Yaak River Watershed
Sediment Total Maximum Daily Loads

Montana Department of Environmental Quality
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SECTION 1.0
INTRODUCTION & EXECUTIVE SUMMARY

1.1 Background and Purpose

Section 303(d) of the federal Clean Water Act (CWA) and Section 75-5 of the Montana Water Quality Act (WQA) provide authority and procedures for monitoring and assessing water quality in Montana's streams and lakes. These also provide authority and procedures for developing Total Maximum Daily Loads (TMDLs) for those waters not meeting state water quality standards. This plan presents all necessary TMDLs for sediment in the Yaak TPA as specified in Montana's *2006 Integrated 305(b)/303(d) Water Quality Report* to the United States Environmental Protection Agency (EPA).

A TMDL is a pollutant budget that identifies the maximum amount of a particular pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded. For streams exceeding water quality standards, a TMDL may be expressed as a reduction in pollutant loading that will result in the attainment of water quality standards. A TMDL plan establishes quantitative water quality goals (targets) and necessary sediment reductions for each impaired stream segment. The plan also provides recommendations for reducing pollutant loads and establishes a framework for the implementation of monitoring and adaptive management strategies.

Primary contributors to data collection, analysis, and technical considerations presented herein include the Kootenai National Forest (KNF), the EPA, and the Montana Department of Environmental Quality (DEQ[1]).

1.2 The TMDL Planning Process

Development of TMDL Plans follows a series of successive steps required by EPA. The first step in developing TMDLs is to thoroughly evaluate and describe the water quality problems of concern. This includes understanding the physical characteristics of the watershed, documenting the location and extent of the water quality impairments, and identifying contributing causes and sources of impairment.

The next step in the process is to develop water quality targets for each impaired stream segment and for each pollutant of concern. Targets are numerical translations of the applicable water quality standards and are used as benchmarks to evaluate attainment of standards. Pollutant reductions necessary to meet water quality targets are then allocated to various identified pollutant sources throughout the TMDL planning area (TPA), and restorative or mitigative measures may be suggested as means to meet allocations. Allocations may be applied on the basis of source category (e.g. forestry, urban, agriculture, mining, transportation, etc.), land ownership (federal, state, private), sub-watersheds or tributaries, or any combination of these. Specific allocations may also be established for future growth and development in the watershed and for any natural sources that may be present.

[1] The acronym "DEQ" refers to The Montana Department of Environmental Quality unless otherwise indicated.

The pollutant allocations and mitigative measures become the basis for a water quality restoration strategy, which may include a combination of non-point and point source pollution control measures. Montana has adopted a policy of voluntary compliance for addressing non-point sources of pollution from private lands. As a result, non-point source control measures rely heavily on public education and other programs that encourage the application of appropriate land, soil, and water conservation practices. Point source pollution is regulated through the state-administered Montana Pollution Discharge Elimination System (MPDES) discharge permit program, and any point source allocations included in a TMDL shall be incorporated into the appropriate MPDES discharge permits (MCA 75-7-703(6)).

Lastly, the TMDL must include a monitoring component designed to evaluate progress in meeting the water quality targets established by the plan and to ensure that restorative measures are implemented and monitored for their effectiveness in reducing pollutant loads. The monitoring strategy also provides useful information to help fine-tune the restoration and reduction plans over the long-term. This process is called adaptive management. It is a component of watershed-scale restoration plans because of the complexity of the water quality problems and the inherent uncertainties involved with establishing cause-and-effect relationships between pollution sources and their effects over such large geographic areas. Taken together, the steps in the process described above constitute a water quality-based approach to water pollution control.

1.3 Yaak Watershed TMDLs: Executive Summary

The majority of the Yaak River Watershed is located in Lincoln County in the northwest corner of Montana. The Yaak Watershed encompasses a geographic area of approximately 507,660 acres, 393,822 of which lie in the United States, with the remaining portion in Canada (113,838 acres). The Yaak Watershed in the U.S. is located within the KNF.

Impaired waterbodies requiring TMDLs within the Yaak Watershed include Seventeenmile Creek, Lap Creek, and the South Fork Yaak River. This document focuses on sediment impairments in three water bodies. Sediment TMDLs are provided for Seventeenmile Creek, Lap Creek, and the South Fork Yaak River. Source assessments identify the unpaved forest road network as the predominant source of human-caused sediment in these three watersheds. Consequently, reductions in sediment from this source are called for through the implementation of best management practices (BMPs) and the application of all reasonable land, soil, and water conservation strategies.

Implementation of restorative and mitigative measures identified in this document is voluntary, cannot divest water rights or private property rights, and does not financially obligate identified stakeholders unless such measures are already a requirement under existing federal, state, or local regulations. The pollution control measures and strategies identified in this document are intended to balance the varying uses of water while adhering to Montana's water quality and water use laws. This document should be considered dynamic by providing an 'adaptive management strategy' approach to restore water quality in the Yaak River Watershed. This water quality plan is intended to identify the knowledge we have at present and to identify a future path for water quality restoration. As more knowledge is gained through the restoration process and future monitoring, this plan may change to accommodate new science and information. Montana's water quality law provides an avenue for using the adaptive management process by providing for future TMDL reviews.

The document structure provides specific sections that address TMDL components and watershed restoration. Sections 1.0 through 3.0 provide background information about the Yaak River watershed, Montana's water quality standards, and Montana's 303(d) Listings. Section 4.0 presents TMDL targets and impairment status reviews by water body. Sections 5.0 & 6.0 present specific sediment source assessments and sediment loading estimates, TMDLs, and allocations. Section 7.0 presents a framework strategy for implantation and water quality monitoring, and Section 8.0 provides a brief summary of the public involvement process. Table 1-1 provides a very general summary of the water quality restoration plan and TMDL components discussed in this document.

Table 1-1. Water Quality Plan and TMDL Summary Information

Impaired Water Body Summary	Seventeenmile Creek, Lap Creek, and South Fork Yaak River are listed as impaired for sediment on the State's most recent (2006) impaired waters list.
Impacted Uses	Coldwater fishery and aquatic life beneficial uses are negatively impacted from sediment-related causes.
Pollutant Source Descriptions	The predominant anthropogenic source of sediment is the unpaved forest road network from historic timber harvest activity. Sediment delivered to streams is primarily from erosion of forest roads, and sediment delivered to streams at stream crossings.
Sediment Targets Indicators	• % fine particles in stream substrates • Macroinvertebrate bioassessment scores • Stream width-to-depth ratios • Variety of supplemental indicators where appropriate
Other Use Support Objectives (non-pollutant & non-TMDL)	• Provide passage of juvenile fish through culverts at stream crossings.
Sediment TMDL and Allocation Summary	• Load allocations are provided for forest roads, natural background, bank erosion sources (lumped category) and mass wasting events. • Estimated annual sediment load allocations to all significant source categories are provided and are based on estimates of BMP performance.
Restoration & Mitigation Strategy	• The restoration strategy identifies general restoration approaches for assessed sources. Addressing the sources in the restoration strategy will likely achieve TMDLs. An adaptive management component is also provided for determining if future restoration will meet targets provided in the document.

SECTION 2.0
WATERSHED CHARACTERIZATION

This watershed characterization provides an overview of watershed characteristics in the Yaak River TPA. This section also provides some detail regarding characteristics of the watershed that may play a significant role in pollutant loading (e.g., geographical distribution of soil types, vegetative cover, or land use). The information provided herein is intended to serve as a general description of physical, climatic, hydrologic, and other ecological features within the planning area.

The majority of the data available is from the portion of the watershed located in the United States. Unless otherwise noted, information on the Canadian portion of the Yaak Watershed is not included in this watershed characterization. Maps illustrating information in this watershed characterization are included in Appendix D.

2.1 Physical Characteristics

2.1.1 Location and Ecoregion

The majority of the Yaak River Watershed is located in Lincoln County in the remote northwest corner of Montana (Map 1, Appendix D). The Yaak Watershed encompasses a geographic area of approximately 507,660 acres, 393,822 of which lie in the US, with the remaining portion in Canada (113,838 acres). The Yaak Watershed in the U.S. is located within the KNF. The North Fork Yaak originates in British Columbia and flows for 25 miles before entering Montana. Three miles within the U.S. border, the East Fork Yaak joins the North Fork, giving rise to the Yaak River. The West Fork Yaak flows from Montana into British Columbia for approximately four miles and then back into Montana where it joins the Yaak River downstream of the confluence of the East and North Forks. The Yaak River flows through the heavily wooded, mountainous terrain of the Purcell Mountains to its confluence with the Kootenai River six miles downstream of the town of Troy.

The entire Yaak Watershed lies within the Northern Rockies Level III Ecoregion (Omernik, 1987). The Yaak Watershed includes the following Level IV Ecoregions: Purcell-Cabinet-North Bitterroot Mountains, Salish Mountains, and patches of High Northern Rockies (Woods et al., 2002).

2.1.2 Topography

The Yaak landscape is dominated by two north-south trending mountain ranges, specifically, the McGillivray range to the east and the Purcell range to the west (Kasworm et. al., 2004). The Yaak River runs through valley bottom land of the Purcell Mountain range. Topography in the watershed is varied, with glaciated rugged peaks in the Northwest Peaks Scenic Area and rounded peaks and ridges in much of the remainder of the watershed where continental glaciation shaped the landscape (Kasworm et. al., 2004). The highest point in the Yaak Watershed is Northwest Peak at 7,705 feet (2,349 meters). Other points over 7,000 feet within the watershed include Robinson Mountain (7,539 feet), Mount Henry (7,248 feet), and Rock Candy Mountain (7,204 feet). The lowest point in the watershed is at the mouth at approximately 1,791 feet (546 meters). The average elevation in the Yaak Watershed is 4,574 feet (1,394 meters) (United States Geological Survey [USGS], 2002).

2.1.3 Climate

The climate in the Yaak Watershed can be described as "modified pacific maritime" in character, meaning that compared to the remainder of Montana, this area's climate resembles that found along the Pacific Coast. The character becomes "modified" by occasional intrusions of arctic air masses more commonly found in the remainder of the state (KNF Environmental Impact Statement [EIS], 1987).

The only long-term climate station within the watershed is Troy 18 N (248395). This station is located in the lower Yaak Watershed just north of the town of Sylvanite. According to SNOTEL weather station data from 1961-1994, average yearly precipitation outside of Troy, MT, was 36.41 inches. Figure 2-1 illustrates average temperature and precipitation patterns for the Troy weather station. The average annual total snowfall for the period of record is 87.06 inches (Western Regional Climate Center, 2001). Map 2 (Appendix D) shows average annual precipitation for the Montana section of the Yaak Watershed. This map illustrates that there are areas in the Yaak Watershed that receive much greater precipitation than the SNOTEL site. Some of the mountainous areas of the Yaak receive 60-70 inches of precipitation annually (Natural Resources and Conservation Service [NRCS] Water and Climate Center, 1998).

Maximum monthly average temperature from the 1971-2000 dataset was 55.1° F, and minimum monthly average temperature was 31.4° F. July is the hottest month of the year in the Yaak Watershed with an average maximum temperature of 82.4° F. The coldest month of the year is January with an average minimum temperature of 16.1° F.

2.1.4 Hydrology

The Yaak River drains an area encompassing approximately 793 square miles (mi^2) (507,660 acres). Of this drainage area, approximately 617 mi^2 (394,850 acres) are located within the United States. From the confluence of the East and West Forks the Yaak meanders through valley bottom land and wetlands for approximately 17 miles. The stream gradually increases gradient for the next 21 miles through a heavily forested setting that is primarily National Forest land. At river mile 38, the Yaak cascades over Yaak Falls. The river then rushes through eight miles of deep canyon then slows down parallel U.S. Highway 2 to the confluence with the Kootenai River (KNF EIS, 1987).

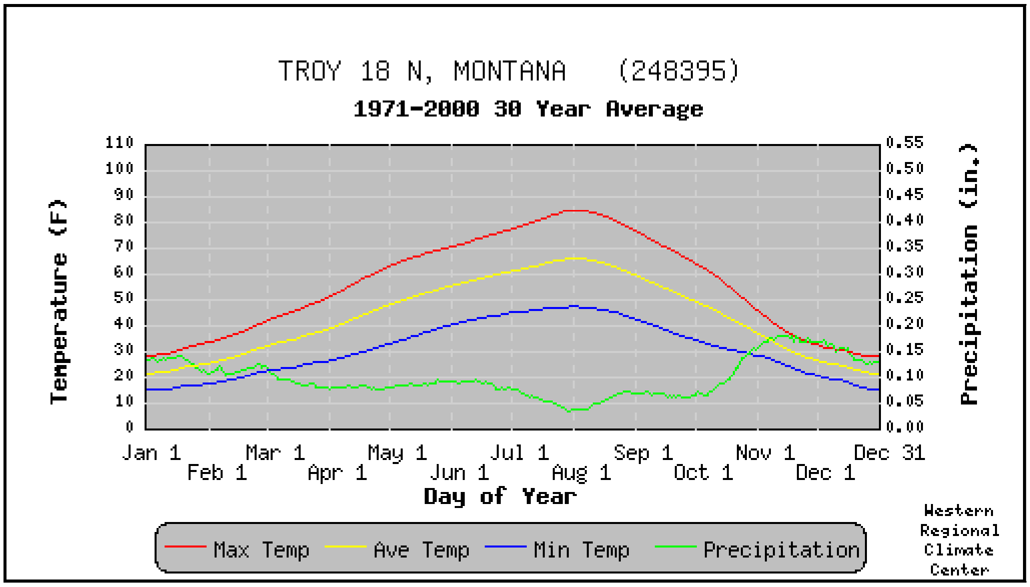

Figure 2-1. Patterns in Average Precipitation and Temperature for Northwest of Troy, MT (Western Regional Climate Center, 2001)

2.1.4.1 Drainage Basin General Characteristics

Subwatersheds within the Yaak Watershed generally are characterized by dendritic drainage patterns. The most common valley types in the Yaak Watershed, following the terminology in Rosgen (1996), include types 1, 2, and 5. Type 1, valleys with notched canyons and rejuvenated sideslopes, are present in the headwaters and are generally associated with stream types A and G. Type 2, valleys with moderately steep, gentle sloping side slopes, are in foothills areas and often associated with 'B' stream types. Type 5, valleys with moderately steep slopes characteristic of U-shaped glacial trough valleys, describes the large valleys of the Yaak River and lower, larger tributary valleys. The Yaak River is low-gradient in many areas and meanders in the floodplain, creating moist meadows and riparian areas (Kasworm et. al., 2004).

2.1.4.3 Streamflow Data

Historical stream gage data are available for two sites on the Yaak River. USGS gage 12304200 Yaak River near the town of Yaak; Montana, has data from only April 1957 – September 1962. The majority of the discharge information is from USGS gage station 12304500. This station has data from 1956 to present and is located at the mouth near Troy, Montana. Figure 2-2 is a hydrograph constructed from historical gauge station data.

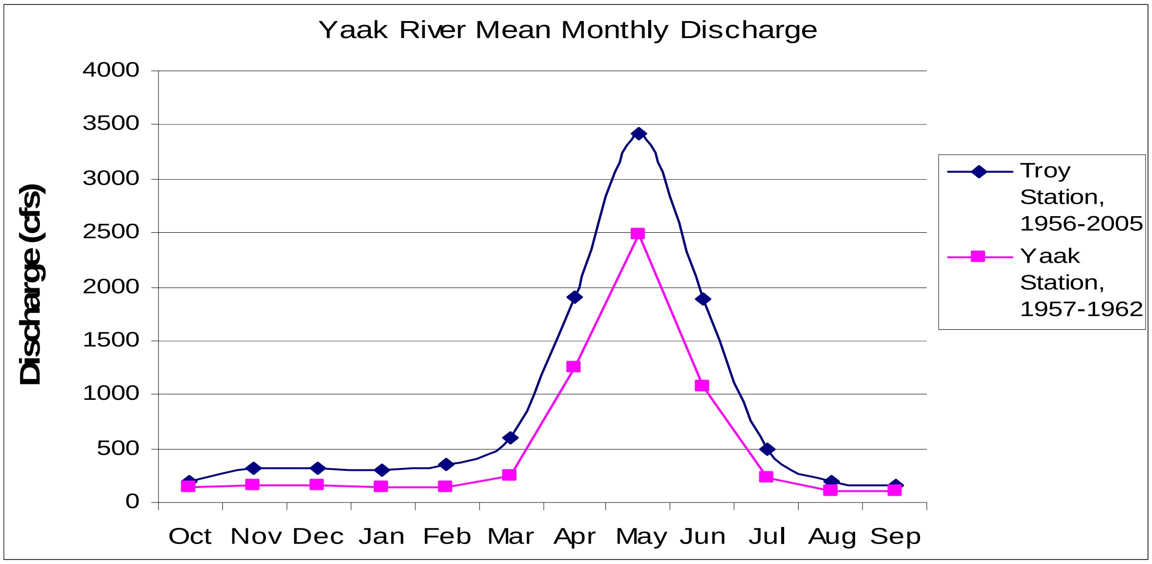

Figure 2-2. Historical Flow Data from Yaak River near Troy and Yaak, MT
(USGS, 2006)

On average, in the last 50 years, mean monthly discharge was below 500 cubic feet per second (cfs) for August through February. Historical data indicate an average peak flow at approximately 3,500 cfs in May (Figure 2-2). The mean historical flow does not reveal the magnitude of, or variation in, peak flows. As an example of the variability in flow, Figure 2-3 illustrates daily mean discharge for 2006, which reached a peak of nearly 6,000 cfs in June.

