River watershed is within the granitic, volcanic and sedimentary parent watershed geology. Depth fines in the midrange of fair are expected to support self-sustaining populations of salmonids and an adequate margin of safety is incorporated into this target range.

Subsurface fine sediment is determined using the McNeil sediment core sampling technique. This sampling technique evaluates subsurface fines, to a depth of 4 in for resident fish species, and indicates expected fry survival as it relates to percentage of intragravel fine sediment <6.35 mm (0.25 in) (McNeil and Ahnell 1964). The McNeil sediment core sampling methodology is described in Appendix A.

There are other parameters for subsurface fines that can affect salmonid production. Chapman (1988) suggested that fine sediment <0.85 mm (0.03 in) is most responsible for suffocation and abrasion of salmonid eggs, and coarser sediment <9.5 mm (0.37 in) can create a survival barrier preventing salmonid fry emergence from the redd (Tappel and Bjornn 1983). Hall (1986) found survival (eyed egg to emergence) of coho, chinook and chum salmon to be only 7-10% in gravel mixtures made up of 10% fines as compared to 50- 75% survival in gravel mixtures with no fines <0.85 mm (0.03 in). Reiser and White (1988) observed little survival of steelhead and Chinook salmon eggs beyond 10-20% fines <0.85 mm (0.03 in). Though these additional sediment parameters affect fry survival, TMDL streams evaluated within the Little Lost River subbasin are generally below the limits identified above at this time. These parameters should continue to be evaluated as part of target monitoring to evaluate any significant shift in subsurface fine particle frequency distribution above those described within this TMDL.

The subsurface fine sediment target for this TMDL is set at 28% or less fine particles <6.35 mm (0.25 in) not including substrate larger than 63.5 mm (2.5 in). Attainment will be expected in habitat capable of supporting salmonid spawning after implementation of BMPs identified to reduce subsurface fine sediment. Subsurface fine sediment will be monitored bi-annually beginning at completion of the initial implementation phase. By completion of the third monitoring phase, if trends are not improving on sediment TMDL streams, additional BMPs will be identified to attain the target. If beneficial use full support and existing applicable temperature water quality standards are met within the same monitoring period targets will be re-evaluated. Adaptive management of BMP implementation in relation to target monitoring results would be considered as a feedback loop.

Temperature

Temperature target selection for the Little Lost River, Wet Creek and Sawmill Creek TMDLs are based exclusively on existing temperature standards adopted by the State of Idaho. It is assumed that an adequate margin of safety exists within the adopted water quality standards for salmonid spawning, coldwater biota, bull trout juvenile rearing, and bull trout spawning.

3.0 Little Lost River Subbasin TMDL

3.1 Little Lost River TMDL

Watershed Description

The Little Lost River Watershed lies within portions of Butte, Custer, and Lemhi Counties, in the vicinity of the community of Howe, Idaho located northeast of the City of Idaho Falls in south-central Idaho (Figure 1). The Little Lost River has a watershed area of 963 square miles with maximum elevations of 12,197 ft. at Diamond Peak in the Lost River range of the western watershed and 12,140 ft. Mt. Breitenbach in the Lemhi Range of the eastern watershed. Stream elevations range from 6,030 feet at the confluence of Summit and Sawmill Creeks to 4,819 feet where the Little Lost River infiltrates into the Snake River Plain just south of Howe.

The Little Lost River is designated within Idaho water quality standards for Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Agricultural Water Supply, Wildlife Habitat and Aesthetics Beneficial Uses. The Little Lost River exhibits Full Support for Salmonid Spawning, and falls into the waterbody assessment category of Needs Verification to show full support for the Cold Water Biota designated Beneficial Uses. The Little Lost River did not appear on the 1996 §303(d) list. It was identified in the Little Lost River Subbasin Assessment as Not Full Support for Cold Water Biota, primarily for stream temperature exceedances. It was added to the 1998 proposed §303(d) list for unknown pollutants from its headwaters at the confluence of Summit and Sawmill Creeks to the confluence of Big Spring Creek. From the confluence of Big Spring Creek to the canal diversion approximately 1 mile below the Howe infiltration trenches it is listed for temperature criteria exceedances and unknown pollutants. Specific load capacities and load allocations/reductions for flow alteration will not be developed within this TMDL. Load allocations for sediment and temperature are developed and will require continued improvement of riparian habitat condition, which will also benefit stream temperature and instream flow and flow related conditions.

The Little Lost River is an important component of the Little Lost River bull trout key watershed identified in Governor Batt's State of Idaho Bull Trout Conservation Plan (Batt 1996) from its headwaters at the confluence of Sawmill Creek and Summit Creek downstream to the confluence of Big Spring Creek. The Little Lost River has been identified as Nodal habitat. Nodal habitats are generally mainstem overwintering areas, and serve as a corridor for migratory life forms.

The Geomorphic Risk Assessment shows the Little Lost River to be the most depositional with regard to sediment of the TMDL streams. Over the §303(d) listed reach of the Little Lost River average stream gradient is 0.5% contained within a downstream progression of channel types from C4 to C5 and C6 as described in Rosgen (1996). The Little Lost River watershed relief ratio (R), the ratio of basin relief to basin length is slight at 0.015. Drainage density is 1.19 mi/mi^2. The product of relief ratio, drainage density and bankfull discharge divided by depositional stream density (miles of stream <1.5% slope per unit area of watershed: 0.21 for the mainstem Little Lost) gives

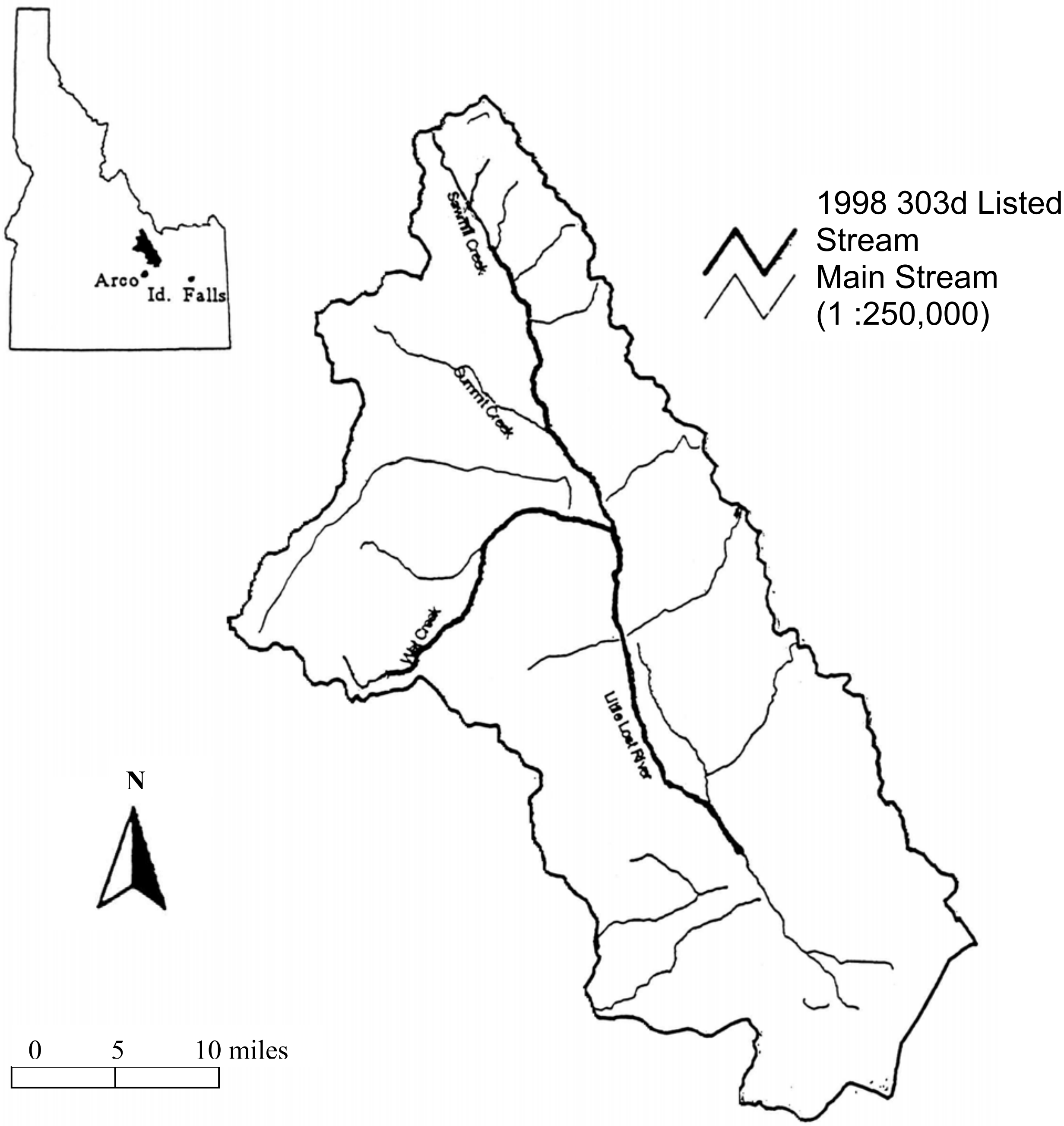

Figure 1 Little Lost River Subbasin.

sediment transport potential (P_S), as previously described. This value for the Little Lost River is 0.09, which is less than Wet Creek (P_S=0.73) and Sawmill Creek (P_S=0.2).

Between Wet Creek and Summit Creek, soils are moderately erosive adjacent to the stream with silt loam and gravelly fine sand loam on the eastern side and loam and gravelly loam to the west at 9 – 17 % slope. Below the confluence of Wet Creek to the lower bound of the §303(d) listed reach soils are only slightly erosive, consisting primarily of gravelly loam soil.

Land use adjacent to the Little Lost River has historically been grazing. Currently it is primarily irrigated agriculture with mixed rangeland and some recreational use at designated access sites. Land ownership is primarily private with some BLM land.

Existing Conditions
BLM has conducted significant long-term monitoring of fisheries, hydrology, temperature, suspended sediment and riparian condition along the Little Lost River that has previously been summarized in the Little Lost River Subbasin Assessment by DEQ (IDEQ 1998). U.S. Forest Service has also conducted riparian habitat, fisheries and temperature monitoring and DEQ has conducted BURP assessment at one location on the Little Lost River, which has also been included in the Subbasin Assessment. The Subbasin Assessment concludes that the Little Lost River, from its source at the confluence of Summit Creek and Sawmill Creek to the sinks below Howe (WBIDs 1, 2, 7, 9, and 10) is water quality limited, primarily based on temperature exceedances. The Idaho Department of Fish and Game has funded and conducted extensive fisheries investigations throughout the basin. Since the release of The Little Lost River Subbasin Assessment BLM has collected additional temperature and riparian habitat condition data, U.S. Forest Service has conducted additional temperature monitoring and DEQ has collected sediment core samples at two locations and done streambank erosion inventories along four reaches of the Little Lost River.

Riparian Condition
Currently, the federally owned land (exclusively BLM) along the listed reach of the Little Lost River is under riparian grazing management directed at reducing sediment and thermal inputs to the stream. The majority of land along this reach is private with several segments under riparian management, though not consistent or continuous.

The trend in riparian condition on the Little Lost River PFC monitoring reaches is mixed (Table 4) with 4.4 miles of the 9.2 miles monitored in an upward trend, 4.4 miles are static and 1.4 miles are in a downward trend (IDEQ 1998). The length of the Little Lost River §303(d) listed reach is 31.9 stream miles. Of this length 12.5 miles are managed by BLM as riparian exclosure and 10.3 miles are managed as riparian pasture. The remaining 9.1 miles are under private management and the type of grazing management is undetermined. The river below the infiltration trenches is virtually dewatered in the winter over the remaining 10.5 miles of the Little Lost River.

Table 4 Little Lost River PFC grazing allotment trends since 1993.

Stream	Allotment (ID #)	Miles Length	Initial Assessment	Initial Condition	Later Assessment	Later Condition	Trend
Little Lost	Bell Mountain	.50	1994	55%	1998	67%	Up
Little Lost	Briggs Canyon	1.28	1994	82%	1998	81%	Static
Little Lost	Briggs Canyon	1.1	1994	70%	1998	75%	Up
Little Lost	Hawley Mt	1.16	1994	73%	1998	45%	Down
Little Lost	Hawley Mt	1.26	1994	49%	1998	56%	Up
Little Lost	Cedarville	1.21	1994	59%	1998	60%	Static
Little Lost	Cedarville	1.52	1994	46%	1998	43%	Static
Little Lost	Cedarville	0.33	1994	43%	1998	43%	Static
Little Lost	Cedarville	0.24	1994	32%	1998	21%	Down
Little Lost	Williams Creek	0.59	1994	48.5%	1998	67%	Up
Little Lost	Horse Creek	1.0	1994	44%	1998	58%	Up

The Little Lost River is incised along much of the listed reach with sagebrush growing to the edge of vertical eroding banks. Most of the Little Lost River is characterized by poor fisheries habitat condition, and recovery is expected to be slow in these areas as the Little Lost River re-develops its flood plain. The Little Lost River is characterized primarily as a sandbar willow community type with significant reaches of water birch and red-osier dogwood community types (BLM 2000) along less incised reaches.

McNeil Sediment core samples were collected on the Little Lost River at two locations in August 1999 and March 2000 (Figure 2). Within the chart, the upper and upper middle reach represent upper and lower Sawmill Creek sample sites. The lower middle and lower reaches represent upper and lower Little Lost River sample sites. Sediment core data evaluates subsurface fine sediment to a depth of 4 in. for resident fish species, and indicates expected fry survival as it relates to percentage of intragravel fines less than 0.25 in (6.35 mm). The mean % fines less than 6.35 mm excluding substrate larger than 2.5 in (63.5 mm) was 34% at the upper sample site located directly behind the BLM trailer at Clyde. The lower site located approximately ¾ mile above the infiltration trenches exhibited 15% depth fines. Expected surface fine sediment values described by Rosgen (1996) for the channel types found along this reach would be in the range of 15 to 20%< 6 mm.

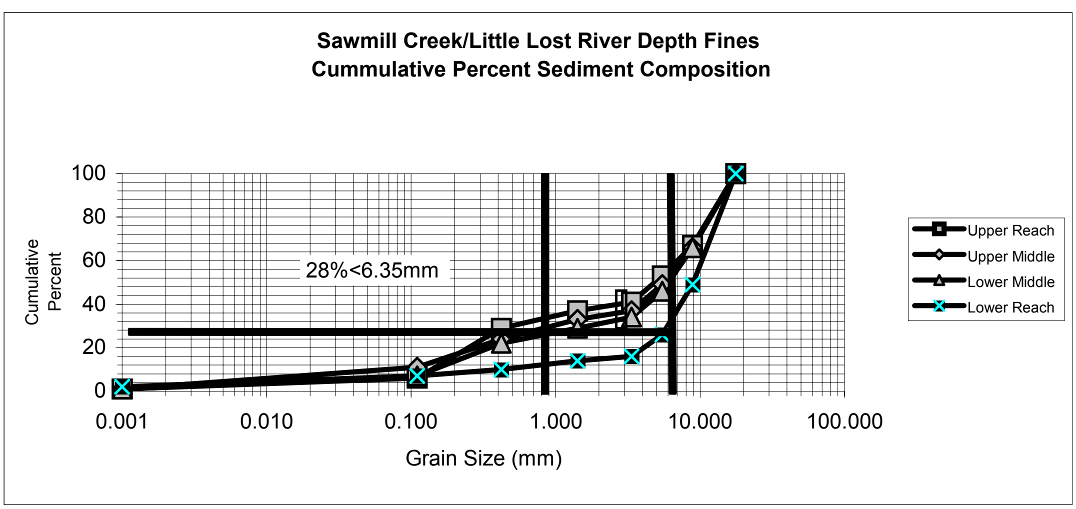

Figure 2 Cumulative percent depth fines on Sawmill Creek and Little Lost River.

An inventory of streambank erosion was conducted along 7,287 feet (3%) of the Little Lost River over 4 sections on the §303(d) listed reach. The streambank erosion inventory is a qualitative evaluation of channel shape, bank stability and riparian vegetation developed by the NRCS as a tool to evaluate erosion condition on streambanks, gullies and roads. Streambank erosion values obtained from the sample reach can be extrapolated to adjacent streambanks of similar condition under like management to estimate direct annual sediment inputs to the stream. Used in conjunction with other available sediment data such as total suspended sediment and depth fines the erosion inventory can be a useful tool to allocate sediment from streambank erosion and to prioritize stream reaches for implementation of BMPs or to track the effectiveness over time of BMPs already implemented.

Streambank erosion estimates are based on the erosive condition and erosive area of streambanks and the rate of lateral recession, or how much of a streambank erodes into the stream. The methodology and background of the streambank erosion inventory is described in Appendix A. The estimates are given as annual average erosion and are expressed in tons of sediment per sample reach or in tons per mile per year. Observed conditions are the result of flow conditions that the stream experiences over time, natural channel migration, and the effects of adjacent land use.

Erosion rates obtained on the Little Lost River range from 12 tons per mile per year below the infiltration trenches (lower reach), to 79 tons per mile per year near Clyde (upper middle reach). Total erosion estimated over the inventory reaches and extrapolated to areas of similar condition is shown in Table 5.

Sampling of total suspended sediment (TSS) is limited for the Little Lost River. Eight samples were collected between 1980 and 1996 at the USGS gauging station at Clyde, just below the confluence of Wet Creek. Sample Values range from 19 to 423 mg/l with a mean of 130 mg/l. These values are well above the range of values from sampling at either the lower Sawmill Creek site (2 to 167 mg/l) and lower Wet Creek site (36 to 250 mg/l). Samples collected at the three sites were not paired samplings.

Table 5 Existing erosion rates and total erosion on the Little Lost River.

Reach	Location	Erosion Rate (t/mi/y)	Total Extrapolated Erosion (t/y)	Percent of Total
Upper	Upper Private boundary to confluence of Summit Creek.	20	32	14%
Upper Middle	BLM Private boundary just above Wet Creek to Little Lost Highway Crossing.	79	135	58%
Middle	Little Lost Highway Crossing to private boundary below Buck and Bird Road	59	41	18%
Lower	Above flood control project to Lower bound of §303(d) listed reach	12	23	10%
	Total	**170**	**231**	**100%**

No additional BURP data has been collected on the Little Lost River since the 1998 Subbasin Assessment.