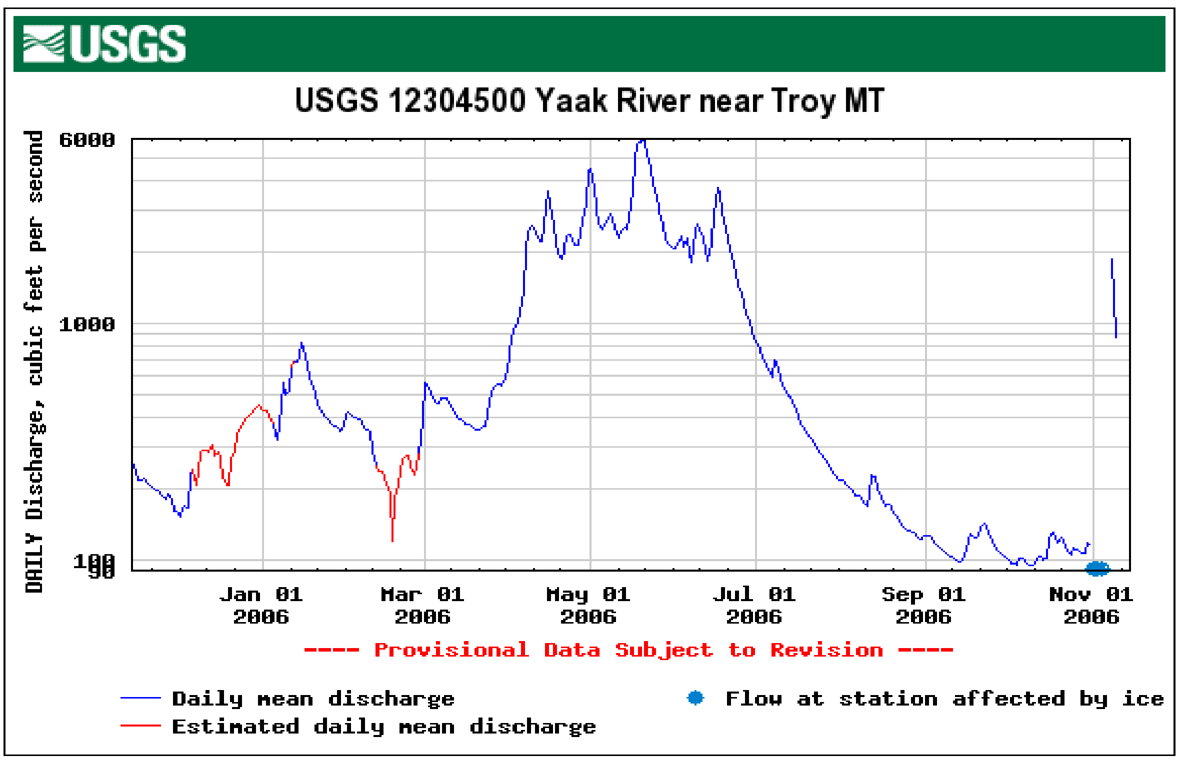

Figure 2-3. Recent Streamflow data for Yaak River
(USGS, 2006)

Figure 2-4 illustrates the range in historical peak flows on the Yaak River at USGS gage station 12304500.

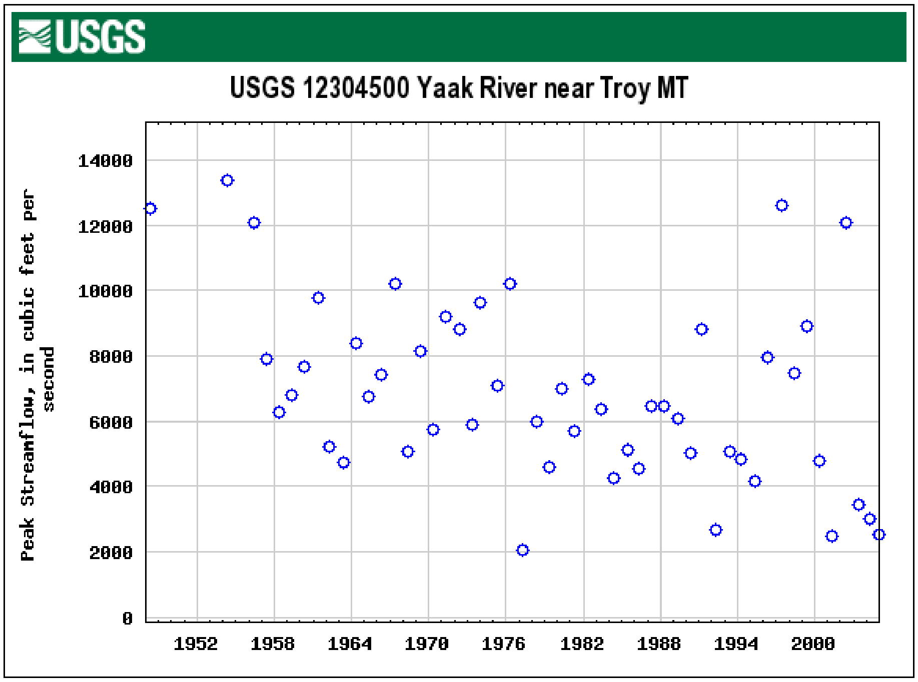

Figure 2-4. Historical Peak Flow Yaak River
(USGS, 2006).

These data demonstrate that the peak flow was over 10,000 cfs seven times in the period of record. The highest flow on record for the Yaak River was 13,400 cfs on May 20, 1954.

2.1.5 Geology and Soils

Glaciation was a forming factor in the landscape of the Yaak River Watershed. The Purcell Mountains were overridden by the continental ice mass, which covered much of the watershed. The ice scoured and rounded the mountains and filled many of the valleys with glacial till. Most of the bedrock exposed in the area belongs to the Belt Supergroup of Precambrian age, which exceeds 40,000 feet in thickness. The dominance of Belt Series geology can be seen in Map 3 (Appendix D). A small percentage of the rock is igneous, diorite sills of the Prichard Formation. The Purcell anticlinorium dominates the structural pattern of the watershed. This is a large north or northwest trending fold that exposes the deepest parts of the Belt Supergroup in the western part of the watershed (Johns, 1970; KNF EIS, 1987). The dominant rock type is Precambrian Belt Supergroup metasedimentary rocks, over lain in places by later glacial deposits. Major soil types in the Yaak Watershed are shown in Map 4 of Appendix D.

2.1.6 Land Use and Land Cover

Land cover types in the Yaak River Watershed are listed in order of dominance in Table 2-1 below. Table 2-1 shows the dominant vegetation in the majority of the watershed is evergreen forest (96.3%). Mixed rangeland is the second most abundant vegetation type (1.3%).

Table 2-1. Land use/cover in Yaak River Watershed

Land Use/Cover Type	Area (Acres)	Percentage
Evergreen Forest	379,390	96.3%
Mixed Rangeland	4,983	1.3%
Brush Rangeland	2,692	0.68%
Mixed Forest	2,514	0.64%
Exposed Rock	1,941	0.49%
Crop/Pasture	1,263	0.32%
Grass Rangeland	293	0.074%
Reservoir	185	0.047%
Lake	175	0.044%
Deciduous Forest	172	0.044%
Residential	94	0.024%
Wetland	94	0.024%
Mine/Quarry	41	0.010%

Data Source: NRIS, from USGS GIRAS files.

This table also shows that very little of the land area in the Yaak Watershed is residential; the watershed is largely undeveloped. Land cover types are also illustrated in Map 5 (Appendix D). A more detailed description of the vegetation follows.

According to the KNF Plan (1987), trees native to the area include western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), western white pine (*Pinus monticola*), lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), grand fir (Abies grandis), whitebark pine (*Pinus albicaulis*), alpine larch (*Larix lyallii*), western larch (*Larix occidentalis*), mountain hemlock (*Tsuga mertensiana*), Englemann spruce (*Picea engelmannii*), and Rocky Mountain juniper (*Juniperus scopulorum*). The Yaak Watershed commonly supports cedar/clintonia and hemlock/clintonia habitat types. Hemlock/devil's club (*Oplopanax horridus*) and cedar/lady fern (*Athyrium filix-femina*) are found in moist high water table bottoms in the watershed (KNF EIS, 1987)

2.2 Biological Characteristics

2.2.1 Fisheries and Associated Aquatic

As a tributary to the Kootenai River, the un-dammed Yaak River and its tributaries provide spawning and rearing habitat for fish populations which produce some of western Montana's popular sport fish, such as brook trout (*Salvelinus fontinalis)* and rainbow trout (*Oncorhynchus mykiss*). Streams in this watershed also support species of special concern including westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) and Columbia Basin redband trout (*Oncorhynchus mykiss gairdneri*).

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) is a subspecies of cutthroat trout native to Montana and is found in the Kootenai Watershed, the Clark Fork Watershed, and the headwaters of the Missouri River. Westslope cutthroat trout were first described by Lewis and Clark and were once extremely abundant. Cutthroat trout have declined due to habitat loss caused by poor grazing practices, historic logging practices, mining, agriculture, residential development, the lingering impact of forest roads, dewatering, and dams. Hybridization with rainbow trout, and even other non-native cutthroat trout subspecies, is another reason for the decline in population. Genetically pure westslope cutthroat trout exist in an estimated 8-20% of their historic habitats (Shepard et al, 2003). Many remnant genetically pure cutthroat trout populations are located above barriers that have protected them from non-native species, such as the barriers found in the Yaak Watershed. The most significant isolated populations of westslope cutthroat trout presently occur in the West Fork Yaak River Watershed. Westslope cutthroat trout occurrence in the Yaak Watershed is summarized in Table 2-3.

The Columbia River redband trout is a subspecies of rainbow trout (*Oncorhynchus mykiss*). It is threatened by logging, mining, agriculture, grazing, dams, over-harvest, and hybridization and competition with other trout species (Muhlfeld N.d). These factors have contributed to the decline of redband trout abundance, distribution, and genetic diversity in the Columbia River Basin (Williams et al., 1989; Behnke, 1992). The Kootenai River redband population in Montana supports subpopulations of the resident form which inhabit smaller tributaries and headwater areas for their entire lives, although a migratory fluvial and/or adfluvial component may be undetectable due to hybridized populations inhabiting the lower portions of the drainage (Muhlfeld, 1999). Results of genetic surveys indicate that redband trout were native to low-gradient valley-bottom streams throughout the Kootenai River drainage but are presently restricted to headwater areas. The Yaak River is not dammed but has a natural fish barrier at Yaak River Falls nine miles from its confluence with the Kootenai River. There is a barrier falls in the lower East Fork of the Yaak River. These falls have isolated Columbia River redband rainbow trout populations. Populations also exist in North Fork Yaak River and Seventeenmile Creek. (Kris Newgard, pers comm.) Table 2-2 summarizes Montana Fisheries Information System (MFISH) data for species and their relative distribution found in the Yaak River.

Table 2-2. Species and relative abundance for the Yaak River

Species	River Mile (RM)							
	0-3.2	**3.2-7.9**	**7.9-8.9**	**8.9-10.0**	**10.0-12.1**	**12.1-17.9**	**17.9-49.2**	**49.2-53.4**
Brook trout	R es	C es	C es	C es	C es	C es	C es	C es
Bull trout	I es	I es	I es					
Columbia Basin Redband Trout	C ess	C es	C es	C es	C es	C es	C es	C es
Kokanee	I es	R es	R es					
Largescale Sucker	A es	A es	A es	A es	A es	A es	A es	
Longnose Dace				A es	A es	A es	A es	
Longnose Sucker	A es	A es	A es	A es	A es	A es	A es	
Mottled Sculpin			R es					
Mountain Whitefish	A es	A es	A es	A es	A es	A es	A es	
Northern Pike Minnow	C es	C es	C es					
Rainbow Trout	C es	C es	C es	C es	C es	C es	C es	
Redside Shiner	C es	C es	C es	C es	C es	C es	C es	C es
Slimy Sculpin			R es		R es			R es

C = Common, A = Abundant, R = Rare, I = Incidental
pj= professional judgment.
es= extrapolation from surveys.
ess=extrapolated from extensive samples
RM = River Mile
Data Source: Montana Fish, Wildlife and Parks (MFWP), MFISH

This data is from the MFISH website and includes only those species with known information. Table 2-3 displays the fish abundance for selected tributaries to the Yaak River.

Table 2-3. Species and relative abundance for 303(d) Listed streams in the Yaak River Watershed

	Westslope Cutthroat Trout	Rainbow Trout	Brook Trout	Mountain Whitefish	Columbia Basin Redband Trout	Sculpin	Slimy Sculpin	Longnose Dace
East Fork Yaak (rm 0.0-13.9)			R es	R es	C es	A es		
East Fork Yaak (rm 6.5-7.2)								
Seventeen Mile Creek (rm 0.0-4.6)			C				R es	
Seventeen Mile Creek (rm 0.0-8.8)			C		C es			
Seventeen Mile Creek (rm 4.6-15.1)	A ess		C					
Seventeen Mile Creek (rm 8.8-15.1)			C pj					
Lap Creek (rm 0.0-0.6)	C pj							
Lap Creek (rm 0.6-4.8)	C es							
Spread Creek (rm 0.0-12.2)			C es	C es				
Pete Creek (rm 0.0-10.1)	C es		C es			A ess		A es
South Fork Yaak (rm 0.9-11.0)		C pj						
South Fork Yaak (rm 3.4-11.0)			C pj					
South Fork Yaak (rm 0.0-11.0)	C pj							
West Fork Yaak (rm 0.0-9.5)	C	R es	R es	R es				
West Fork Yaak (rm 0.0-3.9)	C						R es	
West Fork Yaak (rm 3.9-9.5)	C					C es		
West Fork Yaak (rm 0.0-0.6)	A ess.							
West Fork Yaak (rm 0.6-1.6)	C es							
West Fork Yaak (rm 1.6-4.2)	C pj							
West Fork Yaak (rm 4.2-9.5)	A ess.							

C = Common, A = Abundant, R = Rare, I = Incidental
pj= professional judgment, no survey.
es= extrapolation from surveys.
ess= extrapolated from extensive samples
Data Source: MFWP, MFISH, USFS

2.2.2 Threatened and Endangered Species (and Species of Special Concern)

The Yaak Watershed is home to 17 animal and 19 plant species of concern in the State of Montana's Natural Heritage Program (Table 2-4).

Table 2-4. Yaak Watershed Species of Concern

Scientific Name	Common Name	Species Type	US Fish and Wildlife Status	State Rank	US Forest Service Status
Acipenser transmontanus	White Sturgeon	Animal	ENDANGERED	S1	ENDANGERED
Canis lupus	Gray Wolf	Animal	ENDANGERED, Experimental Population	S3	ENDANGERED
Contopus cooperi	Olive-sided Flycatcher	Animal		S3B	
Corynorhinus townsendii	Townsend's Big-eared Bat	Animal		S2	SENSITIVE
Cottus rhotheus	Torrent Sculpin	Animal		S3	
Falco peregrinus	Peregrine Falcon	Animal		S2B	SENSITIVE
Gavia immer	Common Loon	Animal		S2B	SENSITIVE
Histrionicus histrionicus	Harlequin Duck	Animal		S2B	SENSITIVE
Lynx canadensis	Canada Lynx	Animal	THREATENED	S3	THREATENED
Oncorhynchus clarkii lewisi	Westslope Cutthroat Trout	Animal		S2	SENSITIVE
Oncorhynchus mykiss gairdneri	Columbia River Redband Trout	Animal		S1	SENSITIVE
Picoides arcticus	Black-backed Woodpecker	Animal		S2	SENSITIVE
Plethodon idahoensis	Coeur d'Alene Salamander	Animal		S2	SENSITIVE
Poecile hudsonica	Boreal Chickadee	Animal		S1S2	
Salvelinus confluentus	Bull Trout	Animal	THREATENED	S2	THREATENED
Synaptomys borealis	Northern Bog Lemming	Animal		S2	SENSITIVE
U. arctos horribilis	Brown Bear	Animal	THREATENED	S2S3	THREATENED
Bidens beckii	Beck Water-marigold	Plant		S2	SENSITIVE
Botrychium ascendens	Upward-lobed Moonwort	Plant		S1S2	SENSITIVE
Botrychium crenulatum	Wavy Moonwort	Plant		S2S3	SENSITIVE
Botrychium montanum	Mountain Moonwort	Plant		S3	
Brasenia schreberi	Watershield	Plant		S1S2	SENSITIVE
Bryoria subdivergens	---	Plant		S1	SENSITIVE
Carex rostrata	Beaked Sedge	Plant		S1	SENSITIVE
Corydalis sempervirens	Pale Corydalis	Plant		S2	SENSITIVE
Drosera anglica	English Sundew	Plant		S2S3	SENSITIVE
Lomatium geyeri	Geyer's Biscuitroot	Plant		S2	SENSITIVE
Lycopodium dendroideum	Treelike Clubmoss	Plant		S1	SENSITIVE
Lycopodium lagopus	Running Pine	Plant		S1	SENSITIVE
Peatland	Peatland	Plant		SNR	
Platyhypnidium riparioides	---	Plant		S1	

Table 2-4. Yaak Watershed Species of Concern

Scientific Name	Common Name	Species Type	US Fish and Wildlife Status	State Rank	US Forest Service Status
Racomitrium pygmaeum	---	Plant		S1	
Scheuchzeria palustris	Pod Grass	Plant		S2	SENSITIVE
Scirpus subterminalis	Water Bulrush	Plant		S2	SENSITIVE
Thelypteris phegopteris	Northern Beechfern	Plant		S2	SENSITIVE

State Rank Scale: 1=High Risk to 5=Common
Source: Montana Natural Heritage Program (MNHP)

The majority of these species are considered sensitive according United States Fish and Wildlife Service (USFWS). The gray wolf and white sturgeon are the two federally listed endangered species in the watershed. The gray wolf's status in the area is modified by the fact that the majority of the wolves found in the area are likely reintroduced, (i.e. experimental populations). The brown (grizzly) bear and Canada lynx are threatened species found within the Yaak Watershed. Additionally, bull trout have incidental occurrence downstream of Yaak Falls.