Temperature data was collected at two locations on the Little Lost River in 1997. Approximately 1 km above Wet Creek the absolute maximum temperature recorded was 19.2ºC and the Maximum 7 Day Maximum Moving Average was 18.2ºC. Approximately 5 km below the confluence of Badger Creek at the Buck and Bird Road Bridge the absolute maximum temperature was 18.4ºC and the Maximum 7 Day Maximum Moving Average was 17.5ºC (Gamett 2000).

Water Quality Concerns

The primary water quality concern within the Little Lost River is elevated water temperature and subsurface fine sediment deposited within the stream substrate preferred by salmonids for spawning. Fine sediment is likely impacting the abundance and quality of fish habitat and the potential success of salmonids spawning in the upper half of the Little Lost River. The primary source of sediment appears to be streambank erosion. The primary cause of streambank erosion is related to the downcutting of the stream channel and the subsequent sloughing of streambanks that have resulted from historic grazing practices. The Little Lost River is currently re-establishing its flood plain. This process will likely take many years and will result in much additional streambank erosion. Riparian vegetation appears to be established in many areas on inside point bars and between outside bends, and as outside banks re-slope, stabilizing vegetation will likely quickly appear. It is also possible that depth fines will increase on the lower listed reach as sediment from upper Sawmill Creek and Wet Creek migrates through the system.

Additionally, as riparian conditions improve over the listed reaches of Sawmill Creek and Wet Creek to improve bank stability, the added benefit of reduced thermal loading will likely be realized and the temperature regime on the Little Lost River will likely improve also.

The Little Lost River has limited spawning potential in terms of the amount of spawning substrate and the quality of the available substrate. With reduced sedimentation over time, spawning and habitat features important to rearing fish will likely improve. Currently fish habitat conditions are rated as poor by BLM in the Little Lost (BLM 2000). The primary importance of the Little Lost River is as a migration corridor between the over wintering and rearing habitat that it provides to the spawning habitat and thermal refuge found in Sawmill Creek and Wet Creek (IDEQ 1998).

Load Capacities and Targets

The current state of the science does not allow specification of a sediment or temperature load or load capacity that is known in advance to meet the narrative criteria for sediment and to fully support beneficial uses for coldwater biota and salmonid spawning. All that can be said is that the load capacity lies somewhere between the current loading and levels that approach natural temperature and streambank erosion levels. We presume that beneficial uses were or would be fully supported at natural background sediment loading rates that are assumed to equate to 80% bank stability and temperature regimes that would meet state water quality standards.

Beneficial uses may be fully supported at higher rates of sediment loading. The strategy is to establish a declining trend in sediment targets, and to regularly monitor water quality and beneficial use support status. If it is established that full support of beneficial uses is achieved at intermediate sediment loads above natural background levels the TMDL will be revised accordingly. Numeric water quality standards for temperature provide the loading capacity and targets for temperature.

Elevated stream temperature can affect the success of salmonid spawning, overall distribution and survival of salmonids and the presence and type of macroinvertebrate species in streams. State of Idaho Water Quality Standards for temperature have been adopted to support coldwater biota and salmonid spawning beneficial uses during the critical periods of the year when stream temperatures are naturally elevated. Additional elevation of stream temperature can result from human activities that affect streams by reducing shading plants or increasing the surface area (width) of the stream exposed to sunlight.

The observed heat load within the Little Lost River varies from year to year depending upon winter and summer precipitation, ambient air temperature and the percent of maximum potential solar radiation. The load capacity for heat for the purpose of this TMDL is determined by water quality standards for temperature based on bull trout juvenile rearing and rainbow trout spawning, as numeric water quality standards must be supported in the absence of site-specific criteria, or alternative beneficial use designations. Water quality standards specific to salmonid spawning are the most restrictive of temperature standards, and at the level of compliance with salmonid spawning temperature standards, other temperature standards for coldwater biota would be met during the warmest period of the year. The target for stream temperature within the Little Lost River is identified by the State of Idaho salmonid spawning temperature standard. It is assumed that the water quality standard for bull trout juvenile rearing and salmonid spawning also incorporates an implicit margin of safety adequate to insure self sustaining populations of all salmonids including bull trout.

Temperature Targets

To improve the quality of coldwater biota in the Little Lost River, it will ultimately be necessary to maintain the instantaneous maximum temperature below 13º C and the maximum daily average temperature below 9º C as prescribed in State of Idaho Water Quality and Wastewater Treatment Administrative Rules (IDAPA 58.01.02.250.02.b) for salmonid spawning.

Sediment Targets

To improve the quality of spawning substrate and rearing habitat in the Little Lost River, it is assumed to be necessary to reduce the component of subsurface fine sediment less than 6.35 mm to 28% or less. A detailed discussion of subsurface fine sediment target selection is provided in section 2.2.

Loading Summary

Existing Sediment Sources

Streambank erosion inventories conducted on the Little Lost River show that the primary source of sediment is from streambank erosion with the most significant erosion currently occurring over the upper middle reach above the upper Little Lost Highway crossing. Erosion below this sample reach (lower middle) ranks as the next most erosive segment in Table 5. Roads and road crossings do not present a significant potential sediment source along the course of the Little Lost. Streambank erosion has been accelerated by the combined effect of historic and continued degraded riparian conditions from livestock grazing. Livestock grazing management along private land on the Little Lost River has not undergone the same improvements that have taken place on federal land. There are segments of private land under improved management however.

Existing Heat Sources

Energy responsible for elevating stream temperature enters the stream primarily through direct solar radiation such as sunlight directly striking the water. Indirect scattered and reflected radiation from the sky and clouds and long-wave thermal radiation from the atmosphere also contribute to a lesser degree (Wetzel 1983). The accumulation of heat within a stream can be referred to as heat loading. Heat loading is a cumulative function; it increases along the course of a stream. Heat loading is reduced by riparian vegetation that is capable of shading the stream. Streams that have healthy riparian vegetation tend to have less heat loading because surface area is reduced in streams with lower width to depth ratios. Streams that have reduced riparian vegetation tend to have greater width to depth ratios due to streambank erosion that increases the width of the stream and reduces the depth of the stream. Reduced shade and increased surface area can result from historic and current grazing within the riparian zone.

Reduction of streambank erosion prescribed within this TMDL is directly linked to the improvement of riparian vegetation density and structure to armor stream banks, reduce lateral recession, trap sediment and reduce the erosive energy of the stream thus reducing sediment loading. It is also expected that improvement of riparian vegetation density and structure would reduce the stream surface area and increase stream shading which would reduce stream heat loading.

Estimates of Existing Sediment Load

Based on estimates from streambank erosion inventories on the Little Lost River the total existing streambank erosion for the inventory reaches including extrapolated reaches over the §303(d) segment is 231 tons per year (Table 5). The sediment load estimate from Little Lost River streambanks is less than that estimated for Sawmill Creek (671 t/y) and similar to estimates for Wet Creek (235 t/y).

Load Allocations

Using water quality targets identified in the Little Lost River Watershed TMDL, sediment load allocations or sediment load reductions are outlined in this section.

Because the primary chronic source of sediment loading to the Little Lost River is streambank erosion, quantitative allocations are developed. These sediment load reductions are designed to meet the established instream water quality target of 28% or less fine sediment <6.35 mm in areas suitable for salmonid spawning. Streambank erosion reductions are quantitatively linked to tons of sediment per year and identified by streambank erosion that equates to 80% streambank stability, which is assumed to be natural background. An inferential link is identified to show how sediment load allocations will reduce subsurface fine sediment to or below target levels. This link assumes that by reducing chronic sources of sediment, there will be a decrease in subsurface fine sediment that will ultimately improve the status of beneficial uses. Streambank erosion load allocation is based upon the assumption that natural background sediment production from streambanks equates to 80% streambank stability as described in Overton and others (1995), where stable banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally at 80% or greater for A, B, and C channel types in plutonic, volcanic, metamorphic and sedimentary geology types.

Based on existing sediment load from bank erosion on the Little Lost River, a reduction of 61% is recommended overall. Little Lost River streambank erosion load allocations are broken down by individual inventory segment in Table 6.

Because of the limited availability of summarized temperature data, the maximum observed daily temperature and maximum observed daily average temperature were taken from temperature data collected in 1997 using in-stream temperature data loggers. The maximum observed daily temperature was used to determine the percent reduction

Table 6 Little Lost River streambank erosion load allocations.

Reach	Location	Existing Total Erosion (t/y)	Proposed Total Erosion (t/y)	Proposed Erosion Rate (t/mi/y)	Percent Reduction	After Reduction Percent of Total
Upper Little Lost	Private/BLM boundary above Wet Creek upstream to confluence of Summit Creek.	32	29	19	9.4	32%
Upper Middle Little Lost	BLM Private boundary just above Wet Creek to Little Lost Highway Crossing.	135	35	20	74	38%
Lower Middle Little Lost	Little Lost Highway Crossing to private boundary below Buck and Bird Road	41	11	16	73	12%
Lower Little Lost	Above flood control project to Lower bound of §303(d) listed reach	23	15	8	35	16%
	Total	**231**	**90**	**64**	**61**	**100%**

for instantaneous maximum for the reach by subtracting the instantaneous juvenile bull trout rearing temperature criteria of 12°C from the observed maximum instantaneous temperature and calculating the percent reduction from the observed maximum to comply with the current standard. Similarly the percent reduction for daily average for the reach was determined by subtracting the bull trout spawning daily average criteria from the maximum observed daily average and calculating the percent reduction from the observed maximum daily average to comply with the current standard (Table 7).

Margin of Safety
The MOS factored into load allocations for the Little Lost River is implicit. The MOS is the conservative assumptions used to develop existing sediment loads. Conservative assumptions made as part of the sediment loading analysis include: 1) Desired bank erosion rates are representative of background conditions of 80% streambank stability; 2) Water quality targets for percent depth fines are consistent with values measured and set by local land management agencies based on established literature values and incorporate an adequate level of fry survival to provide for stable salmonid production. The Margin of Safety factored into heat load allocations are implicit within the temperatures identified in State water quality standards.

Seasonal Variation and Critical Time Periods of Sediment Loading
To qualify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak and base flow conditions. While deriving these estimates it is difficult to account for seasonal and annual variation within

Table 7 Little Lost River temperature loading analysis and allocation.[1]

Stream Segment	Maximum Observed Daily Temperature	Maximum Observed Daily Average Temperature	Idaho Instantaneous Juvenile Bull Trout Rearing Temperature	Idaho bull trout/Salmonid spawning daily avg.	Percent Reduction for Instantaneous Maximum	Percent Reduction for Daily Average
Little Lost River 500 m above Wet Creek[2]	18°C 10 July 97 30 Days of Exceedence	16°C 9 July 38 Days of Exceedence	12°C	9°C	33%	44%
Little Lost River at Buck and Bird Road[2]	18°C 22 July 55 Days of Exceedence	15°C 9 July 13 Days of Exceedence	12°C	9°C	33%	40%
Little Lost River below Big Springs Creek[3]	19°C 9 July 37 Days of Exceedence	16°C 9 July 39 Days of Exceedence	13°C	9°C	32%	44%

[1] Allocation based on 1997 temperature data from the Little Lost Subbasin Assessment
[2] Little Lost River Above Big Springs Creek: Rainbow Spawning, Bull Trout Juvenile Rearing.
[3] Little Lost River Below Big Springs Creek: Rainbow Spawning, Coldwater Biota.

a particular time frame, however, the seasonal and annual variation is accounted for over the longer time frame under which observed conditions have developed. Annual erosion and sediment delivery are greatly a function of climate where wet water years typically produce the highest sediment loads. Additionally, annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months. For example, in the Little Lost River watershed, most streambank erosion occurs during spring runoff while most hillslope erosion occurs during summer thunderstorms and spring runoff.

This sediment analysis uses empirically derived hydrologic concepts to help account for variation and critical time periods. First, field-based methods consider critical hydrologic mechanisms. For example streambank erosion inventories account for the fact that most bank recession occurs during peak flow events when banks are saturated. Second, the estimated annual average sediment delivery from a given watershed is a function of bankfull discharge or the average annual peak flow event.

The period of excessive heat loading is characteristically during July, August, and September, when low flow and peak air temperature combine with increased direct solar radiation to warm stream temperatures to critical levels for salmonid rearing and coldwater biota.

3.2 Sawmill Creek TMDL

Watershed Description

Sawmill Creek forms the boundary between Custer and Lemhi County, in south central Idaho, from approximately 3 miles above the confluence of Summit Creek to the confluence of Timber Creek (Figure 1). Above Timber Creek, Sawmill Creek lies within Lemhi County to its source, 4 miles upstream. Below the Custer/Lemhi County boundary Sawmill Creek lies within Butte County. Sawmill Creek is considered the headwaters of the Little Lost River. Below the confluence of Summit Creek it is considered the Little Lost River. Sawmill Creek has a watershed area of 161 mi^2 with maximum elevation of 10,900 ft. Stream elevation ranges from 8,760 at its source to 6,030 ft. at the confluence of Summit Creek where it forms the Little Lost River.

Designated Beneficial Uses for Sawmill Creek are Primary Contact Recreation, Industrial Water Supply, Wildlife Habitat and Aesthetics. Existing Beneficial Uses include Cold Water Biota and Salmonid Spawning. Sediment was listed as the Pollutant of Concern in the 1996 §303(d) list from the headwaters to the confluence of Summit Creek. The Little Lost River Subbasin Assessment (IDEQ 1998) adds temperature to the list and redefines beneficial use support as Not Full Support for Salmonid Spawning and Full Support for Coldwater Biota. The 1998 proposed §303(d) List of water quality impaired waters (IDEQ 1999) adds temperature as a pollutant of concern, and redefines the impaired reach of Sawmill Creek as being from Mill Creek to the Little Lost River confluence, approximately 12.3 stream miles. Load allocations for temperature and sediment will require continued improvement of riparian habitat condition, which will reduce streambank erosion and provide shade to reduce heat loading.

Sawmill Creek is the most critical component of the Little Lost River bull trout key watershed. It has been identified as Focal habitat within the Little Lost River Watershed Bull Trout Problem Assessment (IDEQ 1998). Focal habitat is defined as critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species. Focal habitat exists above the confluence of Warm Creek at the mouth of Sawmill Canyon.

Sawmill Creek is §303(d) listed from the confluence of Mill Creek to the confluence of Summit Creek for excessive sediment and temperature criteria exceedances. The primary problem with excessive sediment and heat loading is related to a channel blowout that was predisposed by historic degradation of riparian vegetation from grazing practices and occurred as a result of 1996 wildfire in upper Sawmill creek and subsequent high runoff events. After the confined stream channel reaches the mouth of the canyon, its course runs through a depositional, widely spread alluvial fan on the lower reach. The stream historically likely had unstable banks as it meandered through this fan. After 1996, the increasing sediment load likely aggraded the channel(s), causing increased lateral instability and extreme channel widening (DEQ 1998, Dan Kotansky BLM personal communication).

Over the §303(d) listed reach overall stream gradient is 1.03% contained within channel types F4 and B3 as defined by Rosgen (1996). Sawmill Creek watershed relief ratio is moderate at .026. Drainage density is 1.13 mi/mi^2. The product of relief ratio, drainage density and bankfull discharge divided by depositional stream density (miles of stream <1.5% slope per unit area of watershed: 0.148 for Sawmill Creek) gives sediment transport potential (P_S), as previously described. This value for Sawmill Creek is 0.2, which is intermediate between Wet Creek (P_S=0.73) and the Little Lost River (P_S=0.09).

Below the confluence of Mill Creek soils are slightly to moderately erosive with the majority of the listed reach of Sawmill Creek within Gravelly loam soils. Soil slope ranges from 17 to 34% within the canyon over the upper half of the listed reach to 3-9% over the lower half below the canyon.

Land use over the listed reach is primarily mixed rangeland with shrub and brush rangeland between Mill Creek and Warm Creek, and herbaceous rangeland between Warm Creek and Summit Creek. Adjacent to the confluence of Summit Creek there is nonforested Wetland. Land ownership is a mix of U.S. Forest Service and BLM with some private inholdings.

Existing Conditions
BLM has conducted significant long-term monitoring of fisheries, hydrology, temperature, suspended sediment and riparian condition along Sawmill Creek that has previously been summarized in the Little Lost River Subbasin Assessment by DEQ (IDEQ 1998). U.S. Forest Service has also conducted riparian habitat, fisheries and temperature monitoring and DEQ has conducted BURP assessment at two locations on Sawmill Creek, which were also included in the Subbasin Assessment. The Subbasin Assessment concludes that Sawmill Creek from Timber Creek to Warm Creek (WBID 14), from Warm Creek to Summit Creek (WBID 12) are confirmed to be water quality limited, primarily based on temperature exceedances. The Idaho Department of Fish and Game has funded and conducted extensive fisheries investigations throughout the basin. Since the release of The Little Lost River Subbasin Assessment BLM has collected additional temperature and riparian habitat condition data, U.S. Forest Service has conducted additional temperature monitoring and DEQ has collected sediment core samples at 2 locations and streambank erosion inventories along 4 reaches of Sawmill Creek.

Riparian Condition
Currently, the majority of the listed segment of Sawmill Creek on BLM land is under riparian management directed at reducing sediment and thermal inputs. Riparian management on BLM is geared toward riparian pasture grazing rotation and exclosure fencing that has been sequentially implemented since the early 1980s. Riparian management on US Forest Service Land is primarily directed at maintenance of current conditions through triggering mechanisms such as residual stubble height.

The trend in riparian condition on Sawmill Creek monitoring reaches has been upward based on proper functioning condition assessment (Table 8). The length of the Sawmill Creek §303(d) reach is approximately 12 miles, of which approximately 1 mile of private land is excluded to cattle, 3 miles are managed as riparian pasture and the approximately

Table 8 Sawmill Creek grazing allotment trends since 1993.

Stream	Allotment (ID #)	Miles Length	Initial Assessment	Initial Condition	Later Assessment	Later Condition	Trend
Sawmill	Hawley Mt	.52	1993	59%	1998	60%	Static
Sawmill	Hawley Mt	.64	1993	65%	1998	75%	Up
Sawmill	Hawley Mt	.59	1993	52%	1998	82%	Up
Sawmill	Hawley Mt	.64	1993	70%	1998	83%	Up

8 miles remaining are managed under stubble height triggering management by US Forest Service. Riparian monitoring has been conducted over 2.4 miles (19%) since 1993. Of the riparian area monitored 87% is in an upward trend and 13% is static. The Hawley Mt. (2) monitoring reach is in a riparian pasture management system that has been in place since 1987. The channel is dynamic as it evolves a new channel, a result of a previous channel blowout. Overall, fisheries habitat conditions are rated as good to fair on Sawmill Creek and are expected to improve over time, as riparian management implementation reaches maturation.

McNeil sediment core samples were collected on Sawmill Creek in September 1999 by DEQ at 2 locations (Figure 2). Sediment Core Data evaluates subsurface fine sediment to a depth of 4 in for resident fish species, and indicates expected fry survival as it relates to percentage of intragravel fines less than 0.25 in (6.35 mm). The mean % fines less than 6.35 mm excluding substrate larger than 63.5 mm was 41% at the upper sample site located above the Fairview Guard Station. The lower site directly behind the BLM trailer at Clyde exhibited 38%. Expected fine sediment values described by Rosgen (1996) for the channel type would be in the range of 15 to 20%< 6 mm.

An inventory of streambank erosion was conducted along 7,615 feet (10.5%) of Sawmill Creek streambank over 4 reaches on the §303(d) reach. The streambank erosion inventory is a qualitative evaluation of channel shape, bank stability and riparian vegetation developed by the NRCS as a tool to evaluate erosion condition on streambanks, gullies and roads. Streambank erosion values obtained from the sample reach can be extrapolated to adjacent streambanks of similar condition under like management to estimate direct annual sediment inputs to the stream. Used in conjunction with other available sediment data such as total suspended sediment and depth fines the erosion inventory can be a useful tool to allocate sediment from streambank erosion and to prioritize stream reaches for implementation of BMPs or to track the effectiveness over time of BMPs already implemented.

Streambank erosion estimates are based on the erosive condition and erosive area of streambanks and the rate of lateral recession, or how much of a streambank erodes into the stream. The estimates are given as annual average erosion and are expressed in tons of sediment per sample reach or in tons per mile per year. Observed conditions are the result of flow conditions that the stream experiences over time, natural channel migration, and adjacent land use.

For Sawmill Creek, erosion values range from 24 tons per mile per year below the established riparian exclosure above Bell Mountain Road (lower reach), to 159 tons per mile per year near below the confluence of Horse Lake Creek (upper middle reach) (Table 9).

Sampling of total suspended sediment (TSS) is limited. Samples were collected between 1990 and 1997 at two locations on Sawmill Creek: above the confluence of Summit Creek (lower) and just below the bridge near the USFS boundary (upper). This paired sampling provides some insight to relative loading between sampling points. Sample values range from 4 to 52 mg/l at the upper site, and from 2 to 167 mg/l at the lower site. Sampling at the lower site during spring runoff ranged from 59 to 167 mg/l producing a peak-flow sediment load ranging from 28 to 47 tons per day. Base flow TSS concentrations range from 2-6 mg/l which produce a corresponding load of 0.07 to 1.7 tons per day.

No additional BURP data has been collected on Sawmill Creek since the 1998 Subbasin Assessment.

Temperature data was collected at five locations between 1997 and 1999 on Sawmill Creek (Table 10). Exceedence of instantaneous maximum temperature is in bold. Bull trout spawning is not considered to occur below Squaw Creek (IDEQ 1998).

Water Quality Concerns
The primary water quality concern in Sawmill Creek is elevated water temperature and subsurface fine sediment deposited within the stream substrate preferred by salmonids for spawning. Fine sediment is likely impacting the success of salmonids spawning and the abundance and quality of fish habitat. The primary source of sediment appears to be streambank erosion. The primary cause of streambank erosion is related to two large wildfires that burned within the Sawmill Creek watershed in 1966 and 1988. The combined result of accelerated spring runoff from the fires and poor riparian conditions prior to the fires were channel blowouts that widened the stream channel beyond the ability of riparian vegetation to quickly revegetate and stabilize streambanks.

Table 9 Existing erosion rates and total erosion on Sawmill Creek.

Reach	Location	Erosion Rate (t/mi/y)	Total Extrapolated Erosion (t/y)	Percent of Total
Upper	Upper Private boundary to Timber Creek Campground	58	210	31%
Upper Middle	Sawmill Canyon Road lower Bridge upstream to Horse Lake Creek confluence	159	345	51%
Middle	Sawmill Canyon Road lower Bridge downstream to lower BLM exclosure	43	63	9%
Lower	Bell Mountain Rd to lower BLM exclosure	24	53	8%
	Total	**284**	**671**	**100%**

Table 10 Water temperature summary for Sawmill Creek (adapted from Gamett 2000).

Reach Location	Temperature Metric	1997	1998	1999
Sawmill Creek above Smithie Fork	Absolute Max. Temp	12.5[1]	13.7[1]	14.0
	Max 7 Day Moving Avg.	12.1[1]	13.5[1]	13.0
	July-Sept. Temp . units	711.0[1]	-	743.7
	July-Sept. Mean Temp.	7.7[1]	8.1[1]	8.1
Sawmill Creek above Moonshine Creek	Absolute Max. Temp			14.4
	Max 7 Day Moving Avg.			13.3
	July-Sept. Temp . units			761.6
	July-Sept. Mean Temp.			8.3
Sawmill Creek above Squaw Creek	Absolute Max. Temp	18.1[2]	16.8[2]	19.1
	Max 7 Day Moving Avg.	16.8[2]	16.4[2]	17.5
	July-Sept. Temp . units	970.1[2]	901.5[2]	952.2
	July-Sept. Mean Temp.	10.5[2]	9.8[2]	10.3
Sawmill Creek at Forest Boundary	Absolute Max. Temp		20.2[3]	19.4
	Max 7 Day Moving Avg.		18.2[3]	17.5
	July-Sept. Temp . units		1111.2[3]	1017.2
	July-Sept. Mean Temp.		12.1[3]	11.1
Sawmill Creek above Summit Creek	Absolute Max. Temp		**23.7**	**22.8**
	Max 7 Day Moving Avg.		21.3	20.8
	July-Sept. Temp . units		1207.4	1171.1
	July-Sept. Mean Temp.		13.1	12.7

[1]In 1997 and 1998, the data logger was located app. 500 m above Smithie Fork, 450 m above temp. monitoring site.
[2]In 1997 and 1998, the data logger was located at the pasture fence app 200 m downstream from the temp. monitoring site.
[3]In 1998, the data logger was located 15 m downstream from the temperature monitoring site.

Elevated stream temperatures are also a water quality concern related to riparian condition. State and federal water quality standards pertaining to stream temperatures are numeric and are species and temporally specific. Water temperature conditions are improving in Sawmill Creek and, like sediment loading, improvement will continue to track with riparian condition.

Biological indicators of beneficial uses show full support for salmonid spawning and coldwater biota in Sawmill Creek; however, further degradation of stream conditions would likely result in reduced support status. Any additional anthropogenic degradation of stream conditions should not be allowed, and where unavoidable should be mitigated for.

Rainbow trout, bull trout, and brook trout are documented present in Sawmill Creek. Bull trout are listed under the Endangered Species Act as threatened species. Hybridization and competition with brook trout is felt to be a significant impact to bull trout populations within the Little Lost River watershed. Brook trout have a higher tolerance for degraded water quality than bull trout. Further degradation of water quality favors brook trout and further imperils the bull trout population.

It is evident that there is successful spawning activity occurring in the Sawmill Creek watershed as evidenced by the presence of self-sustaining populations of trout. The IDFG manages streams in the Little Lost watershed for wild trout fisheries (i.e. favoring natural reproduction and no stocking) with a possession limit of two trout per day. Brook trout have a liberalized possession limit that allows the harvest of up to 12 trout in a day to reduce their numbers. There is currently no legal harvest allowed for bull trout, however rainbow and brook trout populations are able to support a consumptive fishery in Sawmill Creek. Fish habitat conditions are rated good to fair by BLM in Sawmill Creek (BLM 2000).

Thermal refuge is available in the upper reaches of Sawmill Creek and adjacent tributaries, and fish passage appears to be available above and below this reach to allow access to thermal refugia. Currently there is the potential for thermal barriers to develop between the Little Lost River and Sawmill Creek during extreme temperature and flow conditions that could isolate fish below Summit Creek. With continued aggressive riparian management it could be expected that in time riparian vegetation conditions would improve to increase canopy closure, reduce width to depth ratio and subsequently reduce instream fine sediment and temperature loading. The management regime currently employed on Sawmill Creek is felt to be adequate to eventually achieve desired future conditions, although accelerated riparian management improvements would achieve full support of beneficial uses sooner.

Load Capacities and Targets

The current state of the science does not allow specification of a sediment load or load capacity that is known in advance to meet the narrative criteria for sediment and to fully support beneficial uses for coldwater biota and salmonid spawning. All that can be said is that the load capacity lies somewhere between the current loading and levels that relate to natural temperature and streambank erosion levels. We presume that beneficial uses were or would be fully supported at natural background sediment loading rates that are assumed to equate to 80% bank stability, and temperature regimes that would meet state water quality standards.

Beneficial uses may be fully supported at higher rates of sediment loading. The strategy is to establish a declining trend in sediment load indicator targets, and to regularly monitor water quality and beneficial use support status. If it is established that full support of beneficial uses is achieved at intermediate sediment loads above natural background levels and that temperature standards are being met the TMDL will be revised accordingly.

Elevated stream temperature can affect the success of salmonid spawning, overall distribution and survival of salmonids and the presence and type of macroinvertebrate species in streams. State of Idaho Water Quality Standards for temperature have been adopted to support coldwater biota and salmonid spawning beneficial uses during the critical periods of the year when stream temperatures are naturally elevated. Additional elevation of stream temperature can result from human activities that affect streams by reducing shading plants or increasing the surface area (width) of the stream exposed to sunlight.

The observed heat load within Sawmill Creek varies from year to year depending upon winter and summer precipitation, ambient air temperature and the percent of maximum potential solar radiation. The load capacity for heat for the purpose of this TMDL is determined by water quality standards for temperature based on bull trout juvenile rearing and bull trout spawning, as numeric water quality standards must be supported in the absence of site-specific criteria, or alternative beneficial use designations. Water quality standards specific to bull trout are the most restrictive of temperature standards, and at the level of compliance with bull trout temperature standards, other temperature standards for salmonid spawning and coldwater biota would be met during the warmest period of the year. The target for stream temperature within Sawmill Creek is identified as State of Idaho bull trout temperature standard. It is assumed that the water quality standard for bull trout juvenile rearing and spawning also incorporates an implicit margin of safety adequate to insure self sustaining populations of all salmonids including bull trout.

Sediment Targets
To improve the quality of spawning substrate and rearing habitat in Sawmill Creek, it is necessary to reduce the component of subsurface fine sediment less than 6.35 mm to 28% or less. A detailed discussion of subsurface fine sediment target selection is provided in section 2.2.

Temperature Targets
To improve the quality of coldwater biota in Sawmill Creek, it will be necessary to maintain the instantaneous maximum temperature below 13º C and the maximum daily average temperature below 9º C as prescribed in State of Idaho Water Quality and Wastewater Treatment Administrative Rules (IDAPA 58.01.02.250.02.b) for salmonid spawning.

Loading Summary
Existing Sediment Sources
There are 99.2 miles of unsurfaced road in the Sawmill Creek watershed, which equates to approximately one mile of road per square mile. There are several unmaintained low gradient roads that lie within 300 ft of Sawmill Creek. These roads make approximately three stream fords. Roads that receive periodic maintenance make approximately three bridged crossings of Sawmill Creek. These roads are generally not hydrologically connected other than at the crossings. In the upper canyon, timber harvest road densities are significant in the Bear, Mill and Iron Creek watersheds, however they are largely located in upland areas and are not considered to deliver significant sediment to surface water.

Streambank erosion has been accelerated by the combination of extreme hydrologic events resulting from extensive wildfire and degraded riparian conditions from overgrazing. Livestock management has been modified, and riparian vegetation has greatly recovered (IDEQ 1998). The streambank erosion inventories conducted on Sawmill Creek show that the primary source of sediment is from streambank erosion with the most significant erosion currently occurring over the upper middle erosion inventory reach upstream from the Sawmill Canyon Road. The next most erosive segment inventoried is the upper reach near the confluence of Timber Creek.

Existing Heat Sources
Energy responsible for elevating stream temperature enters the stream primarily through direct solar radiation such as sunlight directly striking the water. Indirect scattered and reflected radiation from the sky and clouds and long-wave thermal radiation from the atmosphere also contribute to a lesser degree (Wetzel 1983). The accumulation of heat within a stream can be referred to as heat loading. Heat loading is a cumulative function; it increases along the course of a stream. Heat loading is reduced by riparian vegetation that is capable of shading the stream. Streams that have healthy riparian vegetation tend to have less heat loading because surface area is reduced in streams with lower width to depth ratios. Streams that have reduced riparian vegetation tend to have greater width to depth ratios due to streambank erosion that increases the width of the stream and reduces the depth of the stream. Reduced shade and increased surface area can result from historic and current grazing within the riparian zone.

Within lower Sawmill Creek the increased channel width was predisposed by overgrazing that combined with an extreme peak flow that was related to a fire that burned much of the ground cover in the upper watershed in 1966. The stream channel is more confined over the upper watershed until it reaches a depositional alluvial fan that would have inherently less bank stability. The result of the combination of these factors; reduced streambank stability from the naturally erosive stream channel over this reach, combined with the instability from reduced riparian vegetation due to overgrazing, and an extreme hydrologic event resulted in aggradation of the stream channel and extreme widening.

Reduction of streambank erosion prescribed within this TMDL is directly linked to the improvement of riparian vegetation density and structure to armor stream banks, reduce lateral recession, trap sediment and reduce the erosive energy of the stream thus reducing sediment loading. It is also expected that improvement of riparian vegetation density and structure would reduce the erosion of streambanks and increase stream shading which would reduce stream heat loading. The timeframe required for channel changes over the lower segment of Sawmill Creek will likely be significantly longer than the response time for Wet Creek or Little Lost River.

Estimates of Existing Sediment Load
Based on estimates from streambank erosion inventories on Sawmill Creek the existing accumulated streambank erosion rate for the inventory reaches including extrapolated reaches over the §303(d) segment is 671 tons per year.

In the upper canyon, where timber harvest road densities are significant in the Bear, Mill and Iron Creek watersheds, rather than developing a quantitative load reduction, this TMDL suggests reducing the sediment contribution by implementing adequate BMPs that have been identified in existing agency road guidance documents such as cross bar drainage with effective spacing and drain dip location, out-slope drainage/filtration, regular maintenance to minimize sediment production and transport, and culvert armoring. Continued evaluation for closure and obliteration is recommended for roads that have been identified in inventories as hydrologically connected with high gradients constructed of loose materials such as Williams Creek Road (#405) at the stream crossing approximately 1 m above the Forest boundary.

Load Allocations

Using water quality targets identified in the Little Lost River Watershed TMDL, sediment load allocations or sediment load reductions are outlined in this section. Because the primary chronic source of sediment loading to Sawmill Creek is streambank erosion, quantitative allocations are developed. These sediment load reductions are designed to meet the established instream water quality target of 28% or less fine sediment <6.35 mm in areas suitable for salmonid spawning. Streambank erosion reductions are quantitatively linked to tons of sediment per year. An inferential link is identified to show how sediment load allocations will reduce subsurface fine sediment to or below target levels. This link assumes that by reducing chronic sources of sediment, there will be a decrease in subsurface fine sediment that will ultimately improve the status of beneficial uses. Streambank erosion load allocation is based upon the assumption that natural background sediment production from streambanks equates to 80% streambank stability as described in Overton and others (1995), where stable banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally at 80% or greater for A, B, and C channel types in plutonic, volcanic, metamorphic and sedimentary geology types.

Based on existing sediment load from bank erosion on Sawmill Creek, a reduction of 80 percent is recommended overall. Sawmill Creek streambank erosion load allocations are broken down by individual inventory segment in Table 11.

Table 11 Sawmill Creek streambank erosion load allocations.

Reach	Location	Existing Total Erosion (t/y)	Proposed Total Erosion (t/y)	Proposed Erosion Rate (t/mi/y)	Percent Reduction	After Reduction Percent of Total
Upper Sawmill	Upper Private boundary to Timber Creek Campground	210	52	14	75	40%
Upper Middle Sawmill	Sawmill Canyon Road lower Bridge upstream to Horse Lake Creek confluence	345	32	15	91	24%
Middle Sawmill	Sawmill Canyon Road lower Bridge downstream to lower BLM exclosure	63	22	15	65	17%
Lower Sawmill	Bell Mountain Rd to lower BLM exclosure	53	25	12	53	19%
	Total	**671**	**131**	**56**	**80**	**100%**

Because of the limited availability of summarized temperature data, the maximum observed daily temperature and maximum observed daily average temperature were taken from temperature data collected in 1997 using in-stream temperature data loggers. The maximum observed daily temperature was used to determine the percent reduction for instantaneous maximum for the reach by subtracting the instantaneous juvenile bull trout rearing temperature criteria of 12°C from the observed maximum instantaneous temperature and calculating the percent reduction from the observed maximum to comply with the current standard. Similarly the percent reduction for daily average for the reach was determined by subtracting the bull trout spawning daily average criteria from the maximum observed daily average and calculating the percent reduction from the observed maximum daily average to comply with the current standard (Table 12).

Margin of Safety

The MOS factored into load allocations for Sawmill Creek is implicit. The MOS is the conservative assumptions used to develop existing sediment loads. Conservative assumptions made as part of the sediment loading analysis include: 1) Desired bank erosion rates are representative of background conditions; 2) Water quality targets for percent depth fines are consistent with values measured and set by local land management agencies based on established literature values and incorporate an adequate level of fry survival to provide for stable salmonid production. The marin of safety factored in to heat load allocations are implicit within the temperatures identified in State water quality standards.

Table 12 Sawmill Creek temperature loading analysis and allocation.[1]

Stream Segment	Maximum Observed Daily Temperature	Maximum Observed Daily Average Temperature	Idaho Instantaneous Juvenile Bull Trout Rearing Temperature	Idaho bull trout/Salmonid spawning daily avg.	Percent Reduction for Instantaneous Maximum	Percent Reduction for Daily Average
Sawmill Creek at Bull Creek Road[2]	15°C 15 July 97 6 Days of Exceedence	12°C 10 September 16 Days of Exceedence	12°C	9°C	20%	25%
Sawmill Creek at Sawmill Canyon Road[2]	18°C 24 August 46 Days of Exceedence	15°C 1 September 22 Days of Exceedence	12°C	9°C	29.4%	40%
Sawmill Creek 100 m above Summit Creek[2]	22°C 8 July 29 Days of Exceedence	15°C 9 July 33 Days of Exceedence	12°C	9°C	45%	40%

[1]Allocation based on 1997 temperature data from the Little Lost Subbasin Assessment

[2]Bull trout juvenile rearing and bull trout spawning temperature criteria apply.