2.3 Cultural Characteristics

2.3.1 Population and Land Use History

The Yaak Watershed is predominately National Forest land. The U.S. portion of the watershed has an estimated population of 316 people, according to the 2000 population census. The two towns in the watershed are Yaak and Sylvanite, with population estimated at 19 and 16, respectively (Montana State Library, 2003).

Humans have probably inhabited the Yaak Watershed for at least 7,000 years (KNF, 1987). These early people were wandering hunters and gatherers, who took advantage of the wide range of mineral resources in the watershed, as well as the varied plant, animal, and aquatic life. The last prehistoric group to inhabit the area was the Kootenai Indians. The exact time of their arrival as well as their exact origin is not known. The Kootenai language is unique and remains distinctive from those of neighboring tribes. Recent ethnographic research of the Kootenai Tribe suggests they were highly influenced by elements of the European culture, including horses, fur trapping and trade, missionaries, mining, and homesteading, which were present in the Yaak by the 19th century (KNF EIS, 1987).

Logging and mining are the primary occupations in the area (KNF EIS, 1987). Mining has a long history in the Yaak Watershed. The first placer gold reportedly was discovered in 1864 (Calvi, 1993). The Sylvanite mining district was the heart of the most important placer and lode mining activity in the watershed. Proterozoic rocks of the Belt series underlie the Sylvanite district (Map 3). Ore deposits are associated with the geological structure created by faulting and folding. Specifically, gold-quartz veins, such as those located in the Sylvanite district, are found in the Prichard Formation (Johns, 1970). Gold was found along the lower reaches of the Yaak River in the late 1880s. In this area a temporary camp known as Snipetown was established around 1890. The number of miners grew with the discovery, three years later, of placer gold just over the border on the Moyie River in Idaho (Renk, 1994).

The Keystone and Goldflint mines were both established in the Sylvanite district in the late 1800s. The town of Sylvanite grew with the mines, and at its peak, Sylvanite was home to 500 people. However the town of Sylvanite was short-lived and by August, 1898 the town was nearly deserted, and both the Goldflint and Keystone mills were silent (Hauge, 1994; Renk, 1994).

After more than a decade of inactivity, Canadian investors formed the Lincoln Gold Mining Company in 1910 to operate the Keystone and Goldflint. They reopened the mines, constructed a 20-stamp mill and tramway, and attempted to revitalize the district. Before the mill ever operated, however, a forest fire swept through the valley in August and burned the mill and mine structures along with all but one building in town. Although the company planned to rebuild, it never did. The mines revived in the 1930s under different ownership, operating from 1931-1937 (Timmons, 1986; Renk, 1994).

In the early 1900s, settlers of Troy and Libby migrated to the area. Some intended to homestead, and others worked for the Forest Service fighting fires and packing supplies and materials for the lookout cabins and towers that were being built as a result of the aftermath of the 1910 fire year. The original Yaak Store was built in the early 1930s. It served to supply goods to the local community as well as provide a meeting place for locals to gather and play cards while waiting for the mail to come through. The first school was also built in the early 1930s (Eureka Chamber of Commerce).

The Yaak Valley has been extensively logged. Prior to formation of the KNF, logging in the area was only conducted to meet the needs of the settlers and to support the mining industry. Timber production increased through the 1900s, most notably in the 1950s/1960s and in the early 1980s to address spruce bark beetle outbreak and to meet the demands of the rapidly expanding economy (USFS, 2003). In 1987, forest plans for the KNF established allowable sale quantities (ASQs) for the maximum amount of timber that could be harvested from the forest. Timber production on the Kootenai National Forest since 1987 has been well below the ASQs, due to a number of factors, including a shift in management focus increasingly from timber production to wildlife habitat, watershed concerns, litigation, appeals, deferrals, and changes in management area designation (KNF, 1997). Timber volume sold from the entire Kootenai National Forest in northwest Montana declined from 200 million board feet (mmbf) per year to about 50 mmbf per year from 1998 to 2001 (USFS, 2003). Timber harvest continues in the Yaak at a slower production volume than past levels.

2.3.2 Land Use and Ownership

The vast majority (96.5%) of the land in the Yaak Watershed is public land managed by United States Forest Service (USFS) (Table 2-5)

Table 2-5. Land Ownership in the Yaak Watershed

Owner	Acres	Sq. Miles	% of Total
U.S. Forest Service	381,093	595.5	96.5%
Private	12,814	20.0	3.2%
Stimson Timber lands	692	1.1	0.2%
Water	159	0.2	0.0%
TOTAL	**394,758**	**616.8**	

Source: NRIS, MTNHP

Private land holdings account for 3.2% of the land. In addition, Stimson Timber Company owns another 0.2% of the total area of the watershed (Map 6). Land use in the watershed is primarily logging. In the past, portions of the Yaak Watershed have been heavily logged (Map 7). Past logging operations and their associated roads may contribute to the listed causes of impairment of siltation, habitat alteration, and suspended solids. Current logging operations are significantly reduced on Forest Service land compared to historic levels. Only 0.32% of the total area of the watershed is cultivated (Table 2-1). Grazing, while minimal on the US side, is significant within Canada, specifically along the West Fork Yaak River.

2.3.3 Recreation

Outdoor recreation is considered an important aspect of living in the Yaak Watershed with hunting, fishing, hiking, and camping being popular activities. The Kootenai Forest supports populations of elk, moose, bighorn sheep, mountain goats, whitetail and mule deer, black bear, and mountain lion. Many of these animals are hunted and the rivers and lakes of the watershed provide ample fishing opportunities (KNF EIS, 1987). In addition to local use there is some commercial growth in guiding of outdoor recreation in the area (Eureka, Montana Chamber of Commerce).

2.3.4 Resource Management

There are no major dams located within the Yaak Watershed. As mentioned above, extraction of wood products historically has been important economically to the area. According to the Kootenai Forest Management Plan, the Yaak Watershed contains some of the most suitable timberlands and contributes substantially to the Kootenai annual timber production (KNF EIS, 1987). Map 7 shows the Percent Equivalent Clear Cut Area (%ECA) for the Yaak Watershed. This map illustrates that a considerable portion of the watershed has been impacted by logging. Road density is shown by subbasin in Map 8. Most of these roads were constructed for timber harvest activities on the KNF.

SECTION 3.0
TMDL REGULATORY FRAMEWORK AND WATER QUALITY STANDARDS

Section 3 provides the existing status of all 303(d) Listed waterbodies in the Yaak Watershed TMDL Planning Area (i.e., which waterbodies are listed as impaired or threatened and for which pollutants). This is followed by a summary of the applicable water quality standards.

3.1 TMDL Regulatory Requirements

Section 303(d) of the Federal CWA requires states to identify water bodies within its boundaries that do not meet state water quality standards. States track these impaired or threatened water bodies through the 303(d) List, a component of Montana's Water Quality Integrated Report (IR). State law identifies that a methodology for determining the impairment status of each water body is used for consistency, and the actual methodology is identified in DEQ's *Quality Assurance Project Plan for Sampling and Water Quality Assessment of Streams & Rivers in Montana, 2005*.

Under Montana State Law, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data show that the water body or stream segment is failing to achieve compliance with applicable water quality standards (MCA 75-5-103(11)). A "threatened water body" is defined as a water body or stream segment for which sufficient credible data and calculated increases in loads show that the water body or stream segment is fully supporting its designated uses but threatened for a particular designated use because of a) proposed sources that are not subject to pollution prevention or control actions required by a discharge permit, the nondegradation provisions, or reasonable land, soil, and water conservation practices or b) documented adverse pollution trends (MCA 75-5-103(31)). State law (MCA 75-5-703) requires that DEQ to develop all necessary TMDLs for impaired or threatened water bodies.

TMDLs are developed for pollutants. These are water quality impairments that can be quantified and a load can be calculated. Riparian degradation and habitat alteration are not pollutants but are considered pollution-related impairments and thereby do not require TMDLs. Additionally, flow alteration and dewatering are impairment issues related to water quantity and when viewed alone are not subject to a TMDL. However, sediment-related impairments may be related to stream energy and flow conditions. Likewise, riparian degradation and habitat alteration, when considered alone, do not require a TMDL. Yet both are often linked to pollutant loading and may exacerbate and contribute to the loading and influence of a pollutant in a stream. As such, flow and habitat conditions are often considered when conducting TMDL analysis.

A TMDL is a pollutant budget for a water body identifying the maximum amount of the pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs must account for loads/impacts from point and nonpoint sources, in addition to natural background sources, and must incorporate a margin of safety and consider influences of seasonality on analysis and compliance with water quality standards.

To satisfy the Federal Clean Water Act and Montana State Law, TMDLs are developed for each water body-pollutant combination identified on the state's list of impaired or threatened waters. State Law (Administrative Rules of Montana 75-5-703(8)) also directs DEQ to "support a voluntary program of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source activities for water bodies that are subject to a TMDL…" This is an important directive that is reflected in the overall TMDL development and implementation strategy within this plan. It is important to note that water quality protection measures are not considered voluntary where such measures are already a requirement under existing federal, state, or local regulations.

3.2 Water Bodies and Pollutants of Concern

The assessment of streams, lakes, and wetlands to identify impaired waters for inclusion on the state's Water Quality Integrated Report is an important step a process intended to ensure that all waterbodies in the state will have water quality adequate to support all of their classified beneficial uses. The process has been developed and shaped by legal mandates, water quality standards, the tools and techniques of water quality monitoring, the availability of information, and the funds and administrative resources that can be devoted to assessment efforts.

The impairment causes and sources determination included on the 1996 303(d) List was based on data that showed impairments, however many determinations were based on professional judgment and involved limited data. Since the development of the 1996 303(d) List, DEQ has instituted procedures that more fully assess and identify impaired waters. This procedure, the Sufficient Credible Data Assessment & Beneficial Use-Support Determinations (SCD/BUD) Process, conducted by the DEQ in response to legal requirements stipulated in 75-5-702 MCA, resulted in updates to the 1996 303(d) Listing. Consequently, impaired uses, causes, and sources on the 2006 303(d) List may differ from the original 1996 listings as a result of the data review and associated list revisions.

While the 2006 303(d) List is now Montana's most current list, and is based on more thorough data review and analysis than the 1996 list, a ruling by the U.S. District Court (CV97-35-M-DWM) on September 21, 2000 required that the State of Montana must complete all necessary TMDLs for waters listed as impaired or threatened on the 1996 303(d) List. Where new data has resulted in changes to the 303(d) Listing status for 1996-listed waters through the state's SCD/BUD process, DEQ will complete TMDLs based on updated impairments status resulting from this new information.

Waterbodies reviewed by the state's SCD/BUD process fall into five categories. The level of beneficial use support for the listed waters can be as fully supporting all designated beneficial uses (F), threatened (T), partially support (P), not supporting (N) and lacking sufficient credible data (X). The beneficial use-support determination for the 303(d) Listed streams in the Yaak River TPA is provided in Table 3-1. The causes and sources of impairment for the 1996 303(d) List are shown in Table 3-2. The 2006 303(d) List is summarized in Table 3-3. A map of segment locations is given in Figure 3-1.

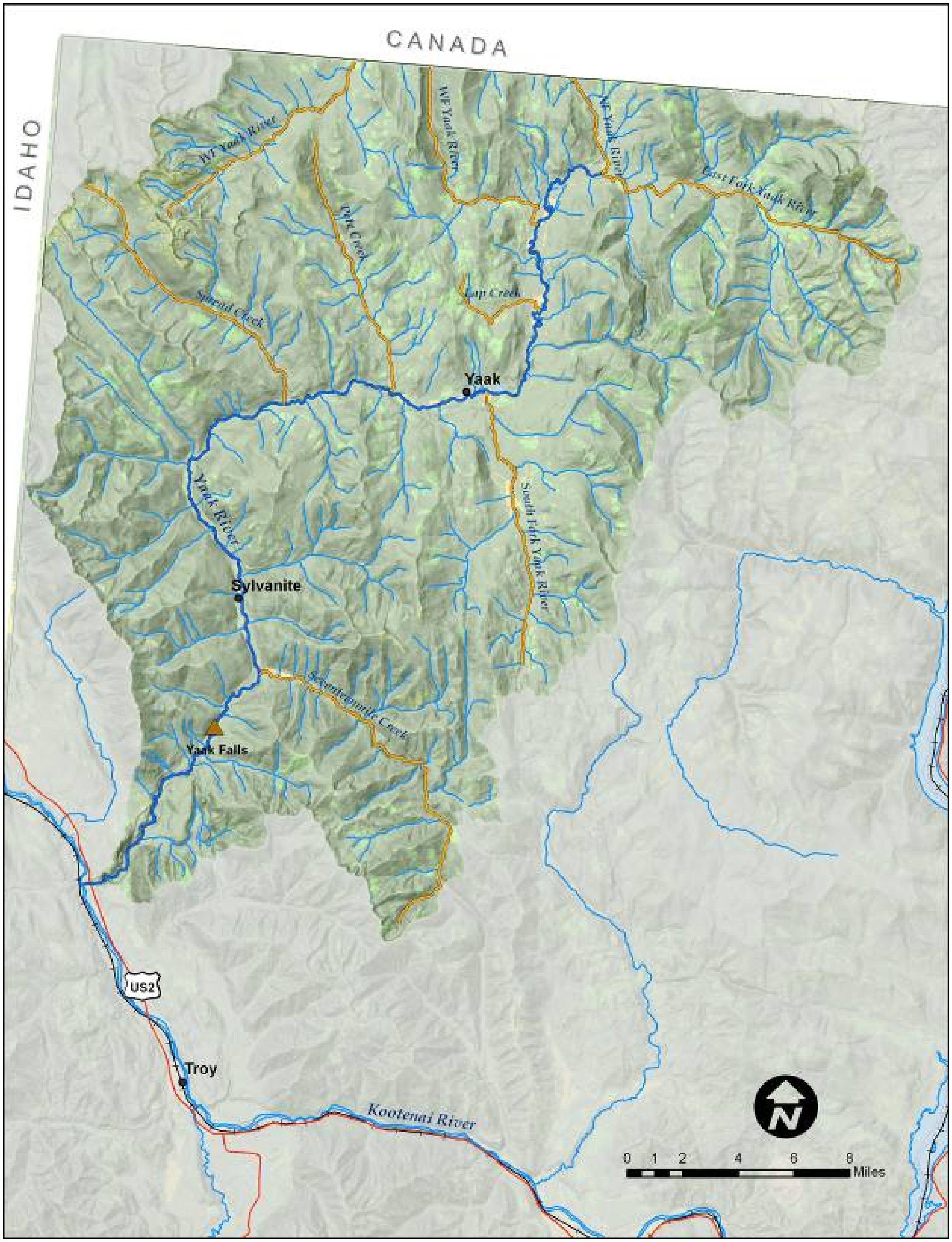

Figure 3-1. Water Body Segments in the Yaak TMDL Planning Area

Table 3-1. Impaired Uses from both 1996 and 2006 303(d) Lists*

	1996 Use-Support	2006 Use Support

Stream Reach (MT Waterbody ID)	**Use Classification**	**Aquatic Life**	**Cold-water Fishery**	**Drinking Water**	**Agriculture**	**Industry**	**Contact Recreation**	**Use Classification**	**Aquatic Life**	**Cold-water Fishery**	**Drinking Water**	**Agriculture**	**Industry**	**Contact Recreation**
SEVENTEENMILE CREEK MT76B002_010	B-1		T					B-1	P	P	F	F	F	F
EAST FORK YAAK RIVER MT76B002_100	B-1		T					B-1	P	P	F	F	F	F
NORTH FORK YAAK RIVER MT76B001_020	B-1		T					B-1	F	F	F	F	F	F
LAP CREEK MT76B002_020	B-1	P	P					B-1	N	N	F	F	F	F
SPREAD CREEK MT76B002_060	B-1		T					B-1	F	F	F	F	F	F
PETE CREEK MT76B002_070	B-1		T					B-1	P	P	F	F	F	F
SOUTH FORK YAAK RIVER MT76B002_080	B-1		T					B-1	N	N	F	F	F	F
WEST FORK YAAK RIVER MT76B002_090	B-1		T					B-1	P	P	F	F	F	F

***DEQ, 1996, 2006**

Table 3-2. 1996 303(d) List Information for the Yaak River TMDL Planning Area*

Segment Name (MT Waterbody ID)	Length (miles)	Probable Cause	Probable Source
SEVENTEENMILE CREEK MT76B002_010	15.1	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture
EAST FORK YAAK RIVER MT76B002_100	13.9	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture
NORTH FORK YAAK RIVER MT76B001_020	4.2	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture
LAP CREEK MT76B002_020	4.8	Flow alteration Other habitat alterations	Harvesting, Restoration, Residue Management Logging Road Construction/Maintenance Silviculture
SPREAD CREEK MT76B002_060	12.2	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture
PETE CREEK MT76B002_070	10.1	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture
SOUTH FORK YAAK RIVER MT76B002_080	11	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture
WEST FORK YAAK RIVER MT76B002_090	19.8	Flow alteration Other habitat alterations **Siltation** **Suspended solids**	Silviculture

***DEQ, 1996**

Table 3-3. 2006 303(d) List Information for the Yaak River TMDL Planning Area*

Segment Name (MT Waterbody ID)	Length (miles)	Probable Cause	Probable Source
SEVENTEENMILE CREEK MT76B002_010	15.1	**Sedimentation/Siltation** **Nitrate/Nitrite**	Forest Roads (Road Construction and Use) Silviculture Harvesting Source Unknown
EAST FORK YAAK RIVER MT76B002_100	13.9	**Nitrate/Nitrite**	Silviculture Harvesting Source Unknown
NORTH FORK YAAK RIVER MT76B001_020	4.2	Fully supporting all beneficial uses	
LAP CREEK MT76B002_020	4.8	**Sedimentation/Siltation** **Nitrate/Nitrite**	Forest Roads (Road Construction and Use) Silviculture Harvesting Source Unknown

Table 3-3. 2006 303(d) List Information for the Yaak River TMDL Planning Area*

Segment Name (MT Waterbody ID)	Length (miles)	Probable Cause	Probable Source
SPREAD CREEK MT76B002_060	12.2	Fully supporting all beneficial uses	
PETE CREEK MT76B002_070	10.1	**Nitrate/Nitrite**	Silviculture Harvesting Source Unknown
SOUTH FORK YAAK RIVER MT76B002_080	11	**Sedimentation/Siltation**	Forest Roads (Road Construction and Use) Silviculture Harvesting
WEST FORK YAAK RIVER MT76B002_090	19.8	**Nitrate/Nitrite**	Silviculture Harvesting Source Unknown

***DEQ 2006**

Stream reassessment information collected since the 1996 303(d) List provided substantial new sufficient and credible data, resulting in changes to the 303(d) Listing status for several water bodies in the Yaak TPA. DEQ will complete TMDLs based on updated impairments status resulting from the updated 2006 listing information.

Pollutants of concern on the 2006 303(d) List (in bold, Table 3-3) include:

- Nitrate/Nitrite (Seventeenmile Creek, East Fork Yaak River, Lap Creek, Pete Creek, West Fork Yaak River)
  Nitrate/nitrite are soluble forms of nitrogen that are bioavailable to aquatic plants and may contribute to nuisance algal growth if present in excessive amounts.

  Because nitrate/nitrite was first identified as a probable source of impairment in 2006, comprehensive nutrient assessments have not yet been completed. Nitrate/nitrite assessments and TMDLs are beyond the scope of this document and will be addressed by DEQ at a future time.

- **Sediment** (Seventeenmile Creek, Lap Creek, South Fork Yaak River)
  Sediment-related impairments relate to excessive sediment deposited on stream bottoms and in the water column. Presently listed sediment impairment causes in the Yaak TPA include sedimentation and siltation.

  Sediment TMDLs are prepared for sediment-impaired streams, Seventeenmile Creek, Lap Creek, and the South Fork Yaak River. Section 4.0 provides an evaluation of sedimentation/siltation conditions for these streams. Section 5.0 presents Sediment TMDLs for these streams.

3.3 Applicable Water Quality Standards

Water quality standards include the uses designated for a water body, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the high quality of a water body. The ultimate goal of this TMDL plan, once implemented, is to ensure that water quality standards are met for all pollutants of concern identified on the state's list of impaired waters, the 303(d) List. Water quality standards form the basis for the primary and supplemental impairment indicators described in Section 4. Section 3.3.2 provides a summary of the applicable water quality standards for each of these pollutants.

3.3.1 Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a water body based on the potential of the water body to support those uses. Designated uses or beneficial uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of "uses" of state waters including growth and propagation of fish and associated aquatic life, drinking water, agriculture, industrial supply, recreation, and wildlife. The Montana WQA directs the Board of Environmental Review (BER, i.e., the state) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (Administrative Rules of Montana [ARM] 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply. However, the quality of that water body must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or non-point source discharges may not make the natural conditions worse.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in Table 3-4. All water bodies within the Yaak River TPA are classified as B-1.

Table 3-4. Montana Surface Water Classifications and Designated Beneficial Uses

Classification	Designated Uses
B-1 CLASSIFICATION:	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. (*ARM 17.30.623(1))*

3.3.2 Standards

In addition to the use classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy. The applicable water quality standards for sediment (i.e., the only pollutant currently being addressed in the Yaak TPA) are narrative.

<u>Narrative</u> standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term "Narrative Standards" commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the "free from" standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a water body. Uses

may be impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life.

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative standard identified in Table 3-5. The standard does not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. This is interpreted to mean that water quality goals should strive toward a condition in which any increases in sediment above naturally occurring levels are not harmful, detrimental, or injurious to beneficial uses (Table 3-5).

Table 3-5. Applicable Rules for Sediment Related Pollutants

Rule(s)	Standard
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices, or other discharges that will:
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.
	The maximum allowable increase above naturally occurring turbidity is 0 NTU for A-closed; 5 NTU for A-1, B-1, and C-1; 10 NTU for B-2, C-2, and C-3)
17.30.602(17)	"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied.
17.30.602(21)	"Reasonable land, soil, and water conservation practices" means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.

SECTION 4.0
WATER QUALITY ASSESSMENT

Section 4.0 provides a review of data and information used to make impairment determinations for streams listed for sedimentation/siltation impairment on Montana's *2006 Integrated 305(b)/303(d) Water Quality Report*: Seventeenmile Creek, Lap Creek, and South Fork Yaak River. Because nitrate/nitrite was first identified as a probable source of impairment in 2006, comprehensive nutrient assessments have not yet been completed. Nitrate/nitrite assessments and TMDLs are beyond the scope of this document and will be addressed by DEQ at a future time.

4.1 Water Quality Assessment Framework

As described in Section 3.0, Montana's water quality standards for sediment are narrative. To determine if the applicable water quality standards are met for pollutants with narrative criteria, it is necessary to develop measurable, numeric interpretations of the narrative criteria.

There are many natural factors that influence the volume and location of sediment in a stream, especially the substrate (channel bottom). Geophysical attributes such as stream depth, stream gradient, flow, precipitation, geology, soils, and channel roughness have a great influence on the size and distribution of sediment deposits found within a stream. Type, size, and distribution of vegetation both along and within the stream corridor also have an impact. Human management, however, such as grazing, timber harvest, road building, and flow alterations can alter these attributes leading to a significant change in the channel substrate and in water quality.

While it is widely acknowledged that changes in sediment can greatly affect the biota within the system, measuring the direct impact of sediment on a system is difficult because 1) it is not always possible to discriminate between an aquatic species response to sediment versus a response from some other stressor, 2) the sediment regime in most streams is both spatially and temporally variable, and 3) inherent variability of biotic systems makes it difficult to evaluate whether a water body is at its full potential, or whether anthropogenic stressors (sediment) limit biological integrity. Because of these concerns, there is not one single indicator or standard to be used to determine if an anthropogenic sediment increase or decrease is impairing fish and aquatic life beneficial uses in Montana streams.

Because no single indicator has been shown to be reliable, a suite of indicators is proposed to assess whether sediment is impairing beneficial uses in the streams within the Yaak TPA. These indicators are listed in Table 4-1 and discussed individually in Sections 4.2.1 – 4.2.7.

Table 4-1. Sediment Impairment Indicators for the Yaak TPA

Sediment Impairment Indicator	Recommended Threshold Value	Indicator Type
In-Stream Sediment Indicators		
Bankfull Width to Depth Ratio	Within Expected Range	Primary
Percentage of Channel Surface Fines <6mm	<20%	Primary
Percentage of Channel Surface Fines <2mm	<20%	Primary
Percentage of Subsurface Fines <6mm	<28%	Primary
Entrenchment Ratio	Within Expected Range	Supplemental
Pfankuch Stream Channel Stability	> "fair" SCS Rating	Supplemental

Table 4-1. Sediment Impairment Indicators for the Yaak TPA

Sediment Impairment Indicator	Recommended Threshold Value	Indicator Type
Stream Channel Stability: Scouring and/or Deposition	> "fair"	Supplemental
Stream Channel Stability: Distribution and Stability of Channel Bottom Materials	> "fair"	Supplemental
Biological Indicators		
Montana Multimetric Index SCORE (MMI)	>63	Primary
River Invertebrate Prediction and Classification System SCORE (RIVPACS)	>.80	Primary
Fine Sediment Index -EPT (FSI-EPT)	≥ 17	Supplemental
Percentage of FSI - Sensitive taxa	>40%	Supplemental
Macroinvertebrate FSI	≥ 205	Supplemental
Landscape-Scale Sediment Indicators		
Current %ECA of Watershed	<25%	Supplemental
Watershed Stream Crossing Density (#/mi^2)	<3	Supplemental
Watershed Total Road Density (miles/ mi^2)	<3	Supplemental
Sediment Source Survey Data	Qualitative Assessment	Supplemental
Historic Information - Channel Morphology, Macroinvertebrates and Stream Channel Stability	Qualitative Assessment	Supplemental

The indicators listed in Table 4-1 are classified into Primary and Supplemental indicators. Primary indicators are those that represent a measure of aquatic life beneficial use support, either as a surrogate parameter (% fines) or as a direct measure of aquatic assemblages (bioassessments). Supplemental indicators are those parameters that do not provide a direct or verified link to beneficial use support but may provide additional information that allows more thorough interpretation of primary indicator values. When combined, this suite of indicators is intended to answer the following four questions relating to a sediment-impairment determination.

1. ***Are the fish/aquatic life beneficial uses impaired?***
   If fish and/or aquatic life are not adversely affected, the water quality standards for support of fish and associated aquatic life are not violated. Therefore, direct and indirect measures of these assemblages have been included in the suite of indicators. Aquatic life applies to a variety of fauna. Typically, support of aquatic macroinvertebrates and fish assemblages is evaluated to assess whether aquatic life uses are being supported.

   Aquatic macroinvertebrate health and support is assessed quantitatively and qualitatively through a variety of metrics. Primary metrics include the Montana Multi-Metric Index SCORE (MMI) and River Invertebrate Prediction and Classification System SCORE (RIVPACS). Supplemental metrics include Fine Sediment Index (FSI) values developed by Relyea (2005).

   Fish health and support is assessed through indirect measures of the health of the fisheries community. Substrate sediment information is predominantly used to assess impacts of sediment on stream habitats and growth and propagation of fish. Typically, percentage of channel surface fines <6mm, percentage of channel surface fines <2 mm, and percentage of subsurface fines <6mm are included as predominant indicators of sediment impacts to fish.

2. ***Have anthropogenic sources increased sediment erosion and/or delivery, contributing to or causing impairment?***
   Impairment is defined as a negative-impact on beneficial uses caused by human sources. Therefore, the chosen suite of indicators provides a means to differentiate between "naturally occurring" conditions and conditions adversely influenced by humans and/or detect the presence or absence of anthropogenic sediment sources/causes.

   %ECA of the watershed, stream crossing density (#/mi^2), total road density (miles/mi^2), and Sediment Source Survey field data have been included in the suite of indicators to provide direct and indirect measures of the extent of human influence within the watersheds of the subject streams in the Yaak TPA.

3. ***Is there a sediment supply problem contributing to impairment (i.e., is there too much or too little sediment in the stream)?***
   Indicators have been selected to demonstrate or indicate whether or not there is, or has been, an excessive discharge of sediment to the stream. The focus here is on the quantity of sediment (coarse, fine, or suspended) in the stream (i.e., too much or too little sediment).

   Percentage of channel surface fines <6 mm and <2 mm, and percentage of subsurface fines <6mm are included in the suite of indicators as a direct measure of a potential sediment supply problem. The bankfull width-to-depth and entrenchment ratios provide information to evaluate this question as well.

4. ***Is there an indication of an in-channel sediment transport problem contributing to or causing impairment?***
   Factors such as natural or human-caused flow alterations (e.g., irrigation, dams, drought, water yield increases) and/or channel modifications can result in symptoms similar to those that may be observed as a result of an excessive sediment supply.

   Stream morphology values such as width-to-depth and entrenchment ratios provide indirect indicators of possible sediment transport problems that may occur, or have occurred in the Yaak TPA. The Pfankuch Stream Channel Stability (Sum), Stream Channel Stability-Scouring and/or Deposition Item, and the Stream Channel Stability-Distribution and Stability of Channel Bottom Materials Items all can be used to answer this question as well.

4.2 Sediment Impairment Indicators

Table 4-1 lists the indicators used to assess sediment impairment in the Yaak TPA. The individual indicators listed are explained below. Due to its relevance to sediment assessments, the concept of "reference condition" precedes a discussion of indicators. The suite of indicators selected for the Yaak TPA were chosen based on:

- the region, ecoregion, and general watershed setting
- the availability of existing data
- the availability of suitable reference data

- EPA and DEQ experiences with sediment indicators
- information being collected by other monitoring programs

4.2.1 Reference Condition

DEQ uses a "reference condition approach" to evaluate *naturally occurring conditions* (those conditions where "all reasonable land, soil and water conservation practices have been applied") for assistance in determination of sediment impairment. Several approaches are used to assist in developing reference criteria. Primary approaches include utilizing data from known equivalent reference sites and historical condition. Secondary approaches include literature-supported criteria, water quality modeling, and judgment of qualified professionals. Typically, a combination of primary and secondary approaches is used to develop appropriate reference condition criteria.

For this study, a total of 83 reference sites that met reference criteria were used to evaluate impairment conditions at Yaak TPA study sites. Reference sites selected were considered to be indicative of "un-impacted conditions" that could be expected at the evaluated reaches if no management impacts had occurred. Nine of these sites were from the nearby Cabinet Mountains. Four reference sites were within the Yaak TPA: Grizzly Creek, North Fork Seventeenmile Creek, Flattail Creek, and Independence Creek. Candidate reference sites were ground-verified before measurement to ensure that channel and stream bottom conditions had not been modified by any human activity.

Since data from reference sites were primarily being used to interpret possible sediment impacts, sample collection focused on physical habitat measurements that are related to or dependent on sediment. Channel morphology and pebble count data were collected at the reference sites following the sampling protocols employed throughout the rest of the study, providing comparable results. Threshold values for entrenchment ratio, width/depth ratio (w/d ratio), and percent surface fines <6mm and <2mm were established by stratifying reference sites by Rosgen stream type and then averaging the values for a given parameter within the stratification. Generally, one standard deviation (SD) was used to define the acceptable range for a given parameter. Some substrate measurement results, however, were evaluated based on a quartile approach in order to minimize the effects of outliers in smaller nonparametric data sets. Further discussion of the application of reference values for each parameter can be found below.

4.2.2 In-Stream Sediment Indicators

4.2.2.1 Primary Indicator: Bankfull Width to Depth Ratio

The bankfull w/d ratio is defined as the bankfull width divided by the mean bankfull depth of a stream channel cross-section. It is a prime descriptor of channel shape; narrow, deep streams will have small w/d ratios; wide, shallow streams will have large w/d ratios (Rosgen, 1994).

Of all the channel morphology parameters, stream width is the most responsive to stress within the channel or watershed (Leopold, 1994). Stream width, and hence, w/d ratio can change due to shifts in boundary stress (energy or stream power available along the channel margin) as a result of changes in riparian vegetation, changes in streamflow, and/or changes in sediment load. These changes can occur as a result of water diversions, channelization, timber harvest, excessive grazing, road encroachment, or other land-uses within the watershed (Rosgen, 1996). In the Yaak TPA, changes in w/d ratio might indicate peak flow increases resulting from excessive harvest within a watershed, riparian clearing, sediment increases from both natural and man-caused actions, or a combination of these.

To effectively utilize the w/d ratio, it must be defined for individual stream types. This can be done through a numerical classification system, such as Rosgen (1994), or by sampling “reference” streams within the region of concern. The use of reference reaches is a recommended approach for comparing managed and un-managed streams (Dissmeyer,1993). As stated above, this is the method used in the Yaak TPA.