Seasonal Variation and Critical Time Periods of Sediment Loading

To qualify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak and base flow conditions. While deriving these estimates it is difficult to account for seasonal and annual variation within a particular time frame, however, the seasonal and annual variation is accounted for over the longer time frame under which observed conditions have developed.

Annual erosion and sediment delivery are greatly a function of climate where wet water years typically produce the highest sediment loads. Additionally, annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months. For example, in the Little Lost River watershed, most streambank erosion occurs during spring runoff while most hillslope erosion occurs during summer thunderstorms and spring runoff.

This sediment analysis uses empirically derived hydrologic concepts to help account for variation and critical time periods. First, field-based methods consider critical hydrologic mechanisms. For example streambank erosion inventories account for the fact that most bank recession occurs during peak flow events when banks are saturated. Second, the estimated annual average sediment delivery from a given watershed is a function of bankfull discharge or the average annual peak flow event.

The period of excessive heat loading is characteristically during July, August, and September, when low flow and peak air temperature combine with increased direct solar radiation to warm stream temperatures to critical levels for salmonid rearing and coldwater biota.

3.3 Wet Creek TMDL

Watershed Description

The Wet Creek Watershed is located in Butte County, Idaho approximately 32 miles northwest of the community of Howe, Idaho (Figure 1). Wet Creek has a watershed area of 117,124 acres with maximum elevation of 11,724 ft above Nolan Lake at the western bound of the watershed. Stream elevations range from 10,800 ft at the headwaters to 5,885 ft at the confluence with the Little Lost River.

Wet Creek Beneficial Use is designated within state water quality standards for Primary Contact Recreation, Industrial Water Supply, Wildlife Habitat and Aesthetics. Wet Creek has been assessed as showing Full Support for Salmonid Spawning and Needs Verification to show full support for the Cold Water Biota beneficial use. Cold Water Biota and Salmonid Spawning are existing Beneficial Uses within Wet Creek. Pollutants of Concern are listed in the Subbasin Assessment as sediment, stream temperature and flow alteration. Stream flow alterations will not have load allocations within this TMDL. Load allocations for sediment and temperature are developed and will require continued improvement of riparian habitat conditions, which will also benefit stream temperature and instream flow and flow related conditions. The 1998 proposed §303(d) List of water quality impaired waters define the impaired reach of Wet Creek as being from Coal Creek to the Little Lost River confluence, approximately 16 stream miles.

Wet Creek is an important component of the Little Lost River bull trout key watershed identified in Governor Batt's State of Idaho Bull Trout Conservation Plan (Batt 1996). Wet Creek has been identified in the Little Lost River Watershed Bull Trout Problem Assessment (IDEQ 1998) as nodal habitat. Nodal habitats are generally mainstem overwintering areas, and serve as a corridor for migratory life forms. It is possible that a remnant focal population exists at the headwaters of Wet Creek.

Along the §303(d) listed reach overall stream gradient is 2.6% in the A and B channel types on the upper third and 1.2% in the C channel type over the lower two thirds as defined by Rosgen (1996), which includes the listed reach described in the State of Idaho 1998 proposed §303(d) list.

Wet Creek can be further characterized by its geomorphic conditions, or the shape of the basin through which Wet Creek flows. Wet Creek watershed relief ratio (R), the ratio of basin relief to basin length is moderate at .052. Drainage density in Wet Creek, the ratio of total channel length to drainage area, is 1.09 mi/mi^2, which is low to moderate. For Wet Creek the depositional stream density is .077, indicating a low proportion of depositional area related to transport area. The product of relief ratio, drainage density and bankfull discharge divided by depositional stream density (miles of stream <1.5% slope) gives sediment transport potential (P_S). The value of P_S for Wet Creek is 0.73. Sediment transport potential is higher in Wet Creek than Sawmill Creek ($P_{S=}$0.2), and the Little Lost River ($P_{S=}$0.09). In a steep watershed with high stream density, the Potential Sediment Transport Coefficient will be high relative to a watershed with moderate relief and many depositional channels.

Soils within the Wet Creek watershed are slightly to moderately erosive with the majority of the listed reach defining the boundary between gravelly loam soils to the north and loam soils to the south at 5 – 9 percent slope. The upper watershed is composed of less erosive gravelly loam-very stony loam and unweathered bedrock, fragmented material and stony loam, though at steeper slopes of 34 to 44%.

Land use is primarily mixed rangeland grazing with some recreation. Land ownership is primarily BLM with some private land and one State section over the listed reach and ownership is primarily USFS from the headwaters to just below (approximately 1 mile) the upper §303(d) boundary at the confluence of Coal Creek.

Existing Conditions
BLM has conducted significant long-term monitoring of fisheries, hydrology, temperature, suspended sediment and riparian condition along Wet Creek that has previously been summarized in the Little Lost River Subbasin Assessment by DEQ (IDEQ 1998). U.S. Forest Service has also conducted riparian habitat, fisheries and temperature monitoring and DEQ has conducted BURP assessment at two locations on Wet Creek also included in the Subbasin Assessment. The Subbasin Assessment concludes that Wet Creek from the headwaters to the mouth (WBID 24 below Coal Creek, and WBID 22 from the confluence of Squaw Creek to the mouth) are confirmed to be water quality limited. The Idaho Department of Fish and Game has funded and conducted extensive fisheries investigations throughout the basin. Since the release of The Little Lost River Subbasin Assessment BLM has collected additional temperature and riparian habitat condition data, U.S. Forest Service has conducted additional temperature monitoring and DEQ has collected sediment core samples at 3 locations and streambank erosion inventories have been conducted along 5 reaches of Wet Creek.

Riparian Condition
Currently, the majority of the listed segment of Wet Creek on BLM land is under riparian management directed at reducing sediment and thermal inputs. Riparian management on BLM is geared toward riparian pasture grazing rotation and exclosure fencing that has been sequentially implemented since the early 1980s. Riparian management on US Forest Service Land is primarily directed at maintenance of current conditions through triggering mechanisms such as residual stubble height. There is one exclosure on Forest Service land on upper Wet Creek, above the listed reach, geared toward protection of bank stability on a wet meadow that has been identified as important bull trout habitat.

The trend in riparian condition on Wet Creek monitoring reaches has generally been upward or static based on proper functioning condition assessment with the exception of the Hawley Mt. Allotment (2) inventory (Table 13). The length of the Wet Creek §303(d) reach is 15.89 miles, of which approximately 6.5 miles are under exclosure to cattle, 8.5 miles are managed as riparian pasture and the approximately 1 mile remaining is managed under stubble height triggering management by US Forest Service. Riparian monitoring has been conducted over 3.8 miles (24%) since 1993. Of the riparian area monitored 32% is unchanged (static), 24% is downward trend and 44% is in an upward trend.

Table 13 Wet Creek grazing allotment trends since 1993.of previous entrenchment.

Stream	Allotment (ID #)	Miles Length	Initial Assessment	Initial Condition	Later Assessment	Later Condition	Trend
Wet Cr.	Squaw Cr. (2)	.81	1993	79%	1997	78%	Static
Wet Cr.	Squaw Cr. (3)	.76	1993	68%	1997	82%	Up
Wet Cr.	Hawley Mt. (8)	.4	1994	56%	1998	58%	Static
Wet Cr.	Hawley Mt. (6)	.38	1994	38%	1998	44%	Up
Wet Cr.	Hawley Mt. (2)	.9	1994	56%	1998	50%	Down
Wet Cr.	Upper Hartman(2)	.55	1993	61%	1998	72%	Up

The Hawley Mt. (2) monitoring reach is in an exclosure management system that has been in place since 1989. The channel is dynamic as it evolves a new flood plain, a result Overall, fisheries habitat conditions are rated as good to fair on Wet Creek and are expected to improve as riparian management implementation reaches maturation.

McNeil sediment core samples were collected on Wet Creek in August of 1999 by DEQ at 3 locations (Figure 3). Sediment Core Data evaluates subsurface fine sediment to a depth of 4 in for resident fish species, and indicates expected fry survival as it relates to percentage of intragravel fines less than 0.25 in (6.35 mm). The mean % fines less than 6.35 mm excluding substrate larger than 63.5 mm was 36% at the upper sample site located just above the upper riparian exclosure on Wet Creek. The middle site at the lower end of the upper riparian exclosure exhibited 36% and the lower site below the Little Lost Highway above the confluence indicated 35%. Expected fine sediment values described by Rosgen (1996) for the C channel type would be in the range of 20 to 30%< 6 mm.

An inventory of streambank erosion was conducted along 8,369 feet (10%) of Wet Creek streambank over 6 reaches of Wet Creek on the §303(d) reach. The streambank erosion inventory is a qualitative evaluation of channel shape, bank stability and riparian

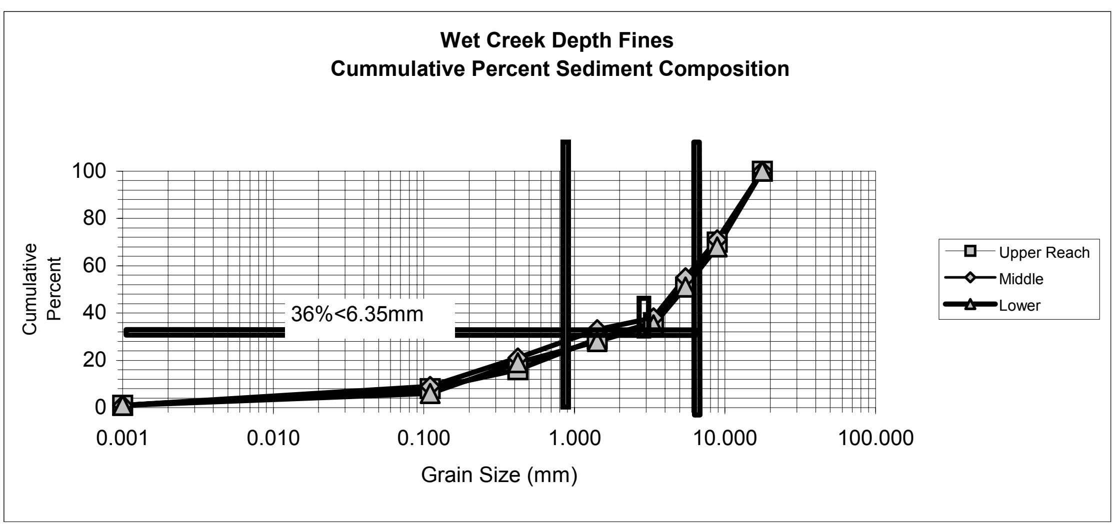

Figure 3 Cumulative percent depth fines on Wet Creek at three locations.

vegetation developed by the NRCS as a tool to evaluate erosion condition on streambanks, gullies and roads. Streambank erosion values obtained from the sample reach can be extrapolated to adjacent streambanks of similar condition under like management to estimate direct annual sediment inputs to the stream. Used in conjunction with other available sediment data such as total suspended sediment and depth fines the erosion inventory can be a useful tool to allocate sediment from streambank erosion and to prioritize stream reaches for implementation of BMPs or to track the effectiveness over time of BMPs already implemented.

Streambank erosion estimates are based on the erosive condition and area of streambanks and the rate of lateral recession, or how much of a streambank erodes into the stream. The estimates are given as annual average erosion and are expressed in tons of sediment per sample reach or in tons per mile per year. Observed conditions are the result of flow conditions that the stream experiences over time, natural channel migration, and adjacent land use.

For Wet Creek, erosion rate values range from 5 tons per mile per year within the most established riparian exclosure above Pass Creek Road to 59 tons per mile per year on the trigger management area adjacent to Coal Creek (Table 14).

Sampling of total suspended sediment (TSS) is limited. Samples were collected in 1995 and 1996 above the Dry Creek Hydropower Project during spring runoff. Sample values range from 10 to 97 mg/l producing a peak-flow sediment load ranging from 0.83 to 19 tons per day. Base flow TSS concentrations range from 2-6 mg/l which produce a corresponding load of 0.12 to 0.44 tons per day. Samples collected below the Dry Creek Hydropower project during peak flows in 1995, 1996 and 1997 show TSS values in the range of 36 to 250 mg/l producing a load of 6 –71 tons per day. One base flow TSS sample was collected showing 15 mg/l, producing a load of 0.62 tons per day.

Table 14 Existing erosion rates and total erosion on Wet Creek.

Reach	Location	Erosion Rate (t/mi/y)	Total Extrapolated Erosion (t/y)	Percent of Total
Upper	Upper Private boundary to beaver complex below Coal Creek.	59	115	49%
Middle 1	Below beaver complex, Approx. 1.7 mi above upper exclosure.	52	26	11%
Middle 2	Between Middle 1 sample and upper exclosure.	53	10	4%
Exclosure	Upper Exclosure	5	16	7%
Lower 1	Pass Cr. Rd to Dry Cr. Hydro	22	23	10%
Lower 2	Confluence to fish ladder just below Dry Cr. Hydro.	33	45	19%
	Total	**224**	**235**	**100%**

Additional BURP data was collected at two sites on Wet Creek; 50 meters above the Coal Creek/Wet Creek confluence and ½ mile below the Loristica Campground. The Loristica site was evaluated on June 22, 1998 at an elevation of 7,760 ft. and had a flow of 7.98 cfs in a B type channel with 5% gradient and width to depth ratio of 14.3. Bank stability was 83%. Surface fines less than 6.35 mm were 25%. The Habitat Index (HI) gives a score based on natural fish habitat conditions. Interpretation of scores are based on a variable scale of ecoregions. The Loristica site is grouped within the Northern Rockies ecoregion and requires a sore greater than 99 to show unimpaired conditions. For the Northern Rockies ecoregion scores less than 65 show impaired conditions and intermediate scores require verification. Habitat Index score at the Loristica site was 109. The Macroinvetebrate Biotic Index (MBI) score was 4.1. Macroinvertebrate scores greater than 3.5 reflect unimpaired conditions while scores less than 2.5 indicate impaired conditions. Intermediate MBI scores need verification. The Coal Creek Confluence site was evaluated on the same day at an elevation of 7160 ft and had a flow of 14.47 cfs in a C type channel with 2% gradient and width to depth ratio of 9.3. Surface fines less than 6.35 mm were 24%. Bank stability was 83%. Habitat Index score was 95; The Macroinvetebrate Index score was 5.6. The Coal Creek site is grouped in the Snake River Basin ecoregion and requires a habitat score greater than 88 to show full support.

Temperature data was collected at five locations between 1996 and 1999 on Wet Creek (Table 15).

Table 15 Water temperature summary for Wet Creek (adapted from Gamett 2000).

Reach Location	Temperature Metric	1996	1997	1998	1999
Wet Creek exclosure above Hilts Cr. (1.3 mi above Coal Cr.)	Absolute Max. Temp	12.2	11.7	12.0	11.1
	Max 7 Day Moving Avg.	11.7	11.4	11.1	10.7
	July-Sept. Temp . units	653.5	670	668.2	616.8
	July-Sept. Mean Temp.	7.1	7.3	7.3	6.7
Wet Creek above Coal Creek	Absolute Max. Temp		15.6[1]	12.2[1]	14.6
	Max 7 Day Moving Avg.		14.8[1]	11.5[1]	13.6
	July-Sept. Temp . units		754.6[1]	639.5[1]	707.8
	July-Sept. Mean Temp.		8.2[1]	6.9[1]	7.7
Wet Creek 0.6 miles below Coal Creek (1st unnamed trib)	Absolute Max. Temp		21.3	19.6	19.8
	Max 7 Day Moving Avg.		19.0	19.0	18.3
	July-Sept. Temp . units		990.2	1004	904
	July-Sept. Mean Temp.		10.8	10.9	9.8
Wet Creek above Forest Boundary	Absolute Max. Temp	18.8[2]	17.8[2]	18.6[2]	17.6
	Max 7 Day Moving Avg.	18.1[2]	16.3[2]	17.8[2]	16.5
	July-Sept. Temp . units	-	944.0[2]	950.1[2]	869.3
	July-Sept. Mean Temp.	10.2[2]	10.3[2]	10.3[2]	9.4
Wet Creek below 1st unnamed tributary below Coal Creek	Absolute Max. Temp			16.7	15.2
	Max 7 Day Moving Avg.			15.9	14.4
	July-Sept. Temp . units			808.9	736.6
	July-Sept. Mean Temp.			8.8	8.0

[1]In 1997 and 1998, the data logger was located on the fenceline between the two private pieces of land
[2]In 1996, 1997 and 1998, the data logger was located at the Forest Boundary fence 340 m below the temperature monitoring site.

Water Quality Concerns
The primary water quality concern in Wet Creek is elevated water temperature and subsurface fine sediment deposited within the stream substrate. Fine sediment is likely impacting the success of salmonid spawning and the abundance and quality of fish habitat. The primary source of sediment appears to be streambank erosion with numerous unmaintained recreational road crossings and Pass Creek road runoff adjacent to Coal Creek also contributing. To a lesser degree elevated stream temperature is a water quality concern. State and federal water quality standards are numeric, species, and temporally specific. Water temperature conditions are improving in Wet Creek and improvement will track with riparian condition improvement along with sediment conditions. Sediment conditions are less variable seasonally.

Biological indicators of beneficial uses show full support for salmonid spawning and coldwater biota, but further decline in stream water quality, particularly through increased sediment loads, would likely result in reduced support status. Ultimately, any additional anthropogenic inputs of sediment, or land management activity that results in elevated stream temperatures should be mitigated for

Rainbow trout, bull trout, and brook trout are documented present in Wet Creek. Bull trout are listed as a threatened species. It is evident that there is successful spawning activity occurring in the Wet Creek watershed as evidenced by the presence of self sustaining populations of trout. The IDFG manages streams for wild trout fisheries (i.e. favoring natural reproduction and no stocking) with a possession limit of two trout per day. There is currently no legal harvest allowed for bull trout, however rainbow trout populations are able to support a consumptive fishery in Wet Creek. Fish habitat conditions are rated good to fair by BLM in Wet Creek (BLM 2000).

Thermal refuge is available above and below the middle reach of Wet Creek, and fish passage appears to be adequate above and below this reach to provide access to refugia. With continued aggressive riparian management it could be expected that in a reasonable amount of time, perhaps 10 to 15 years, riparian vegetation conditions would improve to levels that increase canopy closure, reduce width to depth ratio and subsequently reduce average temperature and instream fine sediment. This management regime is currently in place on Wet Creek.