Collection of data from reference stream reaches on the Kootenai National Forest has yielded the following w/d ratios for stream types commonly found in the area (Table 4-2).

Table 4-2. Bankfull Width / Depth Ratios for Kootenai National Forest Reference Streams

Rosgen Stream Type	Number of Reference Sites	Mean width/ depth ratio	Indicator Acceptable Range
A	4	15.6	7.3 – 23.8
B	58	19.5	11.9 – 27.2
C	10	18.6	13.3 – 23.8
E	3	9.1	8.3 – 9.8
F	8	26.4	14.8 – 37.9

The indicator values for w/d ratios for streams within the Yaak TPA are shown in the right-hand column. These indicator values represent +/- one SD from the mean, and are partitioned into Rosgen classes to more accurately assess the potential at each site. For example, for Rosgen B stream types, the standard display of +/- 1 SD from the mean would produce a range of 11.9 – 27.2. A stream classified as a Rosgen “B” with a w/d ratio outside of this range, especially one greater than the value of 27.2, would imply impairment. Note: Where a small number of sites were involved on creating the mean and SD statistics (A’s and E’s in Table 4-2 above), care must be taken in the use of the threshold value ranges.

4.2.2.2 Supplemental Indicator: Entrenchment

Entrenchment is the ratio between the width of the flood-prone area (horizontal distance across a channel, measured at twice the maximum bankfull depth) and the bankfull width of the channel. It is a prime descriptor of the relationship of the stream channel and its valley/landform features (Rosgen, 1994). Streams that are highly entrenched have little opportunity to dissipate flood flows outside the channel, while floods in slightly or non-entrenched streams spread out across the valley bottom. Consequently, entrenchment ratios will vary with stream type. Changes in entrenchment often occur simultaneously with changes in w/d ratio, and can result from changes in sediment supply or competency of the system.

A significant shift in entrenchment results in severe ramifications for sediment supply, as the ability to dissipate flood flow energy is a large factor in the amount of channel erosion that occurs. Changes in sinuosity, gradient, and w/d ratio can affect the entrenchment ratio. Entrenchment is not as responsive to land-use changes within the watershed as the w/d ratio, but a negative shift in entrenchment (toward a more entrenched state) is an indicator of instability.

Table 4-3 displays average entrenchment ratios of KNF reference streams, and the accompanying acceptable reference range adopted from Rosgen (1994) for streams of different channel types. The threshold values for entrenchment ratio for streams within the Yaak TPA are shown in the right-hand column. As larger entrenchment values are more desirable, an upper threshold value is not given. Rather, reference values from Rosgen (1994) are used as threshold indicators for possible impairment.

Table 4-3. Entrenchment for Kootenai National Forest Reference Streams

Rosgen Stream Type	Number of Reference Streams	Mean Entrenchment Ratio	Indicator Threshold*
A	4	1.4	<1.4
B	54	1.7	>1.4
C	10	3.5	>2.2
E	3	2.6	>2.2
F	8	1.2	<1.4

*from Rosgen (1996)

4.2.2.3 Primary Indicator: Percent Surface Fines Less than 2mm and 6mm, Percent Subsurface Fines <6mm

Streams naturally have a wide variety of bed material sizes. Streams with too much fine material, however, can have inhibited biological communities due to the effects of fine sediment on the habitat requirements of aquatic organisms. Excessive fine sediment deposited on stream substrates can degrade the habitat of aquatic invertebrates and cause shifts in the invertebrate assemblage (Platts et al., 1989; Hawkins et al., 1983; Rinne, 1988; Mebane, 2001). For streams where excess fine sediment is a cause of concern, surface sediment size fractions of <2mm and <6mm in diameter are typically evaluated because aquatic life is most sensitive to increases in these size fractions. Evaluation of these sediment criteria provides evidence for support of aquatic life uses (fish and macroinvertebrates).

Several studies have linked increases in **surface fines <2mm** and **6mm** to detrimental effects on aquatic life:

- In a study of 562 streams in four northwestern states, Relyea et al. (2000) found that changes in invertebrate communities occur as fine sediments <2mm increase above 20% coverage by area.
- Hill et al. (2000) found that percent fines <2mm negatively correlated with periphyton biomass in mid-Atlantic streams.
- Zweig et al. (2001) in their work on four Missouri streams determined that taxa richness significantly linearly decreased with increasing deposited sediment in 3 of 4 streams.
- Suttle et al. (2004) showed that increasing concentrations of fines deceased growth and survival of salmonids. Linear relationship between increasing fine sediment and salmonid growth suggested that there is no threshold below which increased fine sediment delivery would not be detrimental to the growth of salmonids.
- Mebane (2001) found that higher levels of surface sediment <6mm negatively affected ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa and salmonid and sculpin fish species.

Stream channel substrate sampling (pebble counts) provides an indication of the type and distribution of bed material (surface fines <2mm and 6mm) in a stream. Wolman pebble counts (Wolman, 1954) were collected at numerous sites in the Yaak TPA prior to this study and at all 83 sites in 2003/2004 as part of the Yaak TPA Process. Interpretation of pebble count data allows data comparisons to reference conditions, literature values, or other criteria.

In addition to surface fines, increases in <u>subsurface</u> fines (those within the several upper inches of channel substrate) have shown to be detrimental to the propagation of salmonids. Weaver and Fraley (1991) showed a direct correlation between successful fry emergence and fine sediment in spawning gravels: increases in the percentage of fine sediment <6mm resulted in a decrease in fry emergence. Sampling and evaluation of subsurface fines (McNeil et al, 1964) through McNeil core sampling provides an indicator of impacts to embryo survival and emergence and are therefore good indicators to use for evaluation of aquatic life support uses – specifically fishery support.

Surface Fines Criteria (<2mm and <6mm)

Threshold surface fine sediment values have not been fully developed by DEQ or EPA. Local criteria development must consider both 'threshold effects' to aquatic life and reference conditions to determine whether beneficial uses are being impacted.

Recent work completed in the Boise National Forest in Idaho showed a strong correlation between the health of macroinvertebrate communities and the percent surface fines <2mm in diameter. The most sensitive taxa were affected at 20 percent surface fines, and a definite threshold was observed at 30 percent surface fines (Relyea, personal communication, April 28, 2004).

Reference reach data from streams in the KNF classified by Rosgen stream type for surface fines less than 2mm and 6mm is given in Table 4-4. Of all streams measured, most were B stream types, the predominant stream type on the KNF. These data demonstrate that natural (reference) levels of fine sediment for a variety of stream types on the KNF are predominantly under 10%, with the exception of C3 stream types (n=4). Notwithstanding C3 streams, there is also little difference between the percent surface fines less than 6 mm and the percent surface fines less than 2 mm for the 79 reference streams measured. The lower end of particle size distribution curves for reference streams on the KNF is reasonably flat, showing approximately a 2-3% difference between 2mm and 6mm. (Figure 4-1).

Table 4-4. Mean Percent Streambed Fines from KNF Reference Streams

Rosgen Stream Type	Number of Reference Streams	% <2mm	% <6mm
B3	41	6	8
B4	28	4	5
C3	4	15	24
C4	11	2	4
E4	4	6	9
F3	4	10	11
F4	3	9	10

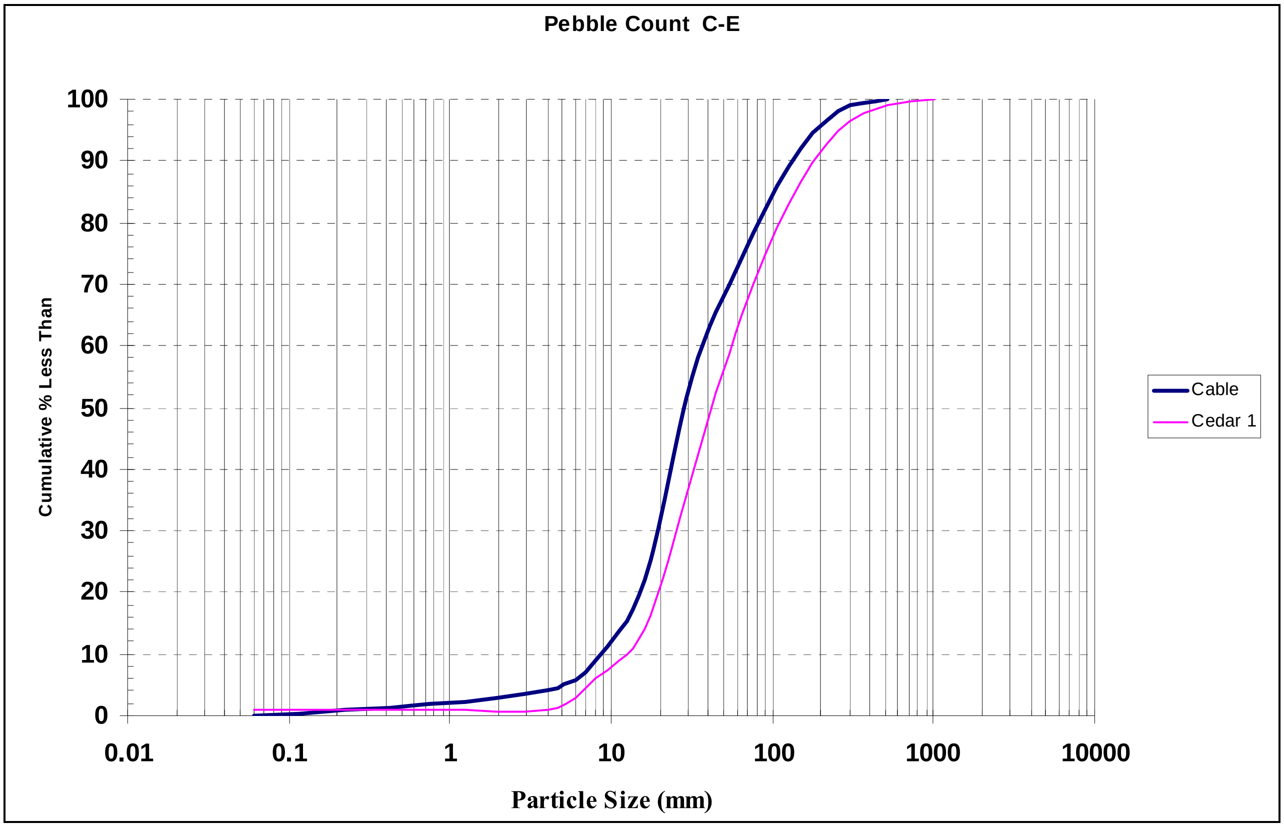

Figure 4-1. Wolman Pebble Count Curves for Two Reference Reaches

Subsurface Fines Criteria (<6mm)

As with percent surface fines, threshold subsurface fine sediment (<6mm) values have not been developed by DEQ or EPA. Criteria development must consider both ‘threshold effects’ to aquatic life and reference conditions.

Weaver and Fraley (1993) found a significant inverse relationship ($r^2 = 0.72$, $P < 0.005$, $N = 17$) between fry emergence success and the percentage of substrate fines <6.35 mm in diameter in streams in the Flathead National Forest. Mean fry emergence success was 76, 55, 39, 34, 26, and 4%, respectively, in cells containing 0, 10, 20, 30, 40, and 50% substrate materials < 6.35 mm (Figure 4-2).

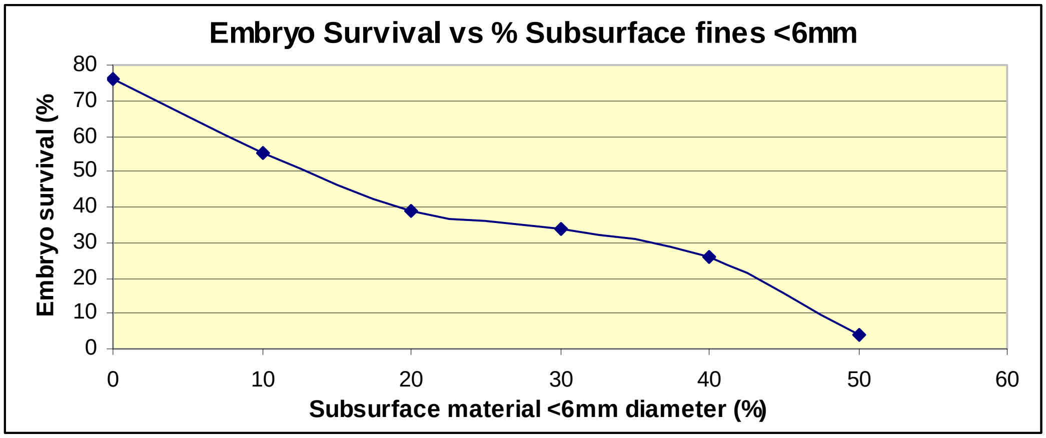

Figure 4-2. Embryo Survival vs. % Subsurface Fines <6mm
(Weaver & Fraley, 1991)

Percentile statistics from reference data from streams in the KNF are given in Table 4-5. Percentile values rather than standard deviations are used to summarize the data. For nonparametric data sets, quartiles are often used to describe the data. Quartiles (25th and 75th percentiles) maintain the benefit of minimizing the effects of skewness and outliers. 75th percentiles of reference data are typically used by DEQ as water quality criteria for non-normal data sets. Kootenai reference site results show average percent substrate fines at reference sites monitored from 1997 –2003 ranged from 17 to 29 percent. Flattail Creek lies within the Yaak TPA and represents the most likely reference conditions suitable for impaired streams in the Yaak TPA. The 75th percentile values in Table 4-5 fall at or below 28% subsurface fines <6mm. Using the relationship in Figure 4-2, a value of 28% subsurface fines <6mm correlates roughly to a embryo survival rate of 34% to 39%, and serves as water quality indicator criteria for evaluation of aquatic life support uses – specifically fishery support for streams in the Yaak TPA.

Table 4-5. Kootenai National Forest Reference Data: Subsurface Fines <6mm

Kootenai Reference Sites (1997 – 2003)	Percent subsurface fines <6mm			
	Mean	SD	25th Percentile	75th Percentile
Bear Creek	19.0	6.0	16.7	22.5
Flattail Creek	26.7	7.2	23.2	28.3
Himes Creek	29.1	4.4	26.4	28.2
Libby Creek	25.4	4.5	24.4	27.9
West Fork Quartz Creek	17.1	3.6	15.2	18.0
Upper Silver Butte Creek	21.0	4.3	19.2	23.0

Summary of Surface and Subsurface Fine Sediment Indicator Values

Based on reference subsurface fines data, and threshold effects studies, **percent surface fines (the fraction <2 mm and the fraction <6 mm) less than 20% are used as indicators of impairment in the Yaak TPA**. Because reference values for surface fines <2mm and <6mm are generally lower than 20% (Table 4-4), and threshold effects on macroinvertebrate communities from fine sediment inputs are unclear, further examination of fine sediment thresholds for evaluation of macroinvertebrate aquatic life support determinations is warranted. Increases in surface fine sediment levels above reference conditions (and below the 20% threshold), while not directly attributable to threshold impacts to aquatic organisms, may impede growth and survival and should be cause for concern. Further monitoring to assess the impacts of increasing fine sediment levels on aquatic organism may help to refine threshold effects levels for aquatic organisms. The **indicator value for subsurface fines <6mm is 28%** based on reference conditions found in the KNF.

4.2.2.4 Supplemental Indicator: Pfankuch Stream Channel Stability

The Pfankuch Stream Channel Stability rating was developed to "systemize measurements and evaluations of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production" (Pfankuch, 1975). This procedure uses a qualitative measurement with associated mathematical values to reflect stream conditions. The rating is based on 15 scoring items in 3 categories: 6 items related to the bottom of the stream channel (the part of the channel covered by water yearlong), 5 items related to the lower banks (covered by water only during spring runoff), and 4 items related to the upper banks (covered by water only during flood stages). The sum of the 15 scoring items is then used to place the reach into one of three Rosgen Stream Type categories: good (or excellent), fair, or poor. Because of the value of this information, and the potential for similar historical information in many Yaak stream segments, the total (sum of the 15 scoring-items) Pfankuch Stream Channel Stability is used in this impairment assessment.

Because of natural differences among variables determining stream types, stream channel stability scores vary by Rosgen stream type. A rating of "fair" was chosen as the threshold for impairment because anything lower (poor) strongly suggests problems with the stream channel. Table 4-6 displays the threshold value score for each Rosgen Stream Type.

Table 4-6. Pfankuch Stream Channel Stability Scores for "Fair" Ratings, based on Rosgen Stream Types

Rosgen Stream Type	Threshold value SCORE for at least "Fair" rating
A2	≤47
A3	≤129
A4	≤132
B2	≤58
B3	≤78
B4	≤84
C2	≤61
C3	≤105
C4	≤110
E3	≤86
E4- E5	≤96

E6	≤86
F2	≤105
F3	≤125
F4	≤125

In addition, two of the individual Pfankuch Stream Channel Stability evaluation items/factors were used to provide additional interpretative information for defining impairment. These are the portion of the channel bottom categorized as stable (called Channel Bottom Size Distribution Description) and the amount of scouring/deposition (Channel Bottom Scour/Deposition Description). These categories can provide information useful for interpretation of potential sediment impairments at selected sites within the Yaak TPA. However, it should be noted that the results of these analyses do not differentiate between natural and anthropogenic causes. Also, the scores do not provide any indication of the natural potential of a stream (i.e., a stream's natural potential may only be "fair" for either of the items). Channel stability ratings are based on visual interpretation, and are therefore subject to observer bias, so use of this data is primarily used as supporting evidence of potential sediment impairments. In lieu of information that indicates the potential of a stream, a rating of "fair" or better is used as an impairment-indicator value for the Channel Stability ratings.

Channel Bottom Scouring and Deposition refers to the amount of movement or rearrangement of stream bottom particles into lateral and mid-channel bars in response to flow events. Scores are assigned from 6 to 24 as defined in Table 4-7.

Table 4-7. Stream Channel Stability, Channel Bottom Scour/Deposition Description

Condition Description	SCORE	Rating
<5% bottom affected by scour or deposition	6	Excellent
6-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	Good
31-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.	18	Fair
More than 50% of bottom in flux nearly yearlong.	24	Poor

Channel Bottom Size Distribution and Percent Stable Materials refers to the fraction of the stream bottom that is considered stable during flow events, i.e., remains in place. This factor is evaluated as a deviation from what is expected for this stream segment, based on the surrounding streams, channels, and recent flood history. Scores are assigned from 4 to 16, as defined in Table 4-8.

Table 4-8. Stream Channel Stability, Channel Bottom Size Distribution Description

Condition Description	SCORE	Rating
Expected distribution of channel bottom materials, stable material 80-100%	4	Excellent
Slight shift from expected distribution of channel bottom materials, stable material 51-80%	8	Good
Moderate shift from expected distribution of channel bottom materials, stable material 21-50%	12	Fair
Pronounced shift from expected distribution of channel bottom materials, stable material 0-20%	16	Poor

Scores of at least "fair" for each of these items was established as the threshold value for these Supplementary Indicators (Table 4-7). Thus if more than 50% of the channel bottom was affected by scouring and/or deposition, or if less than 21% of the channel bottom was identified as being "stable", impairment was implied.

4.2.3 Biological Indicators

Macroinvertebrate data help to provide a better understanding of the cumulative and intermittent impacts that occur over time in a stream and are a direct measure of the aquatic life beneficial use. Macroinvertebrate assemblages respond to siltation with a shift in natural or expected taxa to a prevalence of sediment tolerant taxa over those that require clean gravel substrates. Macroinvertebrate bioassessments scores are an assessment of the macroinvertebrate assemblage at a site and are used by DEQ to evaluate impairment condition and beneficial use support. A variety of macroinvertebrate metrics and indices have been developed to help assess aquatic life support conditions. Some are useful for assessing the overall health of the aquatic life community, while others assess the effects of a specific stressor on macroinvertebrate assemblages. The advantage of these bioassessment tools is that they provide a measure of support of associated aquatic life, an established beneficial use of Montana's waters.

Two bioassessment methods, RIVPACS and MMI (Section 4.2.3.1) have been adopted by DEQ and provide the primary indicator of whether macroinvertebrate aquatic life uses are being supported. Where appropriate, supplemental bioassessment metrics that distinguish cumulative or stressor-specific impacts are qualitatively evaluated. Supplemental biological indicators are not considered to be as reliable in distinguishing between specific stressors or degrees of impact, and so are weighted accordingly in impairment determinations.

4.2.3.1 Primary Indicators: RIVPACS and MMI SCORE

In 2006, DEQ adopted impairment thresholds for bioassessment scores based on two separate methodologies. The Multi-Metric Index method assesses biological integrity of a sample based on a battery of individual biometrics. The River Invertebrate Prediction and Classification System (RIVPACS) method utilizes a probabilistic model based on the taxa assemblage that would be expected at a similar reference site. Based on these tools, DEQ adopted bioassessment thresholds that were reflective of conditions that supported a diverse and biologically unimpaired macroinvertebrate assemblage, therefore a direct indication of beneficial use support for aquatic life.

The MMI is organized based on the different ecoregions within Montana. Three MMIs are used to represent the various Montana ecoregions: Mountain, Low Valley, and Plains. Each region has specific bioassessment threshold criteria that represent full support of macroinvertebrate aquatic life uses. The Yaak Watershed falls within the Mountain MMI region. The MMI score is based upon the average of a variety of individual metric scores. The metric scores measure predictable attributes of benthic macroinvertebrate communities to make inferences regarding aquatic life condition when pollution or pollutants affect stream systems and instream biota.

The RIVPACS model compares the taxa that are expected at a site under a variety of environmental conditions with the actual taxa that were found when the site was sampled. The RIVPACS model provides a single dimensionless ratio to infer the health of the macroinvertebrate community. This ratio is referred to as the Observed/Expected (O/E) value. Used in combination, the results suggest strong evidence that a water body is either supporting or non-supporting its aquatic life uses for aquatic invertebrates.

For the MMI, individual metric scores are averaged to obtain the final MMI score. The score will range between 0 and 100. The impairment threshold for the mountain MMI is 63. This impairment threshold (10th percentile of the reference dataset) represents the point where DEQ technical staff believed macroinvertebrates are affected by some kind of impairment (e.g. loss of sensitive taxa).

The RIVPACS impairment threshold for all Montana streams is any O/E value <0.8. However, the RIVPACS model has a bidirectional response to nutrient impairment. Some stressors cause macroinvertebrate populations to decrease right away (e.g. metals contamination) which causes the score to decrease below the impairment threshold of 0.8. Nutrient enrichment may actually increase the macroinvertebrate population diversity before eventually decreasing below 0.8. High RIVPACS scores (>1.2) may indicate impairment from nutrient enrichment.

Most scores significantly below the RIVPACS and MMI impairment thresholds indicate impairment. Some model scores may be close to the threshold. These sites may be considered unimpaired in some situations. For example, a site classified in the Mountain ecoregion may have a Mountain MMI score of 83, well above the Mountain MMI threshold (63), and a RIVPACS score of 0.76, close to the RIVPACS impairment threshold (0.8). The assessor may determine that the macroinvertebrate community at the site is unimpaired. Ultimately, the assessor will determine the degree of impairment (i.e. moderate or severe) using best professional judgment and guidance found in the state's bioassessment process (DEQ, 2006).

4.2.3.2 Supplemental Indicator: Fine Sediment Index-EPT (FSI-EPT)

A large-scale study of western streams found that not all Ephemeroptera, Plecoptera, and Trichoptera taxa respond to increases in fine sediment in the same way (Relyea 2005). The EPT are generally considered sensitive to pollution and EPT metrics are commonly used in bioassessment protocols. However, when only fine sediment is considered as the pollutant, these groups have taxa that range from very sensitive, Rhithrogena, to very insensitive, Paraleptophlebia, even though both are Ephemeropterans. In a study of 428 streams in the Northern Rockies ecoregion, the average Fine Sediment Index -EPT taxa had 13 sensitive taxa per stream (Relyea, 2005). This value was combined with the maximum FSI-EPT score to select an indicator value of 17 FSI-EPT taxa, a surrogate indicator for streams in the Northern Rockies ecoregion least impacted by fine sediment.

4.2.3.3 Supplemental Indicator: Percentage of FSI-Sensitive Taxa

This metric describes the percentage of the community that is sensitive to increases in fine sediment (Relyea, 2005). In western montane streams, the number of macroinvertebrate taxa that are sensitive to fine sediment is typically 50% of the total or higher. In the Yaak TPA, a value of 40% sensitive taxa was chosen as a surrogate indicator for streams least impacted by fine sediment.

4.2.3.4 Supplemental Indicator: Fine Sediment Index

The FSI is a regional, stressor-specific biomonitoring index for use in assessing fine sediment (<2mm) impacts on macroinvertebrate communities. The FSI can be useful because of the documented relationship between the macroinvertebrate metric, aquatic life health, and sediment stressors. *It is, however, best used to indicate stress to the aquatic system as it is not able to identify a threshold where sediment impacts begin*.

Benthic macroinvertebrate and substrate particles sizes for 1,134 streams spanning 16 western Level III ecoregions (Omernik, 1987) were examined to determine species sensitivity to fine sediment (Relyea, 2005). For every species found, relative abundances and range of occurrence over fine sediment categories from 0% through 100% fines were used to determine species sensitivity to fine sediment. All taxa examined could be found in streams with up to 20% fine sediment (<2mm), however, above this level, taxa started disappearing. In the western U.S., 116 taxa exhibit some degree of sensitivity to fine sediment. Macroinvertebrate taxa are assigned values corresponding to their sensitivity. The values from all sensitive taxa in a sample are then tallied to provide a score for that stream. Using only streams from the Northern Rockies Ecoregion (n=428), a threshold value of 205 was developed at the 75th percentile. Northern Rockies streams scoring 205 or higher are considered not to be stressed by sediment (or other stressors). For streams scoring below 105 (25th percentile), stress by sediment and/or other causes is suggested. Scores between the 75th and 25th percentile suggest moderate stress to the aquatic system, possibly due to fine sediment.

4.2.4 Landscape-Scale Sediment Indicators

Several other landscape-scale information sources were included to help define impairment and to describe the impact and magnitude of potential sources of sediment in the Yaak TPA. Factors used are listed below.

- Percent Equivalent Clear-Cut Acres
- Road/Stream Crossing Density
- Watershed Road Density

These factors were chosen because of the availability of data, the linkage to potential sediment inputs, and because they are congruent with USDA/KNF Watershed Condition Evaluation criteria in the Draft Comprehensive Evaluation Report (CER) for the Kootenai and Idaho Panhandle Proposed Land Management Plans (USDA, 2006).

“The CER evaluates the relevant conditions and trends under the 1987 Forest Plans and the Proposed Land Management Plan (the Plan). The CER identifies factors that affect conditions and trends, includes information on what is causing conditions to change, and describes the influence the Plan has on moving toward desired conditions. In addition, the CER evaluates the likelihood of meeting the desired conditions and objectives pertinent to the social, economic, and ecological sustainability elements through Plan implementation. Results derived from forest plan monitoring and evaluation reports are included in assessing the performance of Land Management Plan direction and implementation.” (USDA, 2006)

Appendix H – Watershed, Soils, and Aquatic Species and Habitat (USDA, 2006), of the CER establishes a methodology for evaluating watershed condition, and utilizes the Watershed Condition Disturbance Evaluation Factors in Table 4-9. Two of the most heavily weighted variables (% ECA and Stream Crossing Density) were used as supplemental indicators of impairment in the Yaak TPA. Screening criteria was set in the 'moderate' range for these indicators. In addition, watershed road density (rather than riparian area road density) was used as a supplemental indicator. These indicators are useful screening tools to evaluate possible impacts to the stream and to aid in interpreting primary indicators. However, they are not direct measurements of water quality condition and may not be a reflection of current channel or ground conditions.

Table 4-9. Watershed Disturbance Calculation

Watershed Condition Disturbance Evaluation Factors	Factor Weight	High (3x)	Moderate (2x)	Low (1x)
1) %ECA for the Watershed	3	>30%	15-30%	<15%
2) % Intact Riparian	2	<70%	70-80%	>80%
3) Stream Crossing Density (#/mi2 of Watershed)	3	>3/mi^2	1.5/mi2-3/mi2	<1.5/mi^2
4) % Detrimental Compaction	1	>10%	4-9.9%	<4%
5) Riparian Area Road Density (Factor based on Mean Annual Precipitation (MAP) for the 6th HUC Watershed)				
MAP >45"	2	>2.0 mi/mi^2	0.5-2.0 mi/mi^2	<0.5 mi/mi^2
MAP 20-45"	2	>3.0 mi/mi^2	1.0-3.0 mi/mi^2	<1.0 mi/mi^2
MAP <20"	2	>3.0 mi mi^2	1.5-3.0 mi/mi^2	<1.5 mi/mi^2

USDA, 2006

4.2.4.1 Supplemental Indicator: Percent Equivalent Clear-Cut Acreage

The potential peak flow impact of forest harvest was evaluated by calculating the equivalent clear-cut acreage (ECA) for each watershed, looking at the last 40 years of information. ECA is an estimate of the cumulative effect of multiple years of forest crown removal (from harvest, fire and roads) and is calculated by considering the timing and/or amount of activities in the watershed. ECA includes a vegetative recovery component for harvested acreages, reflecting current conditions.

Regarding appropriate ECA thresholds that may indicate impacts to surface waters:

- Jones and Grant (1996) stated that a basin harvest of greater than 25% suggests a potential for channel alteration as a result of altered flow regimes within the watershed.
- The Draft Comprehensive Evaluation Report for the Kootenai and Idaho Panhandle Proposed Land Management Plans considers ECAs of <15% low, 15-30% as moderate, and >30% as high in its 'watershed condition disturbance evaluation'.

For this reason a threshold value of 25% ECA was used as supplemental screening threshold in the Yaak TPA analysis.

4.2.4.2 Supplemental Indicator: Stream Crossings Density

Roads have long been known to be the source of the majority of sediment delivered to stream channels from logging operations (Swanston et al, 1976; Rice and Lewis, 1991). Stream crossings are generally the most sensitive part of the road system from a sediment production standpoint and are often the source of introduced fine sediment. The number of stream crossings is an indicator of the opportunity for sediment introduction and also may also represent sites where streamflow is augmented by road-intercepted runoff. For these reasons, this factor was included as one of the Supplemental Indicators for defining and evaluating impairment.

The *Draft Comprehensive Evaluation Report for the Kootenai and Idaho Panhandle Proposed Land Management Plans* considers steam crossing densities of <1.5/mi^2 low, 1.5/mi^2 -3.0/ mi^2 as moderate, and >3.0/ mi^2 as high in its 'watershed condition disturbance evaluation' (Appendix H). A value of 3.0 crossings/ mi^2 was chosen as a screening-level criteria for potential sediment impacts to streams in the Yaak TPA.

4.2.4.3 Supplemental Indicator: Watershed Road Density

As described above under Stream Crossings Density, roads can have a dramatic impact on watershed conditions in a basin. Thus a variable called Road Density was derived that relates the miles of road to the size of the basin, as an indicator of the amount of activity and disturbance within a given watershed.

A road network density of <3.0 miles per square mile of watershed area was used as a screening level criteria for potential sediment impacts to streams in the Yaak TPA. This value does not imply direct sediment impacts to streams but indicates that potential problems may exist where road densities are high. This value was generated in 2002 by the Hydrologists in the KNF as part of a forest wide project to create consistent indicators of watershed health and condition and to assist in impairment status evaluations.

4.2.5 Additional/Supplemental Information

4.2.5.1 Sediment Source Surveys

Sediment source surveys have been conducted in the Yaak TPA by the Yaak Headwaters Partnership Group since 2001. Surveys have been completed in several watersheds within the Yaak TPA including the South Fork Yaak River, Seventeenmile Creek, and Lap Creek. All major stream channels and most tributaries were walked by survey crews. Information was collected at every road crossing and other sites that deliver sediment to streams such as mass wasting sites, road fill failures, bank erosion. Sediment delivery from road crossings and non-crossing sites are classified as "none", "minor", "moderate", or "substantial" based on comparison to other sites reviewed. Both natural and anthropogenic sediment sources were inventoried and quantified where possible.

4.2.5.2 Additional Site- and Basin-Specific Information

At several sites within the Yaak TPA, similar data has been collected in the past at the same locations as were sampled in 2003/2004, and at numerous other locations. Over the last 10-15 years, stream channel stability, channel morphology and aquatic macroinvertebrate-information was also collected within the Yaak TPA. Some of this information is every bit as valuable as that collected during the field-sampling phase of this impairment determination (the aquatic macroinvertebrate information), but some of it is not as precise, or was done differently than is currently done (channel stability and the channel morphology variables).

In addition, some other data-types (i.e. McNeil core data, Riffle Stability Index [RSI]) had been collected as part of these previous surveys. Where available, these data were used to further describe conditions that existed in a given reach.

4.3 Water Quality Impairment Summary

Section 4.3 presents evaluations and summaries of all available water quality data for sediment impaired streams in the Yaak TPA: Seventeenmile Creek, South Fork Yaak River, and Lap Creek. The weight-of-evidence approach described above in Section 4.1, using a suite of delineative criteria, supplemental indicators and supplemental information has been utilized to evaluate sediment impairment conditions.

4.3.1 Seventeenmile Creek

Seventeenmile Creek is a relatively large (39,900 acre watershed) tributary to the mainstem Yaak River, entering the Yaak River Valley from the east about three miles above Yaak Falls (Figure 4-4) Major named tributaries include North Fork Seventeenmile Creek (7,000 acre watershed) and Flattail Creek (6,500 acres).

The Seventeenmile Creek Watershed includes several non-forested areas, with some private cleared fields, particularly in the lower part of the watershed. Two Inventoried Roadless Areas (Roderick and Saddle Mountain) make up over 60% of the watershed. The Forest Service manages the entire watershed with the exception of 330 acres of private land along the lower section of Seventeenmile Creek. Historic fire has played a significant role in the watershed, particularly at the upper elevations, in the early 1900s and in 1994. The Gunsight and Seventeenmile Fires of 1994 (lightning-caused) burned over 2,400 acres (6%) in this watershed.