The restoration of a balanced and natural system that supports beneficial uses is underway in Wet Creek. Temperature trends are beginning to improve or stabilize (IDEQ 1998), though currently in violation of State Water Quality Standards. Fine sediment deposition, though lacking baseline data, has likely improved as evidenced by improving fisheries conditions (Gamett 1998), and existing conditions are not significantly beyond identified target values. Tributaries to Wet Creek are in similar land management and show Full Support of existing Beneficial Uses.

Based on Geomorphic Risk Assessment, Wet Creek is able to adequately transport sediment, however, it also must be considered a source to the Little Lost River. Ultimately streambank erosion must be reduced to at or near natural background levels, and any additional anthropogenic sediment delivery to the Little Lost River should be mitigated for.

Load Capacities and Targets
The current state of the science does not allow specification of a sediment load or load capacity that is known in advance to meet the narrative criteria for sediment and to fully support beneficial uses for coldwater biota and salmonid spawning. All that can be said is that the load capacity lies somewhere between the current loading and levels that relate to natural temperature and streambank erosion levels. We presume that beneficial uses were or would be fully supported at natural background sediment loading rates that are assumed to equate to 80% bank stability, and temperature regimes that would meet state water quality standards.

Beneficial uses may be fully supported at higher rates of sediment loading. The strategy is to establish a declining trend in sediment load indicator targets, and to regularly monitor water quality and beneficial use support status. If it is established that full support of beneficial uses is achieved at intermediate sediment loads above natural background levels and that temperature standards are being met the TMDL will be revised accordingly.

Elevated stream temperature can affect the success of salmonid spawning, overall distribution and survival of salmonids and the presence and type of macroinvertebrate species in streams. State of Idaho Water Quality Standards for temperature have been adopted to support coldwater biota and salmonid spawning beneficial uses during the critical periods of the year when stream temperatures are naturally elevated. Additional elevation of stream temperature can result from human activities that affect streams by reducing shading plants or increasing the surface area (width) of the stream exposed to sunlight.

The observed heat load within Wet Creek varies from year to year depending upon winter and summer precipitation, ambient air temperature and the percent of maximum potential solar radiation. The load capacity for heat for the purpose of this TMDL is determined by water quality standards for temperature based on bull trout juvenile rearing and bull trout spawning, as numeric water quality standards must be supported in the absence of site-specific criteria, or alternative beneficial use designations. Water quality standards specific to bull trout are the most restrictive of temperature standards, and at the level of compliance with bull trout temperature standards, other temperature standards for salmonid spawning and coldwater biota would be met during the warmest period of the year. The target for stream temperature within Wet Creek is identified as State of Idaho bull trout temperature standard. It is assumed that the water quality standard for bull trout juvenile rearing and spawning also incorporates an implicit margin of safety adequate to insure self sustaining populations of all salmonids including bull trout.

Sediment Targets
To improve the quality of spawning substrate and rearing habitat in Wet Creek, it is necessary to reduce the component of subsurface fine sediment less than 6.35 mm to

below 28%. A detailed discussion of subsurface fine sediment target selection is provided in section 2.2.

Temperature Targets
To improve the quality of coldwater biota in Wet Creek, it will ultimately be necessary to maintain the instantaneous maximum temperature below 13º C and the maximum daily average temperature below 9º C as prescribed in State of Idaho Water Quality and Wastewater Treatment Administrative Rules (IDAPA 58.01.02.250.02.b) for salmonid spawning.

Loading Summary
Existing Sediment Sources
There are 138 miles of unsurfaced road in the Wet Creek watershed, which equates to less than one mile per square mile. These roads make at least 24 stream crossings overall. There are numerous unmapped and unmaintained pioneered roads that appear to be equally distributed on BLM, USFS and private property outside of grazing exclosure areas adjacent to Wet Creek. These roads are generally affiliated with recreation and have created at least 5 stream fords over Wet Creek. Pass Creek road extends the length of the basin, makes two crossings and is within the riparian corridor of Wet Creek over approximately 1.5 miles between Big Creek and Coal Creek.

Outflow from the Dry Creek Hydropower Project enters Wet Creek approximately 3.5 miles above its confluence with the Little Lost River. Initially, the added flow resulted in increased incising of Wet Creek and reduced streambank stability. Though streambanks remain erosive in areas, the trend is toward improved stability. Wet Creek below the confluence of diversion water from Dry Creek remains at risk of severe channel alteration that would result from an extreme hydrological event exacerbated by additional flow from the Hydropower Project.

Streambank erosion has been accelerated by historic overgrazing. Riparian management has resulted in improved conditions, though streambank erosion from overgrazing remains the single most significant source of sediment to Wet Creek. The streambank erosion inventory conducted on Wet Creek shows that the primary source of sediment from streambank erosion occurs over the upper evaluation reach from the beaver complex below coal creek upstream through the parcel of private land on Wet Creek. The next most erosive streambanks are found below the hydro project to the confluence with the Little Lost River.

Existing Heat Sources
Energy responsible for elevating stream temperature enters the stream primarily through direct solar radiation such as sunlight directly striking the water. Indirect scattered and reflected radiation from the sky and clouds and long-wave thermal radiation from the atmosphere also contribute to a lesser degree (Wetzel 1983). The accumulation of heat within a stream can be referred to as heat loading. Heat loading is a cumulative function; it increases along the course of a stream. Heat loading is reduced by riparian vegetation that is capable of shading the stream. Streams that have healthy riparian vegetation tend

to have less heat loading because surface area is reduced in streams with lower width to depth ratios. Streams that have reduced riparian vegetation tend to have greater width to depth ratios due to streambank erosion that increases the width of the stream and reduces the depth of the stream. Reduced shade and increased surface area can result from historic and current grazing within the riparian zone.

Reduction of streambank erosion prescribed within this TMDL is directly linked to the improvement of riparian vegetation density and structure to armor stream banks, reduce lateral recession, trap sediment and reduce the erosive energy of the stream thus reducing sediment loading. It is also expected that improvement of riparian vegetation density and structure would reduce the and increase stream shading which would reduce stream heat loading.

Estimates of Existing Sediment Load
Based on estimates from streambank erosion inventories on Wet Creek the existing accumulated streambank erosion rate for the inventory reaches including extrapolated reaches over the §303(d) segment and the reach above to the upper private/USFS boundary is 235 tons per year.

Pass Creek Road is within the riparian corridor of Wet Creek over approximately 1.5 miles between Big Creek and Coal Creek. It is likely that sediment input to Wet Creek from this reach of road would be in the range of 25 to 37 tons per year (IDEQ 1999) and could be reduced by approximately 50%. Rather than developing a quantitative load reduction, this TMDL suggests reducing the sediment contribution by implementing adequate BMPs that have been identified in existing agency road guidance publications such as cross bar drainage, out-slope drainage, regular maintenance to minimize sediment production and transport, and culvert armoring. Continued evaluation for closure is recommended regarding redundant and pioneered roads within riparian areas.

Load Allocations
Using water quality targets identified in the Little Lost River Watershed TMDL, sediment load allocations or sediment load reductions are outlined in this section. Because the primary chronic source of sediment loading to Wet Creek is streambank erosion, quantitative allocations are developed. These sediment load reductions are designed to meet the established instream water quality target of 28% or less fine sediment <6.35 mm in areas suitable for salmonid spawning. Streambank erosion reductions are quantitatively linked to tons of sediment per year. An inferential link is identified to show how sediment load allocations will reduce subsurface fine sediment to or below target levels. This link assumes that by reducing chronic sources of sediment, there will be a decrease in subsurface fine sediment that will ultimately improve the status of beneficial uses. Streambank erosion load allocation is based upon the assumption that natural background sediment production from streambanks equates to 80% streambank stability as described in Overton and others (1995), where stable banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally at 80% or greater for A, B, and C channel types in plutonic, volcanic, metamorphic and sedimentary geology types.

Based on existing sediment load from bank erosion on Wet Creek, a reduction of 62% is recommended overall. Wet Creek streambank erosion load allocations are broken down by individual inventory segment in Table 16.

Because of the limited availability of summarized temperature data, the maximum observed daily temperature and maximum observed daily average temperature were taken from temperature data collected in 1997 using in-stream temperature data loggers. The maximum observed daily temperature was used to determine the percent reduction for instantaneous maximum for the reach by subtracting the instantaneous juvenile bull trout rearing temperature criteria of 12°C from the observed maximum instantaneous temperature and calculating the percent reduction from the observed maximum to comply with the current standard. Similarly the percent reduction for daily average for the reach was determined by subtracting the bull trout spawning daily average criteria from the maximum observed daily average and calculating the percent reduction from the observed maximum daily average to comply with the current standard (Table 17).

Margin of Safety

The MOS factored into load allocations for Wet Creek is implicit. The MOS is the conservative assumptions used to develop existing sediment loads. Conservative assumptions made as part of the sediment loading analysis include: 1) Desired bank erosion rates are representative of background conditions; 2) Water quality targets for percent depth fines are consistent with values measured and set by local land management agencies based on established literature values and incorporate an adequate level of fry survival to provide for stable salmonid production. The marin of safety factored in to heat load allocations are implicit within the temperatures identified in State water quality standards.

Table 16 Sediment load allocations/reductions by erosion inventory reach.

Reach	Location	Existing Total Erosion (t/y)	Proposed Total Erosion (t/y)	Proposed Erosion Rate (t/mi/y)	Percent Reduction	After Reduction Percent of Total
Upper	Upper Private boundary to beaver complex below Coal Creek.	115	19	20	83%	21%
Middle 1	Below beaver complex, Approx. 1.7 mi above upper exclosure.	26`	20	40	23%	22%
Middle 2	Between Middle 1 sample and upper exclosure.	10	4	16	6%	5%
Exclosure	Upper Exclosure	16	14	4	13%	16%
Lower 1	Pass Cr. Rd to Dry Cr. Hydro	23	17	16	26%	19%
Lower 2	Confluence to fish ladder just below Dry Cr. Hydro.	45	15	11	66%	17%
	Total	**235**	**89**	**107**	**62%**	**100%**

Table 17 Wet Creek temperature loading analysis and allocation.[1]

Stream Segment	Maximum Observed Daily Temperature	Maximum Observed Daily Average Temperature	Idaho Instantaneous Juvenile Bull Trout Rearing Temperature	Idaho bull trout/Salmonid spawning daily avg.	Percent Reduction for Instantaneous Maximum	Percent Reduction for Daily Average
Wet Creek at FS Boundary[2]	17°C BTJR 15 July 97 28 Days of Exceedence	11°C 10 September 15 Days of Exceedence	12°C	9°C	29.4%	18%
Wet Creek at Deer Creek Road[2]	19°C 15 July 97 36 Days of Exceedence	15°C 15 July 97 37 Days of Exceedence	12°C	9°C	58%	67%
Wet Creek 100 m above Hydro[2]	19°C 15 July 97 35 Days of Exceedence	15°C 9 July 97 39 Days of Exceedence	12°C	9°C	58%	67%
Wet Creek 200 m above Little Lost[2]	16°C 9 July 17 Days of Exceedence	12°C 15 July 97 35 Days of Exceedence	12°C	9°C	25%	25%

[1]Allocation based on 1997 temperature data from the Little Lost Subbasin Assessment
[2]Bull trout juvenile rearing and bull trout spawning temperature criteria apply

Seasonal Variation and Critical Time Periods of Sediment Loading
To qualify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak and base flow conditions. While deriving these estimates it is difficult to account for seasonal and annual variation within a particular time frame, however, the seasonal and annual variation is accounted for over the longer time frame under which observed conditions have developed.

Annual erosion and sediment delivery are greatly a function of climate where wet water years typically produce the highest sediment loads. Additionally, annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months. For example, in the Little Lost River watershed, most streambank erosion occurs during spring runoff while most hillslope erosion occurs during summer thunderstorms and spring runoff.

This sediment analysis uses empirically derived hydrologic concepts to help account for variation and critical time periods. First, field-based methods consider critical hydrologic mechanisms. For example streambank erosion inventories account for the fact that most bank recession occurs during peak flow events when banks are saturated. Second, the estimated annual average sediment delivery from a given watershed is a function of bankfull discharge or the average annual peak flow event.

The period of excessive heat loading is characteristically during July, August, and September, when low flow and peak air temperature combine with increased direct solar radiation to warm stream temperatures to critical levels for salmonid rearing and coldwater biota.

4.0 Public Participation

There is not an approved Watershed Advisory Group affiliated with the Little Lost River watershed. Through the process of developing the Little Lost River Bull Trout Problem Assessment an informal citizens advisory group was formed by individuals interested in participating in the process, to review and comment on that document. As part of the 3 meetings held in Howe, Idaho that related to the Little Lost River Bull Trout Problem Assessment, the TMDL process, the role of the Division of Environmental Quality and the Environmental Protection Agency in developing TMDLs, the Clean Water Act, and the TMDL process as it relates to the Little Lost River watershed were presented and discussed. The Little Lost River citizens group agreed to review the Little Lost River TMDL when it was completed.

The Division of Environmental Quality State Office developed the Little Lost River Subbasin Assessment as the precursor to the TMDL for the Little Lost River. The Subbasin Assessment was incorporated into the Bull Trout Problem Assessment and discussion at public meetings related to development of the Bull Trout Problem Assessment. Additionally, the Subbasin Assessment was sent out to State and Federal land management agencies as well as local organizations and individuals for review.

In early April 2000, the concepts of the Little Lost TMDL were presented to the Upper Snake River Basin Advisory Group. The methodology of data collection, the results of analysis and loading analysis were presented. In Early June the TMDL was presented at a public meeting, which included the Little Lost River citizens group. The public meeting was publicized through public service announcements in the local general circulation newspaper. After this meeting a public notice was printed in local general circulation newspapers announcing the draft TMDL 30 day public comment period with information describing how to obtain the document, comment deadlines, and where to direct comments.

Throughout the development of the TMDL the Bureau of Land Management and the U.S. Forest Service were involved in study design, review of data collection methods, and document review. Current data collected since the Subbasin Assessment was solicited and obtained from these agencies as well. After the public comment period a follow-up meeting was held with the designated BLM and USFS TMDL personnel to discuss their agencies' comments on the TMDL.

Comments and Responses

Comments submitted by the United States Environmental Protection Agency Region 10 with responses in italics:

- Use 1998 303(d) list information rather than 1996 303(d) list. This will reduce confusion between the ALittle Lost River Subbasin at a Glance≅ table and AWater Body and Pollutants Addressed≅ table and the text of the TMDL.

The "Little Lost River Subbasin at a Glance" will be updated with the current 1998-303(d) list information.

∃ Several of the water quality segments also are listed for temperature. The TMDL does not provide a loading analysis (loading capacity, allocations, etc.) for temperature but rather implies that temperature reductions sufficient to meet standards will be attained through sediment load reduction (>prescription to reduce stream bank erosion≅) (p.11). We are hopeful that this will be the case, but are unclear as to whether this document is intended to be a temperature TMDL. If so, then temperature loading capacities and allocations in quantitative terms should be established, as well as a linkage between sediment and temperature reductions. If not, please clarify that temperature TMDLs will be developed at a later date. If this is the case, Idaho should consider an appropriate change to the TMDL schedule. ***2)*** Finally, it would also be helpful to include information noting EPA=s proposed addition of several waterbodies within the subbasin to the 303(d) list for temperature, although as we discussed, TMDLs for these waters could be established at a later date (See: link to proposed 303(d) waters).

As stated in the TMDL the 303(d) listed waters within the subbasin, with the exception of the lower Little Lost River, are listed for sediment and temperature and are fully supporting beneficial uses of salmonid spawning and coldwater biota. A temperature load allocation will be incorporated into the TMDLs that identifies loading capacities as the State bull trout water quality standards, the allocation will be the percent reduction based on 1997 temperature data required to meet the State water quality standards. A more explicit statement regarding the linkage between streambank stability and thermal loading will be included. The Margin of Safety will be considered implicit within the State water quality standards for temperature.

Given that the biological signal shows that beneficial uses are fully supported on Wet and Sawmill Creeks, the temperature TMDL will be directed toward meeting state water quality standards. The status of full support for coldwater biota and salmonid spawning is supported by data from electrofishing and macroinvertebrate biotic index scores. Low magnitude temperature exceedances are documented to occur in most years over several reaches of the listed streams during periods of salmonid spawning and have occurred between 1994 and 1996. Occasionally the instantaneous coldwater biota temperature standard is minimally exceeded. Bull trout spawning and rearing are considered to occur primarily over the upper reaches of the listed streams where temperature regimes are naturally attractive to spawning fish . The most significant exceedence occurs during late July, August and early September with regard to bull trout juvenile rearing and during early September over the spawning period assigned in the water quality standard over the lower reaches of streams where juvenile rearing and adult spawning are not documented to occur. Bull trout are known to migrate to upper reaches of streams during the warmer periods of the summer. This is generally the case with other non-303(d) listed streams in the subbasin that are known to contain bull trout.

From 1997 through 1998 there were no instantaneous coldwater biota violations on Wet Creek. Juvenile rearing instantaneous temperatures were exceeded at the upper temperature-monitoring site in 1996, but not in 1997, 1998 or 1999. At the USFS monitoring site below Coal Creek bull trout juvenile rearing criteria were met and bull trout spawning criteria were exceeded by a maximum of 2°C during early September.

Given the magnitude, frequency and duration of temperature standard violations on 303(d) listed streams within the Little Lost River watershed, it is reasonable to assume that the needed reduction in thermal loading would be attained from improved stream channel and the associated riparian characteristics without assigning temperature loading capacities and allocations in quantitative terms. A quantitative linkage between sediment and temperature reductions is not necessary to assign that a net reduction in temperature loading would be expected with improved stream channel characteristics such as width to depth ratio and undercut banks so a narrative linkage will be included. Previously approved temperature TMDLs do not exhibit this type of linkage, and there is not an explicit linkage found in current literature.

There will not be a statement included in The Little Lost River TMDL regarding the additional streams within the Little Lost River watershed that EPA has proposed to add to the 1998 303(d) list. Please refer to the comment letters to EPA's Joan Bean from the State of Idaho Division of Environmental Quality dated June 8, 2000, and USFS dated June 2, 2000.

- Would be helpful to include the Asources considered≅ under the table ALittle Lost River Subbasin at a Glance.≅ See Table 5 in AEPA Region 10's TMDL Review Checklist Guidelines≅ for an example.

Sources considered will be added to the "Subbasin at a Glance" section.

- The primary cause of streambank erosion is related to the downcutting of the stream channel and subsequent sloughing of streambanks that resulted from the same hydrologic event that resulted in the channel blowout on Sawmill Creek (pg 20). This would be easier to understand if the hydrologic event was briefly explained in the text, rather than making a reference to it.

We will add a brief description of the effect of the channel blowout that occurred in the early '80s on Sawmill Creek.

- Table 3, p.18, appears to unduly accentuate marginal improvements and understate declining condition. For example: Briggs canyon condition declines by 1% (82 to 81%) but is listed as Astatic.≅ However a 1% increase in condition (59-60%) at Cedarville is listed as Aup.≅ And, a 3% decrease 46-43%) at the second Cedarville segment is listed as Astatic.≅ We believe there should be consistency in the conclusions and also wonder what the statistical significance of a one, or even three percent, change may be. If there is no statistical significance, then they should also be reported as >static.≅

The Bureau of Land Management has agreed to change the table to reflect that any change in riparian condition less than 3% will be considered static. The table within the TMDL will be changed accordingly.

Applicable Water Quality Standards and Numeric Targets

- Sediment targets are set at 28% or less subsurface fine sediment less than 6.35 mm. However, on p.12, streams in Agood condition≅ are stated to have fine sediment of 20%, or less for quartzite streams; and, less than 25% for granitic, volcanic, and sedimentary drainages. During the conference call, you agreed to revise the sediment target to be not greater than 25% fine sediment and to include an explanation of your target selection into the margin of safety discussion.

The TMDL is written to assign levels of pollutants that will result in full support of beneficial uses of salmonid spawning and coldwater biota. The targets that relate to streams in "good condition" are indeed likely to result in full support of beneficial uses. It is felt that beneficial uses would also be fully supported at 28% fines and that 28% fines incorporates an adequate margin of safety to allow for full support of salmonid spawning beneficial uses. The water quality standards that relate to beneficial uses do not identify land management agency defined functional conditions as they relate to depth fines sediment targets as the endpoint for compliance with water quality standards.

Loading Capacity

- You note that current state of science does not allow specification of a sediment load or load capacity to meet the narrative criteria for sediment -- just that load capacity lies between current loading and levels that approach the natural streambank erosion levels. Also, you assume that beneficial uses were or would be fully supported at natural background sediment loading rates (pg 20). Your strategy is to establish a declining trend in sediment load indicator targets and find out which level supports the beneficial uses and then to revise the TMDL accordingly. How will beneficial use support be determined and documented to establish that Afull support≅ is attained? If standards are not met at Asupport≅ levels, how will that discrepancy be resolved? Until then, you imply that you will use natural background levels as the level for supporting the beneficial uses. However, you do not describe the background level in quantitative terms. As discussed in the conference call, you will need to quantify the loading capacity, which initially would be the natural background levels.

Salmonid spawning and coldwater biota beneficial uses are currently fully supported in Wet Creek and Sawmill Creek with regard to the types of monitoring that would be used in implementation monitoring to determine support levels (macroinvertebrate biotic index scores and sampling of salmonid populations to determine age class presence through electrofishing). The reason the TMDL streams are assessed as Not Full Support is because of the temperature standard violations identified in the Subbasin Assessment.

At the time temperature standards are met, as determined by monitoring with data loggers, it is expected that full support of beneficial uses will be attained..

The lower 303(d) listed segment of the Little Lost River is not an exception to the adaptive management strategy identified within the TMDL. As stream channel characteristics and riparian shading improve through BMP implementation, implementation monitoring will determine at what point beneficial uses are fully supported and the TMDL will be adapted to reflect observed conditions.

It is not necessary to quantitatively describe the loading capacity beyond that described in the TMDL. The gross allocation of sediment within the TMDL relates to natural background levels of sediment and are quantified in the load allocation as the streambank erosion that equates to 80% bank stability, which was used to identify the percent reduction in the allocation of sediment. This will be stated more explicitly in the TMDL.

<u>Wasteload Allocations</u>

- There are apparently no point sources and therefore no wasteload allocations. If this is the case, then this should be explicitly stated in the TMDL, and a wasteload allocation of zero established in the TMDL.

We will explicitly state that there are no point source discharges within the Little Lost subbasin.

<u>Implementation Plan</u>

- We appreciate your efforts to link measures in the TMDL with actual practices that will be used to implement it. Although it is not a required element, we believe that it makes the TMDL much more meaningful to the people who have to implement it. Throughout the document, you have included information of how the load reductions will be attained. For example for Sawmill Creek and Wet Creek, you referenced BLM=s ongoing riparian management geared toward riparian pasture grazing rotation and exclosure fencing with triggering mechanisms such as residual stubble height. You may want to consider including a separate and more comprehensive section on an implementation plan or actions.

The Implementation Plan for the Little Lost River subbasin will be developed within 18 months of the EPA approval of the Little Lost River TMDL.

<u>Public Participation</u>

- During the conference call, you agreed to update the public participation portion of the TMDL to include the publication of a public notice in a general circulation newspaper announcing the draft TMDLs and providing the public with at least 30 days to comment on the draft, as well as inclusion of those comments and response to comments in the final TMDL.

The Public Participation section will be updated to reflect the public meetings held that specifically, and in-part dealt with The Little Lost River TMDL, and the parameters of the Public Comment Period will be described. Response to Comments received will also be included.

Comments received from the United States Forest Service, Lost River Ranger District Salmon-Challis National Forest with responses in italics:

- Why is a TMDL for sediment being written for Wet Creek and Sawmill Creek when data clearly indicate that the beneficial uses for these streams are fully supported? Idaho water quality standards indicate that "Sediment shall not exceed…quantities which impair designated beneficial uses." The beneficial uses being addressed by the draft TMDL on Wet Creek and Sawmill Creek are Salmonid Spawning (SS) and Cold Water Biota (CWB). However, data indicate that both the SS and CWB beneficial uses are fully supported on both streams. However, we feel the data indicate there is no need to proceed with the sediment portion of the TMDL on Wet Creek and Sawmill Creek. If the department wishes to proceed with the sediment portion of the TMDL on these two streams we would like to meet with you to discuss these concerns.

The listed water quality limited segments within the Little Lost River hydrologic unit were re-assessed using all available data according to current Idaho water quality standards and the IDEQ Water Body Assessment Guidance (IDEQ, 1996) as specified under IDAPA 16.01.02.053 (now under tittle 58), in the Little Lost River Subbasin Assessment (IDEQ 1998). The 303(d) listed streams addressed in the Little Lost River Subbasin TMDL were identified within the Subbasin Assessment as Not Full Support for Salmonid Spawning and Coldwater Biota. The primary reason that the TMDL streams were assessed as Not Full Support is due to exceedence of water quality standards for temperature that relate to Coldwater Biota, Salmonid Spawning, Bull Trout Juvenile Rearing and Bull Trout Spawning.

It is felt that the predominant anthropogenic (i.e. human) cause of the exceedence of water quality standards for temperature is due to the increase in net solar radiation. The increases to net solar radiation are from reduced riparian vegetation and increased surface area (i.e., width/depth ratio) of streams due to streambank erosion that are a result of riparian impacts from historic and current grazing activities.

Water bodies with an assessment of "Not Full Support" due to an identified pollutant are required to have TMDLs established. TMDLs are defined in 40 CFR Part 130 as the sum of the individual Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for nonpoint sources, including a margin of safety and natural background conditions. There are no National Pollution Discharge Elimination System (NPDES) pollutant sources present within the Little Lost River hydrologic unit. Therefore, the *entire allocation specified within the Little Lost River TMDL is a Load Allocation for nonpoint sources.*

Wet Creek and Sawmill Creek are considered sources of sediment to the Little Lost River below their respective confluences and the LA for sediment to the Little Lost River relies in part on the LA for Wet Creek and Sawmill Creek.

It is difficult to identify a quantitative linkage between observed stream temperature and stream channel characteristics. It is generally accepted, however, that the primary variables that are related to reducing direct solar radiation to streams that result in elevated stream temperature are shading and surface area. Reducing streambank erosion is the single most effective mechanism within the Little Lost River TMDL streams to achieve full support for salmonid spawning and coldwater biota over the largest area of the listed reaches.

Initially, the TMDL was intended to improve stream temperature regime through quantitative reductions in sediment without assigning a quantitative load allocation for temperature. The available data on temperature loading is limited and the margin of safety required would be significant in relation to the margin of temperature exceedence. After reviewing TMDL comments from EPA, however, a quantitative reduction in stream temperature will be identified to comply with State of Idaho Water Quality Standards for temperature that will result in restoring full support to Salmonid Spawning and Coldwater Biota beneficial uses. The load allocation will be based on water quality standards for bull trout rearing and spawning. The Little Lost River TMDL will retain the Load Allocation for sediment to further describe the reduction of pollutants that will result in improvements in water quality that will be necessary to restore Full Support to beneficial uses on the lower listed segment of the Little Lost River.

Comments received from the Idaho Watersheds Project with response in italics:

- This letter represents the comments of Idaho Watersheds Project (IWP) on the June 2000 Draft of the Little Lost River Watershed TMDL.

  IWP incorporates pertinent comments from our comment letter of August 30, 1999 on the Lemhi River draft TMDL especially the sections on the failure of the DEQ to address flow alteration and dewatering of stream segments in the Little Lost watershed.

  IWP believes that the DEQ cannot ignore the need for a TMDL for temperature when cold water biota is listed as an unsupported beneficial use. DEQ must provide a TMDL to ensure compliance with cold water and bull trout temperature.

  Thank you for the opportunity to comment; IWP looks forward to receiving the final copy of the TMDL with corrections as suggested.

As discussed in the response to comments from the EPA, temperature load allocations were incorporated into the TMDLs.

Comments received from the Upper Snake Basin Advisory Group with response in italics:

- Thank you for the opportunity to review the "Little Lost Subbasin TMDL". I found the TMDL well conceived, explained, and complete. It appears that you have engaged the public in TMDL development and used the available data. The only suggestion I can offer is on page 17, item 4.0 Public Participation, paragraph three. We are the **Upper** Snake Basin Advisory Group.

  Thank you again for the opportunity to review this TMDL.

This change was made in the final draft.

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Glossary

"A" channel - A Rosgen channel type characterized by a fairly straight (sinuosity < 1.2), steep (high gradient 2-10%), highly confined (<1.4), single channel, with a low (<12) width to depth ratio.

Adaptive Management – An explicit and analytical process for adjusting management and research decisions to better achieve management objectives; and this process should be quantitative wherever feasible. Adaptive management recognizes that knowledge about natural resource systems is uncertain. Therefore, some management actions are best conducted as experiments in a continuing attempt to reduce the risk arising from that uncertainty. The aim of such experimentation is to find a way to achieve the objectives as quickly as possible while avoiding inadvertent mistakes that could lead to unsatisfactory results. The concept of adaptive management is readily understood because it represents the common sense of "learning by doing".

Agriculture Water Supply - A beneficial use, designated by the Division of Water Quality, which indicates that water quality is at such a level that it can be used for irrigation or livestock watering.

Aesthetics and Human Health - A beneficial use, designated by the Division of Water Quality, which indicates that water quality is good enough to not pose a significant health risk or be aesthetically unpleasant.

allotment - An area of land designated and managed for the grazing of livestock.

Allotment Management Plan (AMP) - A plan designed by the permitting agency and the user which prescribes the grazing management for the allotment, including rotation system and resource objectives.

amsl - above mean sea level (elevation)

Animal Unit Month (AUM) - The amount of forage necessary to feed one cow or its equivalent (in horses or sheep) for the period of one month.

anthropogenic – arising from man or man's presence/use.

aspect - The direction a surface is facing, generally related to a magnetic bearing. A south aspect would face south.

attainable beneficial use or attainable use – A beneficial use, that with appropriate point and nonpoint source controls, a water body could support in the future.

background – The biological, chemical, or physical conditions of waters measured at a point immediately upstream (up gradient) of the influence of an individual point or nonpoint source discharge, or existing prior to the point or nonpoint discharge if no valid up gradient site is available.

base flow - The water flow as measured during the period of lowest standard flow; in this area, it is usually mid-summer.

"B" channel - A Rosgen channel type characterized by a moderately straight (sinuosity 1.2-1.4), steep (high gradient < 2-9%), moderately confined (1.4-2.2), single channel, with moderate (14-26) width to depth ratio.

beneficial use - A term used by the Idaho Division of Environmental Quality to identify uses which water quality supports in a given stream or lake.

Best Management Practice (BMP) - A State of Idaho standard that defines a component practice or combination of component practices determined to be the most effective, practical means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals.

biological evaluation/assessment - A process document which evaluates the effect of a regulated action on the biologic species under investigation and quantifies the extent of that effect. If it is determined that an action "May Affect" the given species, consultation with the designated oversight agency (either National Marine Fisheries Service or US Fish and Wildlife Service) is required.

BLM - Bureau of Land Management, United States Department of the Interior.

C - Celsius; a temperature scale where freezing occurs at 0 degrees and boiling at 100 degrees.

candidate species - A species under investigation for listing under the ESA, but for which limited information is known about its current status or biological vulnerability, or for which regulatory rules have been created but not issued.

"C" channel - A Rosgen channel type characterized by a winding (sinuosity > 1.4), flat (low gradient < 1-3.9%), unconfined (> 2.2), single channel, with a moderate to high (> 12) width to depth ratio .

***Carex/Juncus* community** - A vegetative community composed predominately of sedges and rushes.

cfs - cubic feet per second; used for characterizing the volume of moving water in a stream.

channelization - The action of altering the natural stream channel and hydrology of the system to redirect water flow or prevent soil loss.

channel type - A classification system which seeks to identify the hydrologic characteristics of a stream, such as sinuosity, gradient, meander potential and bank characteristics.

cobble embeddedness - The degree to which cobbles are surrounded or covered by fine sediment (sand or silt), usually expressed as a percentage.

cold water biota - A beneficial use, designated by the Idaho Division of Water Quality, which indicates that water quality is high enough to support macroinvertebrates and fish.

cumulative effects - All of the combined actions and resultant effects which must be considered to effectively evaluate the effect of an additional, new action (ie. a review to see if this is "the straw that will break the camel's back").

deferred rotation - A grazing system in which pastures are used at different times each year.

degradation - The alteration of a given biological community in a negative manner which reduces the viability or diversity of the community and results in a change in ecological processes.

discretionary action - An action which a land management agency has the ability to regulate.

dispersed recreation - Any recreational activity that doesn't occur at a designated recreational site or area.

diversion - A physical structure which redirects water flow from a stream or spring into a ditch used for irrigation purposes.

diversity - A variety of plants, animals or community types.

ecological condition - A reflection of the dynamic equilibrium of an overall watershed, the long term health of the complete system and not individual parts of it.

ephemeral - A water source which only flows at certain, irregular times of the year, such as at spring runoff or during thunderstorms.

F - Fahrenheit; a temperature scale where freezing occurs at 32 degrees and boiling at 212 degrees.

fault - A fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture.

fecal coliform bacteria – A type of bacteria common to the digestive tract of warm blooded animals that is identified as an indicator of the presence of a range of pathogenic bacteria that can cause illness to man or livestock if ingested.

fines – a particle of sediment below a designated diameter (such as 6.35 mm) that is known to effect salmonid egg or fry survival through emergence.

fish screen - A screen on a diversion designed to allow water to flow through it while preventing passage by fish and directing them back into the stream.

flood irrigation - A method of irrigation using water diverted from a stream or spring through a ditch which allows the water to flow across a wide area, using gravity or topography to spread the water.

forb - Any herbaceous plant, other than a grass, especially one growing in a field or meadow.

forest land - Forested lands of ten or more acres capable of being ten percent stocked by forest tree species, and not currently set aside for non-timber use.

friable (soil) - Soil that crumbles readily.

Full Support – A category of water quality status. A water body whose status is "Full Support" is in compliance with those levels of water quality criteria listed in Idaho's *Water Quality Standards and Wastewater Treatment Requirements*, or with reference conditions approved by the Idaho Division of Environmental Quality Director in consultation with the appropriate Basin Advisory Group.

Functional At Risk Condition - Riparian-wetland areas that are in a functional condition but an existing soil, water or vegetation attribute makes them susceptible to degradation.

GAWS - General Aquatic Wildlife Survey; a USFS office-based survey of maps and existing information to provide basic stream mileage and fish presence/absence information.

geometric mean – The nth root of the product of n data: $((X_1)(X_2)(X_3))^{1/3}$ Used to establish the central tendency when averages of rates or index numbers are required.

gradient - A measure of steepness of ascent or descent. In this document it is usually used in reference to streams and the topographical rate of descent.

habitat inventory - A stream habitat inventory evaluates and attempts to characterize the stream channel. A riparian habitat inventory evaluates the vegetative characteristics of the riparian corridor.

herbaceous (vegetation) - A vegetative group including grasses and forbs, but excluding woody vegetation such as willows or sagebrush.

Habitat Index (HI) - A tool used to evaluate whether beneficial uses of aquatic life are being supported; aquatic habitat criteria are scored and compared against a standard based on the ecoregion being evaluated.

hydrologic divide - Topographical feature which bounds a watershed or watershed by forcing all water to flow one direction (e.g. Continental Divide).

hydrology - The scientific study of the properties, distribution and effects of water on and below the earth surface. The effect of flowing water on the land or stream channel.

IDEQ - State of Idaho Division of Environmental Quality.

IDFG - Idaho Department of Fish and Game.

instantaneous – A characteristic of a substance measured at any moment (instant) in time.

interdisciplinary team - A team comprised of people with various educational or professional backgrounds and individual abilities.

intermittent - A water source which only flows on the surface at irregular intervals along the stream channel, going subsurface along the remainder of the stream channel.

issue - A matter of wide concern.

land disposal - A process of transferring land from public ownership to private ownership.

land exchange - A transfer of land of nearly equal value between public and public ownership.

lateral recession rate - The rate at which a streambank erodes away from its original position in relation to the stream.

loading: acute – The relatively short duration of presence or addition of a pollutant, such as sediment or bacteria, above specified water quality criteria, to surface water.

loading: chronic – The longer term duration of presence of a pollutant, such as sediment or bacteria, above specified water quality criteria, to surface water.

Macroinvertebrate Biotic Index (MBI) - A tool used to evaluate water quality based on quantitative measurements of biological attributes of the communities of aquatic insects present at a sample site. Scores are adjusted based on the ecoregion being evaluated.

Margin of Safety – The additional load reduction applied to a load allocation to increase the likelihood that beneficial uses will be restored in a reasonable period of time.

monotype - A community that contains only one species of vegetation, lacking the normal diversity found in similar locations.

moraine - A pile of debris, including rocks and dirt, which is pushed ahead of, or along the sides of a glacier.

natural condition – A condition without human-based disruptions.

National Register of Historic Places - A legally created, federally-managed, listing of historic properties which have been determined to qualify for inclusion on the list because of their local, state or national significance.