Forest management (timber harvest) was significant in the upper watershed between the 1950s and early 1980s. Since harvest, Grizzly Bear Core Management Area (GCMA) designation has resulted in the closure of forest roads within GCMA in the Seventeenmile Creek watershed. Many roads within GCMA have been closed for at least ten years (more in some areas).

The cold-water fishery beneficial use was listed as impaired on the 1996 303(d) List for flow alteration, other habitat alteration, siltation, and suspended solids. The basis for the 1996 listing was unknown. DEQ lacked sufficient credible data to include this waterbody on the 2000 303(d) List. As a result, reassessment sampling for Seventeenmile Creek began in August of 2003 and was completed in October of 2004, and updated impairment determinations were included on the 2006 303(d) List.

Several survey sites were established and measured on Seventeenmile Creek in 2003 and 2004 as part of the Yaak TPA (Figure 4-4). Three sites were established on the mainstem and one each on the North Fork Seventeenmile, Flattail Creek, and Lost Fork Creek. In addition, information from several other sites on the mainstem and on tributaries was evaluated in the basin review, including some with data back to the 1990s.

The main channel of Seventeenmile Creek flows through a Type II valley bottom. Typical of most Type II valleys, the Seventeenmile Creek channel is predominately a Rosgen "B" stream type with many Rosgen "C" reaches. There is little evidence of channel instability caused by natural processes, and the streambanks are stable and well-vegetated. Figures 4-5 through 4-8 display some of the stream and channel characteristics common to sites on Seventeenmile Creek.

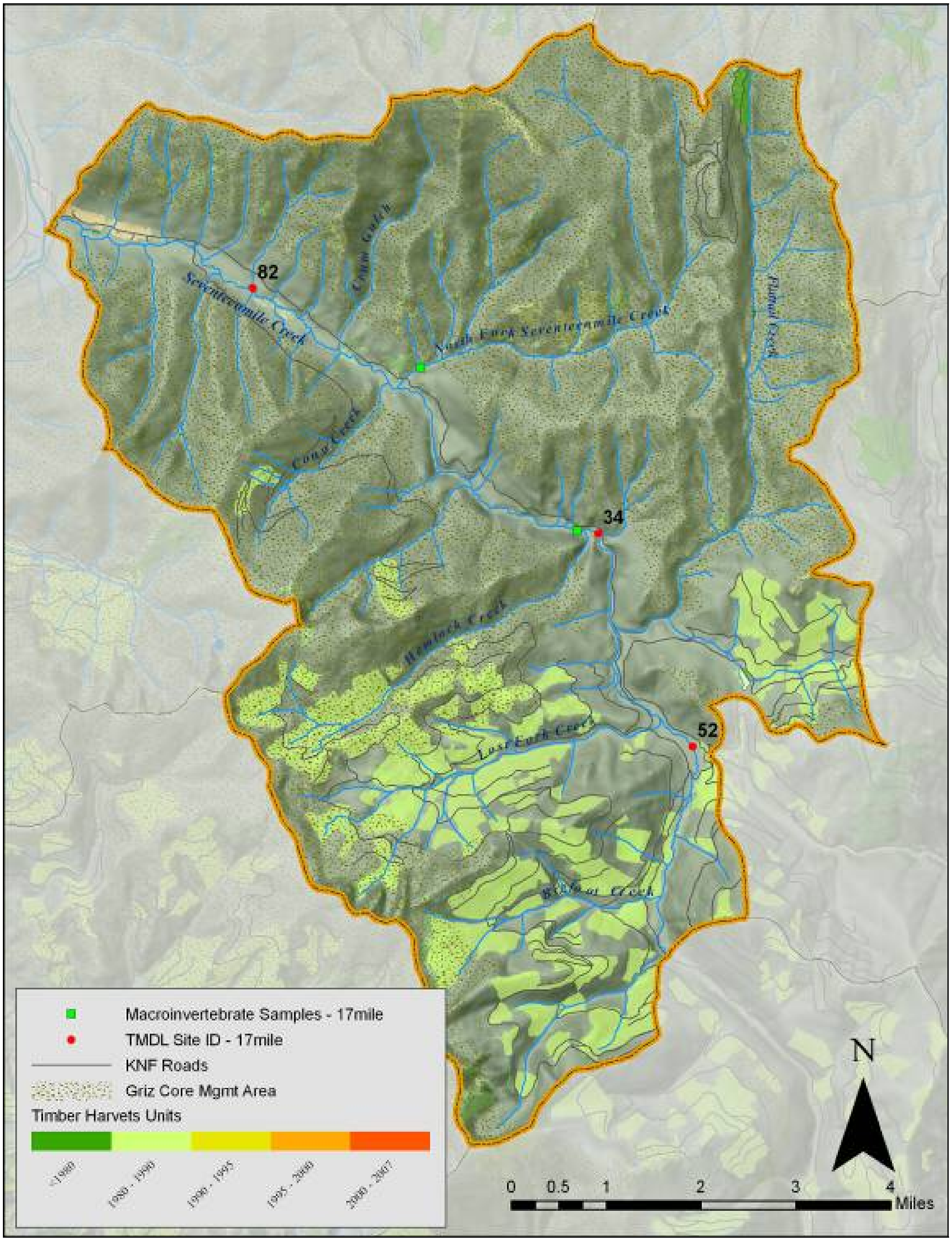

Figure 4-3. Seventeenmile Creek Watershed: 2003/2004 Sample Sites

Figure 4-4. Upper Seventeenmile Creek
(site 52 above Bridle Creek)

Figure 4-5. Middle Seventeenmile Creek at Site 34, looking downstream
(site is above Hemlock Creek confluence)

Figure 4-6. Middle Seventeenmile Creek above Hemlock Creek
(site 34, upper reach looking upstream)

Figure 4-7. Lower Seventeenmile Creek at Site 82 looking downstream
(site is above Bridle Creek)

4.3.1.1 Seventeenmile Creek In-Stream Sediment Indicators

A review of the available data is presented here including channel morphology information, channel substrate (Wolman pebble counts), Pfankuch Channel Stability Items, RSI, McNeil core samples, and potential sediment sources.

Cross-section channel morphology data was collected at three sites on Seventeenmile Creek in 2003 and 2004. Site 82, lowest Seventeenmile Creek, was added in 2004 to provide information for the lower part of the channel. These data were analyzed to determine width-to-depth ratios and entrenchment (i.e. channel morphology) for each sampling location and the results were compared to data from local reference sites. The results for each site are presented in Table 4-10. Bolded-values indicate delineative criteria exceedences.

Table 4-10. Mainstem Seventeenmile Creek Channel Morphology Values, 2003/2004

Site ID	Site Name	Stream Type	Entrenchment	Width/Depth Ratio
52	Upper Seventeenmile (above Lost Fork)	B3c	1.5	21.2
34	Seventeenmile(above Hemlock)	C4	3.5	19.9
82	Lower Seventeenmile (above Bridle)	C4c	2.5	14

Review of this table reveals that all sites on the mainstem of Seventeenmile Creek met the channel morphology criterion. At the site (reach) above Hemlock Creek (34), there are numerous unvegetated gravel bars, signs of localized instability. RSI information collected at this site in both 1995 and 2003 indicated a high percentage of the channel was instable. This is an area that has historically had beaver dams and it could have been affected by a beaver-dam breach during one of the recent high water events (spring runoff). Given the natural beaver and recent runoff history here, it does not appear that the channel morphology parameters imply sediment impairment.

Table 4-11 displays historic channel morphology and channel stability information collected on Mainstem Seventeenmile Creek, collected in 1993 and 1995, from sites located between just above Bridle Creek to above Big Foot Creek (criterion exceedences are noted in bold).

Table 4-11. Mainstem Seventeenmile Creek Channel Morphology Values, 1993 and 1995

Site ID	Site Location	Date sampled	Stream Type	Width/depth	Entrench-ment	SCS SCORE
CE-13	Seventeenmile above North Fork	1993	B3c	21.5	1.4	
CE-14	Seventeenmile above Bigfoot	1993	B4c	**30**	1.8	
17MI3560	Seventeenmile above Lost Fork (near 52)	7/6/1995	C4	23.4	--	
17MI3600	Seventeenmile between Lost Fork and Big Foot	7/22/1993	C4	15.2	--	**120**
17MI3760	Seventeenmile above Big Foot	7/20/1993	C4	15.0	4.0	108

Width-depth exceedences (bold): CE-14 value is above/outside of the reference range and suggest concern. All other exceedences are below the bottom value in the threshold value range.

Stream Channel Stability exceedences (bold): 17MI3600 is the only site in this historic data set that exceeded the threshold value.

Channel Surface Fine Sediment Less than 2 mm and 6 mm: Channel substrate information has been collected at five sampling sites on Seventeenmile Creek. Two sites have data from the early 1990s, and the remaining three sites were sampled in 2003 (Table 4-12).

Table 4-12. Seventeenmile Creek Channel Surface Fine Sediment (% <2mm and <6mm)

Site ID	Site Name	1991		1992		1993		1995		2003/2004	
		<2	<6	<2	<6	<2	<6	<2	<6	<2	<6
52	Upper Seventeenmile (above Lost Fork)									**21**	**21**
34	Seventeenmile (above Hemlock)									**20**	**20**
CE 13	Seventeenmile (above North Fork)	16	16	5	10	14	**20**	5	9		
CE 14	Seventeenmile (above Bigfoot)					12	**25**				
82	Lower Seventeenmile (above Bridle)									5	10

Bolded-text indicates exceedence of threshold values (less than 20%, for both size classes). Analysis of the 2003 and 2004 data indicates that two of the three sites have percent surface fines values that are just at or slightly above the threshold value of 20%. Surface fines at the lower mainstem sampling location (82) had surface fine values below threshold values. Both of the long-term cumulative effects stations (CE-13 and CE-14) slightly exceeded the threshold value in 1993 but were within thresholds in all other years sampled. No observable trend in surface sediment is observed in the data.

High surface fines levels at the upper two sites (52 and 34) suggests that there may be an impairment to fish and aquatic life (indirect evidence given the relationship between % fines and these beneficial uses). Also, the data at the upper two sites suggests that there may be a sediment supply problem that has resulted in deposition of fines <2mm and <6mm above reference levels (Table 4-4).

Other available data included McNeil core samples that were collected in the early to mid-1990s at site CE-13. The McNeil core data from this site ranged from 16.6% to 22.3% for subsurface fines between 1991 and 1995, below the 28% criteria for McNeil core data.

Channel Stability evaluations were conducted at three sampling locations in 2003 and 2004 (Table 3-18). All three sites met both the total and the specific-item thresholds. Field notes indicate the middle and lower sampling locations (sites 34 and 82) reflected some past accelerated bedload sediment movement in the form of depositional bars, reflected in the scores for these two items. These findings were corroborated by data from the 1990s.

Table 4-13. Seventeenmile Creek Channel Stability Ratings, 2003/2004

Site ID	Stream Name	Channel Stability		Scouring and Deposition	Stable Channel Bottom Materials
		Threshold value	SCORE		
52	Upper Seventeenmile (above Lost Fork)	≤78	60 / Good	Good	Good
34	Seventeenmile (above Hemlock)	≤110	93 / Fair	Fair	Fair
82	Lower Seventeenmile (above Bridle)	≤110	63 / Good	Good	Fair

In addition, Stream Channel Stability evaluations were conducted on Seventeenmile Creek between 1993 and 1995 at seventeen different reaches, from the headwaters upstream of Big Foot Creek to the confluence with the Kootenai River. Examination of these Channel Stability Ratings indicated that almost all sites met the core values for their specific stream type. Only Seventeenmile Creek at elevation 3,600 feet (17MI3600), a Rosgen C4 channel reviewed in 1993, had a channel stability outside of the acceptable range.

4.3.1.2 Seventeenmile Creek Biological Indicators

During the primary data gathering period for the Yaak TPA Impairment Determination, macroinvertebrate samples were collected at two stations. One sampling location on the mainstem of Seventeenmile Creek (K03SVNTC02) and one site on lower end of the North Fork of Seventeenmile Creek (K03SVNTC01) (Figure 4-4) were sampled. Tables 4-13A and 4-13B display and summarize the available macroinvertebrate information for both sites. Bolded values indicate exceedences of threshold values (threshold values indicated in parentheses).

Table 4-14a. Seventeenmile Creek RIVPACS and MMI Results

Site Name	**RIVPACS** (>0.80)	**MMI** (>63)
Seventeenmile Creek (K03SVNTC02)	0.93	76.9
North Fork of Seventeenmile Creek (K03SVNTC01)	1.00	85.4

Table 4-14b. Seventeenmile Creek FSI Summary

Site Name	**FSI- EPT** (≥17)	**% FSI Sensitive** (>40)	**FSI** (≥205)
Seventeenmile Creek (K03SVNTC02)	17	60	225
North Fork of Seventeenmile Creek (K03SVNTC01)	23	56	265

Seventeenmile Creek scored within the threshold values for all macroinvertebrate metrics. Macroinvertebrate assessments in Seventeenmile Creek do not imply impairments to the macroinvertebrate community: 60% of the community is sediment sensitive and seven taxa are semivoltine, meaning that more than one year is required for the aquatic portion of the life cycle. Semivoltine organisms usually require stable stream conditions and their presence indicates minimal stream disturbances and adequate flows.

4.3.1.3 Seventeenmile Creek Landscape-Scale Sediment Indicators

Table 4-15 displays the landscape-scale sediment indicators analyzed for Seventeenmile Creek watershed, including information for tributary watersheds with confluences above the identified sites.

Table 4-15. Seventeenmile Creek Basin-Level Forest Management Indicators

Site ID	Site Name	%ECA Value (<25%)	Stream Crossing Density (<3.0 crossings/mi^2)	Road Density (<3.0 mi/mi^2)
52	Upper Seventeenmile (above Lost Fork)	20	2.9	**4.1**
34	Seventeenmile (above Hemlock)	14 (19*)	2.3 (2.9*)	2.7 (**3.5***)
82	Lower Seventeenmile(above Bridle Creek confluence)	12	1.7	1.8

**values with reference watershed, Flattail Creek, removed from analysis*

Percent Equivalent Clearcut Acres: ECA values for all sites met the threshold value of 25%. With the exception of Flattail Creek drainage which has a low %ECA, ECAs in the upper watershed are moderate (20%). In the 1970s, the calculated ECA for the watershed was 30% so the current ECA reflects the vegetative recovery that has occurred since that timeframe.

Stream Crossing Density: Stream crossing densities for each site were at or below the indicator value of 3.0 crossings per square mile at all sampling sites located along the mainstem of Seventeenmile Creek.

Road Density: The road density threshold was exceeded at the upper mainstem site (52), but was well under at the other sites and for the portion of the basin above that site.

ECA, stream crossing density, and road density in the upper watershed are the highest in the entire watershed. Upper Seventeenmile Creek was heavily managed for timber harvest in the early 1980s (Figure 4-4). This activity may have contributed to the higher surface fine values at sites 52 and 34 (Table 4-12) and may be contributing to legacy fine sediment effects in Seventeenmile Creek.

4.3.1.4 Seventeenmile Creek Sediment Source Surveys

Sediment Source Surveys were conducted in Seventeenmile Creek by the Yaak Headwaters Restoration Partnership[2] (YHRP) in the summer of 2005 and 2006. Survey crews identified and assessed nearly all (over 130) road/stream crossings in the watershed: over 75% of crossings were in the Upper Seventeenmile watershed (above site 34). Many road/stream crossing sites were within GCMA, a special designation by the USFWS. All roads within GCMA are closed to motorized use, and a majority of the forest roads have been closed for more than ten years. Since closure, vegetative growth on many GCMA roads has drastically reduced sediment contributed to streams at these crossings. Approximately 30% of the road/stream crossings in Seventeenmile Creek are within GCMA.

[2] YHRP is a collective consisting of representation from the USFS, USFWS, FWP, Yaak Valley Forest Council, Trout Unlimited, and the Cutthroat Trout Foundation.

In addition to roads within GCMA, the USFS has closed other roads for administrative use only. Sediment contributions from these roads is likely considerably less than from seasonally-open forest roads.

Survey crews also identified twelve (12) non-road-related sediment sources in the Seventeenmile Creek Watershed. Non road related sources consisted of areas of identified bank & hillslope erosion and upslope mass failure. Non-road – related sources were predominantly natural occurrences: anthropogenic non-road-related source occurrences were not significant sources of sediment to Seventeenmile Creek.

4.3.1.5 Seventeenmile Creek Water Quality Impairment Summary

Table 4-16 provides a summary of Primary and Supplemental Indicators used for determining impairment condition for Seventeenmile Creek.