Needs Verification- A category of water quality status. A water body whose status is "Needs Verification" has not been assessed, due to need for additional information that will allow distinction between "Full Support" and "Not Full Support."

Non-Functioning Condition - Riparian-wetland areas that are clearly not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows and thus are not reducing erosion, improving water quality, etc. The absence of certain physical attributes such as a floodplain where one should be are indicators of nonfunctioning conditions.

non-point source pollution – NPS, A pollution source which is ill-defined or comes from a broad area, such as sedimentation.

Not Full Support – A category of water quality status. A water body whose status is "Not Full Support" is not in compliance with those levels of water quality criteria listed in Idaho's *Water Quality Standards and Wastewater Treatment Requirements*, or with reference conditions approved by the Idaho Division of Environmental Quality Director in consultation with the appropriate Basin Advisory Group.

noxious weed - A weed arbitrarily defined by law as being especially undesirable, troublesome and difficult to control.

OHV - Off-highway vehicle; any vehicle capable of traveling off the highway.

outmigration - The action of fish leaving their birthplace, rearing or spawning area and moving a significant distance out of a given system into another for the needs of a different life stage.

PACFISH - A BLM and USFS directed, comprehensive and coordinated strategy for restoring and protecting the habitat of anadromous fish affected by dam construction and operation, water diversions, hatchery operations, fish harvest and the widespread degradation of the habitats of these species.

parcel - Any piece of land.

patented land - Land that has been transferred to private ownership, and which is still retained by the original owner.

perennial - A water source which flows throughout the year, each and every year.

physiographic province - A region of which all parts are similar in geologic structure and climate, and which has consequently had a unified geomorphic history.

pollution – Any alteration in the character or quality of the environment that renders it unfit or less suited for beneficial uses.

Primary Contact Recreation - A beneficial use, designated by the Division of Water Quality, which indicates that water quality is good enough for any activity in which full or partial, unprotected bodily contact occurs with water (ie. swimming or wading).

Proper Functioning Condition - Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration and temperature necessary for fish production, waterfowl breeding and other uses; and support greater biodiversity. The functioning condition of riparian wetland areas is a result of interaction among geology, soil, water and vegetation.

"prove up" - The Desert Land Entry Act of March 3, 1877, as amended required applicants to perform improvements upon the land and to spend set amounts of money to reclaim the arid land. The improvements and expenditures were completed prior to the land being patented. If the applicant has "proven" that he has met the requirements a patent can be completed.

range condition - A classification system (Excellent, Good, Fair or Poor), which provides an indication of the ecological health of the area and the degree of management necessary to maintain or improve the current condition. These classifications are generally indicated by differences in species composition, or deviation from perceived potential of the site. Differences between condition classes are somewhat arbitrary because they form a continuum across a spectrum with ill-defined borders.

reconnaissance – An exploratory or preliminary survey of an area.

redd - The spawning nest of a fish dug in the stream bottom, which covers the eggs until emergence.

reference condition – A condition that fully supports applicable beneficial uses, with little effect from human activity and representing the highest level of support attainable.

regression analysis – The analysis of the relationship of two variables that may allow prediction of one variable from another variable (the dependent variable is assumed to be determined by - i.e., is a function of –the magnitude of the second variable, the independent variable).

resident fish – non anadromous fish that are generally native or naturalized exotic species. Resident fish may migrate within or between subbasins or watersheds at various life history stages to utilize various habitat aspects within their preferred range.

resource objective - An objective to be reached or maintained, which defines the desired condition of the resources.

riparian - A vegetative community associated with surface or subsurface waters and watercourses within active watersheds. This community is rich in diversity of plants, as well as wildlife and aquatic organisms. The habitat includes not only lake and river ecosystems, but also wetland communities.

Riparian Habitat Conservation Agreement (RHCA) - A PACFISH term designating portions of watersheds where riparian-dependant resources receive primary emphasis, and management activities are subject to specific standards and guidelines. These areas include traditional riparian corridors, wetlands, intermittent headwater streams and other areas where proper ecological processes are crucial to the maintenance of the stream's water, sediment, woody debris and nutrient delivery systems.

Riparian Management Objective (RMO) - Objectives that are designed to measure the functionality of the riparian area and its affected stream channel. PACFISH has a set of RMO's which must be met for streams with anadromous fish unless local biologists have data that can define ones better suited to local conditions.

RMP - Resource Management Plan; Bureau of Land Management document which provides guidance over all land management activities.

salable timber - Timber in an area designated for commercial timber harvest, accessible for harvest, and which contains trees favorable for sale.

Salmonid Spawning - A beneficial use, designated by the Idaho Division of Water Quality, which indicates that water quality is good enough for salmonid fish to use for spawning with a high chance of egg survival.

screened diversion - A diversion which has a fish screen on it. (See fish screen).

Secondary Contact Recreation - A beneficial use, designated by the Idaho Division of Water Quality, which indicates that water quality supports any activity in which partial or incidental, protected bodily contact occurs with water (ie. fishing).

sediment-sorbed – Molecules adhering to the surface of a solid sediment.

shrub - Multi-stemmed woody vegetation not large enough to be considered trees, such as rose, willow, current, etc.

sinuosity - The ratio of stream channel length to valley length.

subbasin - A collection of watersheds that forms a much larger area; such as the Lemhi River subbasin, which yet drains into another, larger system, such as the Salmon River.

substrate - The stream bottom, composed of silt, sand, gravel, cobble, boulder or bedrock. The type of substrate and its looseness affects the ability of fish to spawn and the survivability of the eggs.

suspended sediment - Fine sediment suspended within the water column of moving or standing water.

synoptic sampling - Sampling at an upstream site, and timing sampling at a downstream site such that the sample is collected at the time the same water sampled upstream is passing the sampling location downstream. The purpose is to take out any diurnal variance in water conditions.

terminal moraine - A pile of dirt and rocks pushed in front of a moving glacier that was left behind when the glacier receded.

thermal sanctuary - A refuge area which has water temperatures lower or higher than the surrounding waters, to the degree that it reduces the metabolic stress to the fish (ie. a tributary spring or upwelling groundwater source).

thrust fault - A fault with a dip of 45 degrees F or less over much of its extent, on which the hanging block appears to have moved upward relative to the footwall. Horizontal compression rather than vertical displacement is its characteristic feature.

topography - The physical features of a place or region.

transverse fault - A fault that strikes obliquely or perpendicular to the general structural trend of the region.

tributary - A river or stream that flows into a larger river or stream.

unauthorized use - An action or use of federal lands which has not been authorized by the regulatory agency or is outside the allowable season of use.

unscreened diversion - A diversion which does not have a fish screen on it. (See fish screen).

USFS - United States Forest Service, Department of Agriculture.

viability - Capability to grow or develop under normal conditions.

Warranted but Precluded - A phrase used to indicate that a species under consideration for listing probably should be listed but other species are in more immediate danger and time or monies don't allow for equal consideration at this time.

WEPP – Water Erosion Prediction Project: the WEPP model is a process-based, distributed parameter, continuous simulation, erosion prediction model for use on personal computers. The software is produced by the USDA National Soil Erosion Research Laboratory at Purdue University and is available for free download at: http://topsoil.nserl.purdue.edu/weppmain/wepp.html.

water body – A homogeneous classification that can be assigned to rivers, lakes, esturaried, coastlines, streams or other water features.

water quality – A term used to describe the biological, chemical and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Target – An interim goal of water quality or habitat condition that provides the potential for beneficial use status of Full Support. Percent subsurface or instream surface fine sediment, streambank stability, percent overhead cover, riparian buffer width and average daily stream temperature are examples of possible targets.

watershed - A side stream (such as Agency Creek), and all the land that it drains, which is a tributary to a much larger stream or river (such as the Lemhi River).

Wolman Pebble Count - A monitoring tool used to determine the amount of surface fines (material < 6.35 mm) as an index of sedimentation and beneficial use impairment. The samples are conducted at the same sites macroinvertebrates are collected. The sampler walks across the stream, from banfull width to bankfull width, selecting pebbles at equidistant intervals. The intermediate axis is measured and recorded for each sample. A minimum of 50 samples from each cross-section must be obtained.

woodland - Forested land used to provide forest resources such as firewood and Christmas trees, and is not used in the determination of the annual allowable cut.

Appendix A. Sediment TMDL Methods and Results

Introduction
This appendix documents the analytical techniques and data used to develop the gross sediment budget and instream sediment measures used in the TMDLs. It describes the methods, data, and results for the following: 1) streambank erosion inventory and 2) surface and subsurface fine sediment data collection techniques. These data are intended to first characterize the natural and existing condition of the landscape, second estimate the desired level of erosion and sedimentation, and third provide baseline data which can be used in the future to track the effectiveness of TMDL implementation. For example, the streambank erosion inventories can be repeated and ultimately provide an adaptive management or feedback mechanism.

Streambank Erosion Inventory
The streambank erosion inventory used to estimate background and existing streambank erosion followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (1983). Using the direct volume method, sub-sections of 1996 §303(d) watersheds were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS Stream Bank Erosion Inventory is a field based methodology, which measures streambank/channel stability, length of active eroding banks, and bank geometry. The streambank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categories of rating the factors and rating scores are:

Bank Stability:
- Do not appear to be eroding - 0
- Erosion evident - 1
- Erosion and cracking present - 2
- Slumps and clumps sloughing off - 3

Bank Condition:
- Some bare bank, few rills, no vegetative overhang - 0
- Predominantly bare, some rills, moderate vegetative overhang - 1
- Bare, rills, severe vegetative overhang, exposed roots - 2
- Bare, rills and gullies, severe vegetative overhang, falling trees - 3

Vegetation / Cover On Banks:
- Predominantly perennials or rock-covered - 0
- Annuals / perennials mixed or about 40% bare - 1
- Annuals or about 70% bare - 2
- Predominantly bare - 3

Bank / Channel Shape:

V - Shaped channel, sloped banks - 0
Steep V - Shaped channel, near vertical banks - 1
Vertical Banks, U - Shaped channel - 2
U - Shaped channel, undercut banks, meandering channel - 3

Channel Bottom:

Channel in bedrock / noneroding - 0
Soil bottom, gravels or cobbles, minor erosion - 1
Silt bottom, evidence of active downcutting - 2

Deposition:

No evidence of recent deposition - 1
Evidence of recent deposits, silt bars - 0

Cumulative Rating

Slight (0-4) Moderate (5-8) Severe (9+)

From the Cumulative Rating, the lateral recession rate is assigned.

0.01 - 0.05 feet per year	**Slight**
0.06 - 0.15 feet per year	**Moderate**
0.16 - 0.3 feet per year	**Severe**
0.5+ feet per year	**Very Severe**

Streambank stability can also be characterized through the following definition and the corresponding streambank erosion condition rating from Bank Stability or Bank Condition above are included in italics.

Streambanks are considered stable if they do not show indications of any of the following features:

- **Breakdown** - Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*
- **Slumping or False Bank** - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*
- **Fracture** - A crack is visibly obvious on the bank indicating that the block of bank I about to slump or move into the stream. *Bank Stability Rating 2*
- **Vertical and Eroding** - The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Streambanks are considered covered if they show any of the following features:

- Perennial vegetation ground cover is greater than 50%. *Vegetation/Cover Rating 0*
- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*
- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*
- At least 50% of the bank surfaces are protected by logs of 4 inch diameter or larger. *Vegetation/Cover Rating 1*

Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton, 1993). The modification allows for measuring streambank stability in a more objective fashion. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- **Mostly covered and stable (non-erosional).** Streambanks are Over 50% Covered as defined above. Streambanks are Stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative Rating 0 - 4 (slight erosion) with a corresponding lateral recession rate of 0.01 - 0.05 feet per year.*
- **Mostly covered and unstable (vulnerable).** Streambanks are Over 50% Covered as defined above. Streambanks are Unstable as defined above. Such banks are typical of Afalse banks" observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and stable (vulnerable).** Streambanks are less than 50% Covered as defined above. Streambanks are Stable as defined above. Uncovered, stable banks are typical of streambanks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and unstable (erosional).** Streambanks are less than 50% Covered as defined above. They are also Unstable as defined above. These are bare eroding streambanks and include ALL banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative Rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Streambanks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection

The first step in the bank erosion inventory is to identify key problem areas. Streambank erosion tends to increase as a function of watershed area (NRCS, 1983). As a result, the lower stream segment of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types).

Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates are extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically between 10 and 30 percent of streambank needs to be inventoried. Often, the location of some stream inventory reaches is more dependent on land ownership than watershed characteristics. For example, private land owners are sometimes unwilling to allow access to stream segments within their property.

Stream reaches are subdivided into *sites* with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominate bank characteristics change substantially. In a stream with uniform channel geometry there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites. Subdivision of stream reaches is at the discretion of the field crew leader.

Field Methods

Streambank erosion or channel stability inventory field methods were originally developed by the USDA USFS (Pfankuch, 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people and are trained as a group to ensure quality control or consistent data collection. Field crews survey selected stream reaches measuring bank length, slope height, bankfull width and depth, and bank content. In most cases, a Global Positioning System (GPS) is used to locate the upper and lower boundaries of inventoried stream reaches. Additionally, while surveying field crews photograph key problem areas.

Bank Erosion Calculations

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS, 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor. The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * \rho_B]/2000 \text{ (lbs/ton)}$$

where:
E = bank erosion over sampled stream reach (tons/yr/sample reach)
A_E = eroding area (ft^2)
R_{LR} = lateral recession rate (ft/yr)
ρ_B = bulk density of bank material (lps/ft^3)

The bank erosion rate (E_R) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:
E_R = bank erosion rate (tons/mile/year)
E = bank erosion over sampled stream reach (tons/yr/sample reach)
L_{BB} = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold and others 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long term average. For example, a 50 year flood event might cause five feet of bank erosion in one year and over a ten year period this events accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding. For example, the bank on the outside of a meander. However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS, 1983). Several techniques are available to quantify bank erosion rates: for example, aerial photo interpretation, anectodal data, bank pins, and channel cross-sections.

To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates. For the Little Lost River TMDL, anectodal data were used to estimate bank recession rates. Table A-1 summarizes the results and recession rates from Lemhi River TMDL streams that are in general agreement with the NRCS (1983) categories. Additionally, Table A-2 is included to compare estimated recession rates to rates measured in recent research projects.

Table A-1 Bank lateral recession rates measured in Lemhi River Subbasin using anecdotal data.

Site	Lateral Recession (ft)	Time (yr)	Recession Rate (ft/yr)	Comments
18 - mile Creek (silt-clay)	2.5	2	1.25	Bank erosion results from cattle trampling bank rather than stream discharge. Likely not a good measure for other streams.
Kitley Creek (clay-silt)	14	37	0.38	Fence posts exposed, Fence built in late 1950s. Assume 1960 for rate calculation. Two feet lost in 1997 flood event.
Geertson Creek (silt-sand)	15	52	0.29	Cedar fence built in 1945.

The *bulk density* (ρ_B) of bank material is measured ocularly in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

The aerial photos were interpreted using standard techniques described by Compton (1996). Resource aerial photos, taken by the BLM, from 1946, 1960, 1974, 1992, and 1993 were used to characterize the location of features and to quantify the approximate time of gully and mass wasting initiation. The photos were also used to characterize changes in land use, riparian cover, and bank condition where possible.

Subsurface Fine Sediment Sampling

McNeil Sediment Core samples were collected to describe size composition of bottom materials in salmonid spawning beds of streams on the 303(d) list for sediment. Research has shown that subsurface fine sediment composition is important to egg and fry survival, Hall (1986), Reiser and White (1988). Data gathered as part of the TMDL and other studies relevant to the Little Lost River Subbasin are presented after the narrative section of this appendix.

Site Selection

Sample sites selected displayed characteristics of gravel size, depth and velocity required by salmonids to spawn and were determined to be adequate spawning substrate by an experienced fisheries biologist. Samples were collected during periods of low discharge, as described in McNeil and Ahnell (1964) to minimize loss of silt in suspension within the core sampling tube. Sample sites were generally in the lower reach of streams where spawning habitat was determined to exist.

Table A-2 Bank lateral recession rate measured in various research projects.

Reference	Average Migration Rate (ft/yr)		Comments
From Burckhardt and Todd (1998)	forested	unforested	Data collected in North Central Missouri in glacial deposits.
	0.7	5.3	Included here to show extreme values in highly
	1.9	5.6	unstable sand-gravel bank material.
	1.4	3.1	
	2.3	7	
	0.3	1.7	
	0.9	5.6	
	2.3	10.5	
	4.5	8.6	
	0.6	0.9	
From Trimble (1997)	0.65		Urbanized watershed. Sand-silt bank material
	13		

Field Methods
A 12 inch stainless steel open cylinder is worked manually as far as possible, at least 4 inches, into spawning substrate without allowing flowing water to top the core sampling tube. Samples of bottom materials were removed by hand, using a stainless steel mixing bowl, to a depth of at least 4 inches and placed into buckets. After solids were removed from the core sampling tube and placed into buckets, the remaining suspended material was discarded. It is felt that this fine material would be removed through the physical action of excavating a redd and would not be a significant factor with regard to egg to fry survival. Additionally, rinsing of sieves to process the sample results in some loss of the fraction below the smallest (0.053 mm) mesh size.

Samples were placed wet into a stack of sieves and were separated into 10 size classes by washing and shaking them through nine standard Tyler sieves having the following square mesh openings (in mm): 63, 25, 12.5, 6.3, 4.75, 2.36, .85, .212, .053. Silt passing the finest screen was discarded.

The volume of solids retained by each sieve was measured after the excess water drained off. The contents of each of the sieves were placed in a bucket filled with water to the level of a spigot for measurement by displacement. The water displaced by solids was collected in a plastic bucket and transferred to a 2,000 ml graduated cylinder and measured directly. Water displaced by solids retained by the smaller diameter sieves was also collected in a plastic bucket and measured in a 250 ml graduated cylinder. Variation in sample volumes was caused by variation in porosity and core depth. All sample fractions were expressed as a percentage of the sample with and without the 63 mm fraction.

Three sediment core samples were collected at each sample site and grouped together by fractions 6.3 mm and greater and 4.75mm to 0.53mm. The results for a particular site are the percentage of 4.75mm to 0.53mm as a percent of the total sample. Standard deviation is calculated for estimates including and excluding particles 63 mm and above.

Surface Erosion from Roads
Surface erosion from unimproved/unsurfaced roads and four-wheel drive trails considered to generally be within 50 meters of TMDL waters was estimated using numerical values from an extension of the US Department of Agriculture WEPP model. This model has been widely applied to estimate surface erosion from unsurfaced roads, particularly on USFS lands. The model is based on the gradient of the road, the distance to the stream (buffer distance), the slope angle to the stream (buffer slope), the width of the road, the soil type adjacent to the road and the amount of precipitation on the road. The assumptions used for the estimated tons of sediment produced over a particular reach of road were that the buffer slope was 25%, road width was 15 feet, distance to the stream was 30 feet, the soil or road material was gravelly loam and erosion was primarily snowmelt driven which uses an annual precipitation of 32 inches. It is likely that erosion is consistently over estimated given these assumptions within the Little Lost watershed, however the purpose is to conservatively estimate erosion load and to prioritize sources

that may be having an impact on aquatic beneficial uses. It is felt that erosion estimates are a valid tool for identifying and ranking sources in which to apply reductions based on implementation of BMPs.

Segments to be evaluated were identified using 7.5 minute USGS topographical maps and orthoquad aerial photos. The distance to water was estimated using the same maps and photos. Gradient was determined using a Scale Master Plus® digital plan measure to determine road distance for each 40 foot contour interval along the road being evaluated.

Erosion estimates from the WEPP model were made for gradients of 2%, 4%, 8% and 16%. Linear regression was used to interpolate intermediate values for gradients from 1 to 44 percent. Predicted tons per mile were then applied to the various segment lengths at each of the observed gradients and accumulated to estimate the tons of sediment produced by each segment of Road. Tons of sediment was broken down by the distance to the stream to show the relative amount in each distance interval, even though the buffer distance was assumed to be a constant 30 feet over the road segment being estimated. The result is a conservative estimate of sediment delivered to the stream in question with an implicit margin of safety.

Stream Bank Erosion Inventory Worksheet

Stream Sawmill Creek
Section Upper Sawmill From Campground to Fairview Guard Station
Field Crew Rochelle Mason, Nathan Ennen
Data reduced by Tom Herron, DEQ

Land Use Grazing, Recreation

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	20.8323	
	W	113	21.8062	7139
Downstream	N	44	20.4097	
	W	113	21.5438	7095

Stream Bank Erosion Calculations

AVE. Bank Height:	2.48	feet	**Inv. bank to bank length (L_{BB})**	4300	feet
bank to bank Eroding Seg. Length	2904	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.68				
Bank erosion over sampled reach (E)	24	tons/year/sample reach			
Erosion Rate (E_R)	58	tons/mile/year			
Feet of Similar Stream Type	16858	feet			
Eroding bank extrapolation	25674	feet			
Total stream bank erosion	**210**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	6	tons/year/sample reach
Erosion Rate (E_R)	14	tons/mile/year
Feet of Similar Stream Types	16858.00	feet
Eroding bank extrapolation	7603.20	feet
Total stream bank erosion	**52.2**	tons/year

Comments

Flow a contributing factor?: Yes, stream is downcut with vertical banks

Other contributing factors?: Not under any apparent grazing management
Other Notes: This reach was likely hardest hit by blowout, actively eroding.

Stream Bank Erosion Inventory Worksheet

Stream Sawmill Creek

Section From Sawmill Canyon Road Bridge upstream to private boundary

Field Crew Rochelle Mason, Nathan Ennen : BURP Crew.

Data reduced by Tom Herron, DEQ

Land Use Grazing, Recreation

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	18.1683	6628
	W	113	20.5742	
Downstream	N	44	18.6593	6574
	W	113	20.3962	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.5	feet	**Inv. bank to bank length (L_{BB})**	2318	feet
bank to bank Eroding Seg. Length	1586	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.68				
Bank erosion over sampled reach (E)	35	tons/year/sample reach			
Erosion Rate (E_R)	159	tons/mile/year			
Feet of Similar Stream Type	10298	feet			
Eroding bank extrapolation	15678.00	feet			
Total stream bank erosion	**345**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	3	tons/year/sample reach
Erosion Rate (E_R)	15	tons/mile/year
Feet of Similar Stream Types	10298	feet
Eroding bank extrapolation	4582.80	feet
Total stream bank erosion	**31.51**	tons/year

Comments

Flow a contributing factor?: Possibly at peak flow.

Other contributing factors?: This reach is within riparian exclosure. Good riparian vegetation with side channels.

Other Notes: Stream Channel previously blown out by peak flows, post fire, late 70's

Stream Bank Erosion Inventory Worksheet

Stream Sawmill Creek
Section Bridge downstream to lower slope toe
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst — **Data reduced by** Tom Herron, DEQ

Land Use Grazing, Recreation

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	18.698	6574
	W	113	20.351	
Downstream	N	44	17.459	6460
	W	113	20.048	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.6	feet	**Inv. bank to bank length (L_{BB})**	2700	feet
bank to bank Eroding Seg. Length	1280	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.47				
Bank erosion over sampled reach (E)	11	tons/year/sample reach			
Erosion Rate (E_R)	43	tons/mile/year			
Feet of Similar Stream Type	6359	feet			
Eroding bank extrapolation	7309.27	feet			
Total stream bank erosion	**63**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (E_R)	15	tons/mile/year
Feet of Similar Stream Types	6359.00	feet
Eroding bank extrapolation	3083.60	feet
Total stream bank erosion	**22.30**	tons/year

Comments

Flow a contributing factor?: Possibly at peak flow.

Other contributing factors?: This reach is within riparian exclosure. Good riparian vegetation with side channels.

Other Notes: Stream Channel previously blown out by peak flows, post fire, late 70's

Stream Bank Erosion Inventory Worksheet

Stream Sawmill Creek
Section Lower reach above confluence with Summit Creek to below riparian exclosure
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Grazing, Recreation

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	17.459	
	W	113	20.048	
Downstream	N	44	14.151	
	W	113	18.41	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.0	feet	**Inv. bank to bank length (L_{BB})**	5912	feet
bank to bank Eroding Seg. Length	2206	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.37				
Bank erosion over sampled reach (E)	14	tons/year/sample reach			
Erosion Rate (E_R)	24	tons/mile/year			
Feet of Similar Stream Type	8597	feet			
Eroding bank extrapolation	8621.76	feet			
Total stream bank erosion	**53**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	6	tons/year/sample reach
Erosion Rate (E_R)	12	tons/mile/year
Feet of Similar Stream Types	8597.00	feet
Eroding bank extrapolation	4621.20	feet
Total stream bank erosion	**25.3**	tons/year

Comments

Flow a contributing factor?: Yes, stream is downcut with vertical banks

Other contributing factors?: Not under any apparent grazing management
Other Notes: This reach was likely hardest hit by blowout, actively eroding.

Stream Bank Erosion Inventory Worksheet

Stream Upper Little Lost

Section Lower Waymire Property to extrapolated to the confluence of Summit Creek

Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Grazing, Irrigated Agriculture

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	10.302	5958
	W	113	15.748	
Downstream	N	44	9.878	5945
	W	113	15.708	

Stream Bank Erosion Calculations

AVE. Bank Height:	3.3	feet	**Inv. bank to bank length (L_{BB})**	4696	feet
bank Eroding Seg. Length	1668	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.36				
on over sampled reach (E)	9	tons/year/sample reach			
Erosion Rate (E_R)	20	tons/mile/year			
eet of Similar Stream Type	5866	feet			
roding bank extrapolation	5835.16	feet			
Total stream bank erosion	**32**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	8.3	tons/year/sample reach
Erosion Rate (E_R)	18.6	tons/mile/year
Feet of Similar Stream Types	5866.00	feet
Eroding bank extrapolation	3285.60	feet
Total stream bank erosion	**29.0**	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: High density willows to streams edge.

Other Notes:

Stream Bank Erosion Inventory Worksheet

Stream Little Lost River
Section USGS Guage at Clyde upstream to private boundary
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Riparian exclosure (recent)

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	8.32	
	W	113	14.703	
Downstream	N	44	9.88	
	W	113	15.71	

Stream Bank Erosion Calculations

AVE. Bank Height:	3.1	feet	**Inv. bank to bank length (LBB)**	7306	feet
bank to bank Eroding Seg. Length	3568	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.49				
Bank erosion over sampled reach (E)	55	tons/year/sample reach			
Erosion Rate (ER)	79	tons/mile/year			
Feet of Similar Stream Type	5358	feet			
Eroding bank extrapolation	8801.33	feet			
Total stream bank erosion	**135**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	14	tons/year/sample reach
Erosion Rate (ER)	20.4	tons/mile/year
Feet of Similar Stream Types	5358.00	feet
Eroding bank extrapolation	3604.40	feet
Total stream bank erosion	**34.8**	tons/year

Comments

Flow a contributing factor?: Yes, channel is slightly downcut

Other contributing factors?: Bank material is mostly sand with some gravel, many verticle banks

Other Notes: Riparian vegetation is primarily willows with varying age classes and shrubs. Few large woody plants.

Stream Bank Erosion Inventory Worksheet

Stream Lower Middle Little Lost

Section BLM/Private boundary upstream to Buck and Bird Road.

Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Grazing, Irrigated Agriculture, recreation

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	43	59.522	5445
	W	113	12.935	
Downstream	N	43	58.97	5407
	W	113	12.571	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.7	feet	**Inv. bank to bank length (LBB)**	2490	feet
bank Eroding Seg. Length	768	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.31				
on over sampled reach (E)	14	tons/year/sample reach			
Erosion Rate (ER)	59	tons/mile/year			
eet of Similar Stream Type	2448	feet			
roding bank extrapolation	2278.09	feet			
Total stream bank erosion	**41**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (ER)	15.9	tons/mile/year
Feet of Similar Stream Types	2448.00	feet
Eroding bank extrapolation	1477.20	feet
Total stream bank erosion	**11.1**	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: Riparian zone progressively degrades upstream

Other Notes: Mixed management, BLM reach borders private land above and below.

Stream Bank Erosion Inventory Worksheet

Stream Lower Little Lost

Section Diversion trench downstream 1.25 miles to double diversion. Extrapolated upstream to private boundary.

Field Crew Tom Herron DEQ; Sr. Water Quality Analyst   **Data reduced by** Tom Herron, DEQ

Land Use Grazing, Irrigated Agriculture, recreation

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	43	55.27	5050
	W	113	8.124	
Downstream	N	43	52.092	5033
	W	113	5.089	

Stream Bank Erosion Calculations

AVE. Bank Height:	1.4	feet	**Inv. bank to bank length (L_{BB})**	2572	feet
bank Eroding Seg. Length	780	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.30				
on over sampled reach (E)	3	tons/year/sample reach			
Erosion Rate (E_R)	12	tons/mile/year			
eet of Similar Stream Type	8593	feet			
roding bank extrapolation	5991.93	feet			
Total stream bank erosion	**23**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	2	tons/year/sample reach
Erosion Rate (E_R)	8.1	tons/mile/year
Feet of Similar Stream Types	8593.00	feet
Eroding bank extrapolation	3951.60	feet
Total stream bank erosion	**15.2**	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: Riparian zone progressively degrades upstream

Other Notes: Mixed management, BLM reach borders private land above and below.

Stream Bank Erosion Inventory Worksheet

Stream Wet Creek
Section Lower Reach from Confluence to Fish Ladder: Extrapolated to Dry Creek Diversion discharge (elev. 6170) (Lower2)
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Grazing; primarily on BLM land.

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	8.707	5885
	W	113	15.749	
Downstream	N	44	8.44	5960
	W	113	14.643	

Stream Bank Erosion Calculations

AVE. Bank Height:	1.9	feet	**Inv. bank to bank length (L_{BB})**	4268	feet
bank to bank Eroding Seg. Length	1438	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.34				
Bank erosion over sampled reach (E)	13.3	tons/year/sample reach			
Erosion Rate (E_R)	33	tons/mile/year			
Feet of Additional Similar Stream Type	5178	feet			
Eroding bank extrapolation	4927.21	feet			
Total stream bank erosion	**45**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4.3	tons/year/sample reach
Erosion Rate (E_R)	11	tons/mile/year
Feet of Similar Stream Types	5178	feet
Eroding bank extrapolation	2924.80	feet
Total stream bank erosion	**15**	tons/year

Comments

Flow a contributing factor?:

Other contributing factors?:

Other Notes: 2 Road crossings, Large beaver complex with diminishing riparian cover approx 1 mile below

Stream Bank Erosion Inventory Worksheet

Stream Wet Creek
Section Pass Creek Road to Dry Creek Hydro Outlet confluence (Lower1)
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst
Data reduced by Tom Herron, DEQ

Land Use Grazing: Primarily BLM

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	9.151	6310
	W	113	21.184	
Downstream	N	44	9.412	6170
	W	113	19.64	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.9	feet	**Inv. bank to bank length (L_{BB})**	2492	feet
bank to bank Eroding Seg. Length	364	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.15				
Bank erosion over sampled reach (E)	5.2	tons/year/sample reach			
Erosion Rate (E_R)	21.9	tons/mile/year			
Feet of Similar Stream Type	4368	feet			
Eroding bank extrapolation	1640	feet			
Total stream bank erosion	**23**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (E_R)	16	tons/mile/year
Feet of Similar Stream Types	4368.00	feet
Eroding bank extrapolation	2246	feet
Total stream bank erosion	**17.4**	tons/year

Comments

Flow a contributing factor?: No.

Other contributing factors?: Recently placed under riparian management, beginning recovery.

Other Notes: 2 water gaps noted over this reach. Lower segment channelized.

Stream Bank Erosion Inventory Worksheet

Stream Wet Creek
Section Middle Reach of Canyon Approx 1.7 mi above riparian exclosure (Middle1)
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst | **Data reduced by** Tom Herron, DEQ

Land Use Grazing/Stock Watering

Stream Segment Location

		Degrees	Minutes	Elevation	
GPS: Upstream	N	44	4.512	6780	Wet 07
	W	113	24.422		
Downstream	N	44	4.863	6750	Wet 06
	W	113	24.145		

Stream Bank Erosion Calculations

AVE. Bank Height:	6.5	feet	**Inv. bank to bank length (LBB)**	2198	feet
bank to bank Eroding Seg. Length	604	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.27				
Bank erosion over sampled reach (E)	11	tons/year/sample reach			
Erosion Rate (ER)	52	tons/mile/year			
Feet of Similar Stream Type	1543	feet			
Eroding bank extrapolation	1452.02	feet			
Total stream bank erosion	**26**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	8	tons/year/sample reach
Erosion Rate (ER)	40	tons/mile/year
Feet of Similar Stream Types	1543	feet
Eroding bank extrapolation	1057	feet
Total stream bank erosion	**20.2**	tons/year

Comments

Flow a contributing factor?:

Other contributing factors?:

Other Notes: 2 Road crossings, Large beaver complex above with diminishing riparian cover approx 1 mile below

Stream Bank Erosion Inventory Worksheet

Stream Wet Creek

Section Middle 2: Upper Riparian Exclosure to Lower Middle 1.

Field Crew Tom Herron DEQ; Sr. Water Quality Analyst

Data reduced by Tom Herron, DEQ

Land Use Grazing with solar powered offsite watering source.

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	4.863	6750
	W	113	24.145	
Downstream	N	44	5.71	6630
	W	113	23.689	

Stream Bank Erosion Calculations

AVE. Bank Height:	2.8	feet	**Inv. bank to bank length (LBB)**	2028	feet
to bank Eroding Seg. Length	546	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.27				
osion over sampled reach (E)	10	tons/year/sample reach			
Erosion Rate (ER)	53	tons/mile/year			
Feet of Similar Stream Type	0	feet			
Eroding bank extrapolation	546.00	feet			
Total stream bank erosion	**10**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	3	tons/year/sample reach
Erosion Rate (ER)	16	tons/mile/year
Feet of Similar Stream Types	0	feet
Eroding bank extrapolation	405.60	feet
Total stream bank erosion	**3.17**	tons/year

Comments

Flow a contributing factor?: No.

Other contributing factors?: Unprotected Private Grazing, above BLM Riparian Exclosure

Other Notes: Utilization cell present mid reach, recently placed under riparian management

Obvious fenceline contrast with reaches above and below

Stream Bank Erosion Inventory Worksheet

Stream Wet Creek
Section Riparian Exclosure Upstream bound to Pass Creek Rd crossing (Exclosure).
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Riparian Exclosure within BLM grazing

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	6.264	6580
	W	113	23.476	
Downstream	N	44	8.865	6343
	W	113	21.589	

Stream Bank Erosion Calculations

AVE. Bank Height:	1.2	feet	**Inv. bank to bank length (LBB)**	2616	feet
k to bank Eroding Seg. Length	338	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.13				
rosion over sampled reach (E)	1	tons/year/sample reach			
Erosion Rate (ER)	5	tons/mile/year			
Feet of Similar Stream Type	16788	feet			
Eroding bank extrapolation	4676.18	feet			
Total stream bank erosion	**16**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (ER)	4	tons/mile/year
Feet of Similar Stream Types	16788.00	feet
Eroding bank extrapolation	4704.96	feet
Total stream bank erosion	**14.15**	tons/year

Comments

Flow a contributing factor?: No

Other contributing factors?: Apparent increasing sinuosity, riparian vegetation well established.
Other Notes: 2 Road crossings, 2 water gaps noted over this section.

Stream Bank Erosion Inventory Worksheet

Stream Wet Creek
Section Upper reach from switchback to culvert below Coal Creek confluence then to beaver complex (Upper). Extrapolated to upper private boundary.
Field Crew Tom Herron DEQ; Sr. Water Quality Analyst **Data reduced by** Tom Herron, DEQ

Land Use Grazing and transportation corridor.

Stream Segment Location

		Degrees	Minutes	Elevation
GPS: Upstream	N	44	2.626	
	W	113	27.37	
Downstream	N	44	3.465	
	W	113	26.195	

Stream Bank Erosion Calculations

AVE. Bank Height:	3.8	feet	**Inv. bank to bank length (LBB)**	3136	feet
bank to bank Eroding Seg. Length	1004.2	feet	(Inventoried stream length X 2)		
Percent eroding bank	0.32				
Bank erosion over sampled reach (E)	18	tons/year/sample reach			
Erosion Rate (ER)	59	tons/mile/year			
Feet of Similar Stream Type	8683	feet			
Eroding bank extrapolation	6565	feet			
Total stream bank erosion	**115**	tons/year			

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	6	tons/year/sam
Erosion Rate (ER)	20	tons/mile/year
Feet of Similar Stream Types	8683.00	feet
Eroding bank extrapolation	4100.40	feet
Total stream bank erosion	**38.2**	tons/year

Comments

Flow a contributing factor?: No.

Other contributing factors?:

Other Notes: 2 Road crossings, Large beaver complex below with diminishing riparian coverabove.