Table 4-16. Sediment Impairment Data Evaluation - Seventeenmile Creek

Sediment Impairment Indicator	Threshold Value	Available Data or Information
In-Stream Sediment Indicators		
Width to Depth Ratio	Variable (Table 4-2)	23 sites evaluated- All sites except 1 site in 1993 and 1 in 1995 met threshold
Entrenchment	Variable (Table 4-3)	20 sites evaluated: seven sites exceeded threshold.
Percentage of Surface Fines <6 mm	<20%	8 site/date combinations evaluated- 1 of 3 2003/2004 sites met threshold, 2 slightly exceeded; 2 sites in 1993 exceeded
Percentage of Surface Fines <2 mm	<20%	8 site/date combinations evaluated- 1 of three 2003/2004 sites met threshold, 2 slightly exceeded
Percentage of Subsurface Fines <6mm	<28%	One site evaluated: met threshold.
Pfankuch Stream Channel Stability	≥ "fair"	20 sites evaluated- All 2003 sites met threshold, 1 site in 1993 exceeded
Stream Channel Stability- Scouring/Deposition	≥ "fair"	3 sites evaluated in 2003- All sites met threshold
Stream Channel Stability- Distribution and Stability of Channel Bottom Materials	≥ "fair"	3 sites evaluated in 2003- All sites met threshold
Biological Indicators		
Montana Multimetric Index SCORE (MMI)	>63	Both mainstem and North Fork tributary met threshold
River Invertebrate Prediction and Classification System SCORE (RIVPACS)	>0.80	Both mainstem and North Fork tributary met threshold
Fine Sediment Index-EPT	≥17	Both mainstem and North Fork tributary met threshold
Percentage of FSI-Sensitive Taxa	≥40%	Both mainstem and North Fork tributary met threshold
Macro-Invertebrate FSI	≥ 205	Both mainstem and North Fork tributary met threshold
Landscape-Scale Sediment Indicators		
% Equivalent Clear-Cut Area	<25%	3 sites met threshold
Stream Crossing Density (#/mi2)	<3.0	3 sites met threshold
Total Road Density (miles/mi2)	<3.0	2 of 3 sites met threshold
Sediment Source Survey	Qualitative	125 road/stream crossings

Information contained in Table 4-16 was used to answer the four key questions relating to a sediment-impairment determination.

1. *Are the fish and aquatic life beneficial uses impaired?*
   Primary biological indicators (MMI and RIVPACS) do not suggest impairment to macroinvertebrate communities. Primary sediment indicators (surface fines <6mm and <2mm) suggest possible aquatic life impairment (fish) as there were exceedences among the data, particularly for the upper reaches. Elevation of surface fines above reference and/or threshold conditions is an indicator of potential impacts to aquatic life and is cause for an impairment determination when supported by supplemental indicators of impairment.

2. *Have anthropogenic sources increased sediment erosion and/or delivery, contributing to or causing impairment?*
   Historic timber harvest in upper Seventeenmile Creek Watershed has resulted in high % ECA, stream crossing density, and total road density (table 4-15). This activity has increased sediment loading (predominantly from road/stream crossings) to streams and may be responsible for high channel surface fine values in Seventeenmile Creek.

3. ***Is there a sediment supply problem contributing to impairment (i.e., is there too much or too little sediment in the stream)?***
   Sediment Source Surveys verify fine sediment contribution at road/stream crossings and channel surface fines are elevated above reference conditions. In some instances, surface fines are elevated above aquatic impairment thresholds, indicating potential impairment to aquatic life.

4. ***Is there an indication of an in-channel sediment transport problem contributing to or causing impairment?***
   Current bankfull width-to-depth and the entrenchment ratios also do not suggest sediment transport problem contributing to or causing impairment. Pfankuch Stream Channel Stability Information collected at 20 sites over a 10 year period, Stream Channel Stability- Scouring and/or Deposition Item, and the Stream Channel Stability- Distribution and Stability of Channel Bottom Materials Items also do not indicate sediment transport problem contributing to or causing impairment.

Due to elevated surface fine values and legacy effects of historic timber harvest activities (high ECA, road crossing densities, and total road densities) in the Upper Seventeenmile watershed, Seventeenmile Creek was listed as impaired from sediment on the 2006 303(d) List. **A sediment TMDL for Seventeenmile Creek is presented in Section 6.**

4.3.2 Lap Creek

Lap Creek is a relatively small (3,500 acre watershed), generally east-flowing 3rd order tributary to the Yaak River (Figure 4-9). Lap Creek Watershed is almost entirely managed by the Forest Service. Forest harvest was significant in the upper watershed between the 1950s and early

1980s. Since harvest, GCMA designation has resulted in the closure of nearly all forest roads within Lap Creek Watershed in the early 1990s.

The cold-water fishery beneficial use was listed as impaired on the 1996 303(d) List for flow alteration and other habitat alteration. The basis for the 1996 listing was unknown. DEQ lacked sufficient credible data to include this water body on the 2002 303(d) List. As a result, reassessment sampling was completed for the Lap Creek in August 2003 and updated impairment determinations were included on the 2006 303(d) List.

Three monitoring sites were located on Lap Creek in 2003 for the Yaak TPA Process (Figure 4-9). The sampling locations included one site (28) very near a Forest Service Cumulative Effects (CE) site that had been established in 1991 (CE-21) in the middle portion of the watershed; and two additional sites above and below the CE site, sites 53 and 27, respectively.

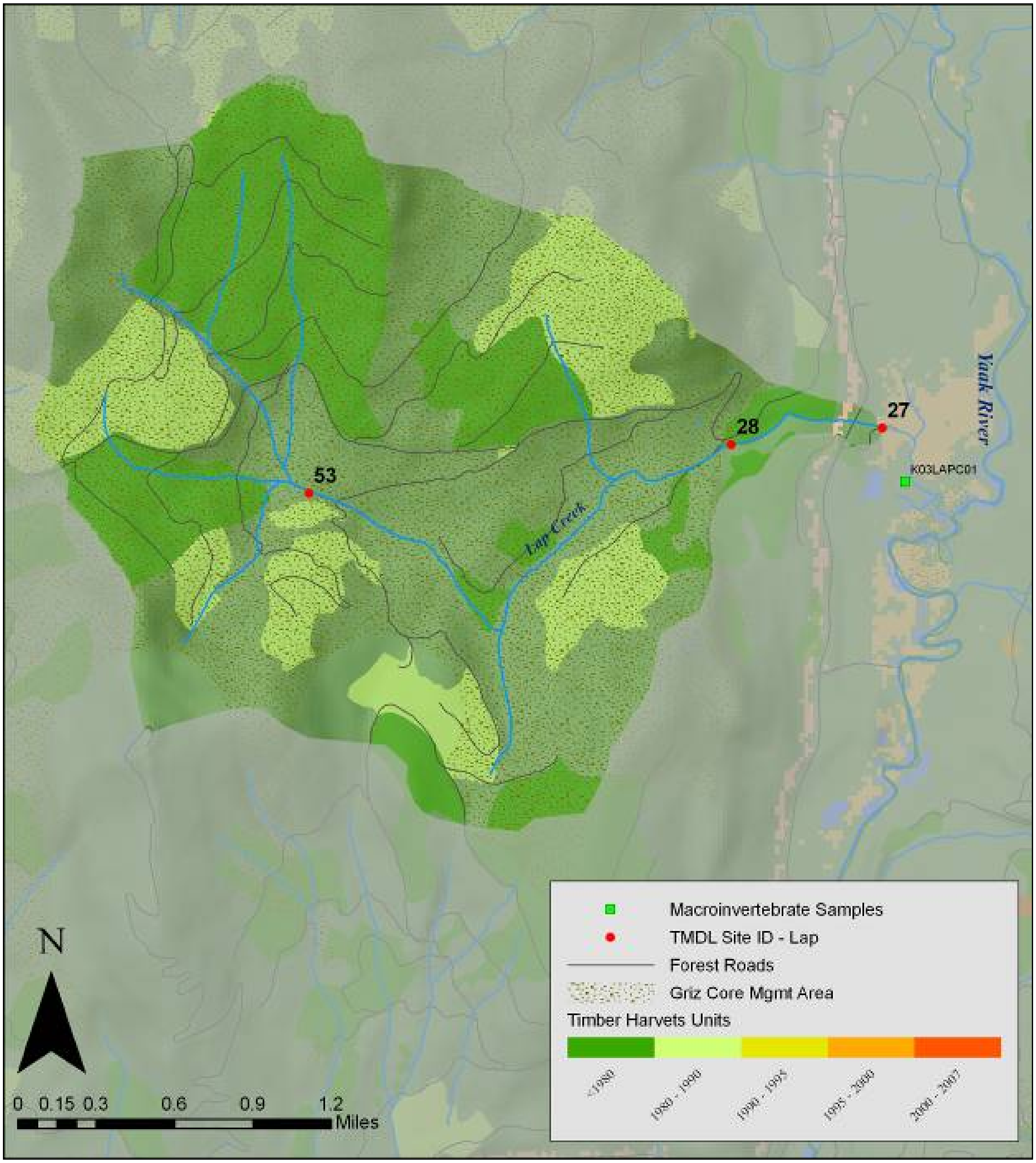

Figure 4-8. Lap Creek Watershed: 2003/2004 Sample Sites

The main channel of Lap Creek flows through a Type II valley bottom. Typical of Type II Valleys, Lap Creek is predominately a Rosgen "B" stream type. There is little evidence of channel instability caused by natural processes. Stream banks are stable and well-vegetated. Figures 4-10 through 4-12 display some of the stream and channel characteristics common to sites on Lap Creek.

Figure 4-9. Lap Creek, Lower Reach (Site 27) Looking upstream

Figure 4-10. Lap Creek, Lower Reach (Site 28) Looking downstream

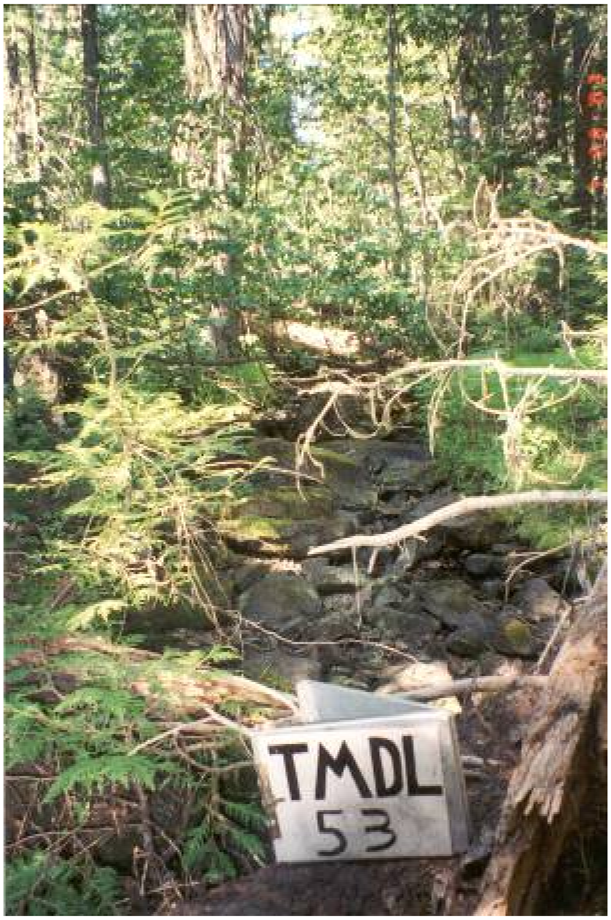

Figure 4-11. Lap Creek, Upper Reach (Site 53) Looking upstream

4.3.2.1 Lap Creek In-Stream Sediment Indicators

A review of the available data is presented here, including channel morphology information, channel substrate (Wolman pebble counts), Pfankuch Channel Stability Items, RSI, Mc Neil core samples, and potential sediment sources.

Cross-section channel morphology data was collected at three locations on the mainstem of Lap Creek in 2003 (Table 4-17). These data were analyzed to determine width-to-depth ratios and entrenchment for each sampling location and the results were compared to data from reference sites. The results for each site sampled in 2003 are presented in Table 4-17. Table 4-18 displays historical channel morphology data from the CE-site sampled in 1993 and from 3 other sites sampled in 1995. In both tables, **bolded-values** indicate delineative criteria exceedences.

Table 4-17. Lap Creek Channel Morphology Values, 2003/2004

Site ID	Site Name	Stream Type	Entrenchment	Width/Depth Ratio
53	Upper Lap Creek	B3a	1.8	**10.5**
28	Middle Lap Creek	B3a	1.6	**45.6**
27	Lower Lap Creek	B3	1.6	18.5

Table 4-18. Lap Creek Channel Morphology Values, 1993 and 1995					
Site ID	**Site Location**	**Date sampled**	**Stream Type**	**Width / depth**	**Entrench-ment**
LAP4040	Lap Creek headwaters, at elevation 4040'	6/29/1995	A3+	13.9	---
LAP3640	Lap Creek middle, below site 53, at elevation 3640'	6/29/1995	B3a	17.3	---
CE-21	Lap Creek, above site 28	8/31/1993	C4	14.1	2.3
LAP3160	Lap Creek lower-middle, below site 28, at elevation 3160'	6/28/1995	B2a	16.9	---

W/d ratio at the upper 2003 site (53) was less than the threshold range, meaning it was "deeper" than the reference values, which is not necessarily a sign of impairment. The high value at site 28, however, reveals that this parameter was well outside of the KNF reference range that was based on 54 sampled segments. Entrenchments at all three 2003-sites were all within the threshold ranges. Historic w/d ratios were all within the threshold ranges.

Channel Surface Fine Sediment Less than 2 mm and 6 mm: Channel substrate information was available for four sites on Lap Creek (Table 4-19). One site (CE-21) had data from 1993, and the remaining three sites were only sampled in 2003.

Table 4-19. Lap Creek Channel Surface Fine Sediment (% <2mm and <6mm)

Site ID	**Site Name**	**1993**		**2003**	
		<2	**<6**	**<2**	**<6**
53	Upper Lap Creek			**22**	**22**
28	Middle Lap Creek			7	7
27	Lower Lap Creek			6	8
CE-21	Lap Creek, above site 28	11	14		

In 2003, the percent surface fines exceeded the threshold value at the upper site on Lap Creek but the other two sites were well within the threshold value range. The overall steep gradient of Lap Creek (average 6.2%) moves fine sediment through the system, so deposition of fine sediment within the channel would be unexpected. The gradient at site 53, a Rosgen B3a was 5.6%, so this level of fine sediment is unusual.

Channel stability measurements were taken at three sites on Lap Creek in 2003 (Table 4-20).

Table 4-20. Lap Creek Channel Stability Ratings

Site ID	**Stream Name**	**Channel Stability**		**Scouring and Deposition**	**Stable Channel Bottom Materials**
		Threshold value	**Overall SCORE**		
53	Upper Lap Creek	≤78	**99 / Poor**	Good/Fair	Good/Fair
28	Middle Lap Creek (CE)	≤78	59 / Good	Good	Good
27	Lower Lap Creek	≤78	72 / Fair	Good	Good

Only at site 53 did the overall Channel Stability ratings fall outside the threshold value range for this parameter. Scoring of Upper and Lower-Channel bank items produced the "Poor" overall score, even though scouring and deposition, and the stable channel bottom item scores (listed), were in the good/fair category. Neither Scouring and Deposition nor Percent Stable Bottom Materials rated Poor at any of the sites.

4.3.2.2 Lap Creek Biological Indicators

During the primary data gathering period for the Yaak TPA Impairment Determination, a macroinvertebrate sample was collected at a single site on Lap Creek (K03LAPC01, just below site 27) (Figure 4-9). Tables 4-21a and 4-21b display and summarize the available macroinvertebrate information at site K03LAPC01. Bolded values indicate exceedences of threshold values (threshold values indicated in parentheses).

Table 4-21a. Lap Creek RIVPACS and MMI Results

Site Name	RIVPACS (>0.80)	MMI (≥63)
Lap Creek (K03LAPC01)	**0.786**	72.4

Table 4-21b. Lap Creek FSI Summary

Site Name	FSI- EPT (≥17)	% FSI Sensitive (>40)	FSI (≥205)
Lap Creek (K03LAPC01)	**10**	**19**	**120**

Lap Creek was outside the threshold values for all but one of the many macroinvertebrate metrics. This stream had the lowest FSI score, 120, of all streams in the Yaak TPA study. Forty-nine percent of the aquatic community was dominated by three sediment tolerant taxa which could help explain the low FSI score. Only 18% of the entire macroinvertebrate community was sediment sensitive; typically western streams have 50% or higher sediment sensitive taxa. The two most sediment sensitive groups only comprised 6.6% of the total population.

A relatively low number of macroinvertebrates were captured (227 organisms) in comparison to the average number captured (1,728 organisms) in the study area. Lap Creek is the smallest stream in the study but another small stream, Grizzly Creek, had twice the number of organisms per sample and much higher diversity than Lap Creek. While the poor metric scores and lack of sediment sensitive taxa does indicate sediment impairment in Lap Creek, the low numbers of organisms collected in this stream also may indicate other sources of disturbance and also may confound interpretation of metric results.

4.3.2.3 Lap Creek Landscape-Scale Sediment Indicators

Supplemental indicators (%ECA, road and stream crossings – variables) were calculated at each sampling location using Geographic Information System (GIS) derived data from the forest record. Table 4-22 displays the Landscape-Scale Sediment Indicators analyzed for Lap Creek, including a summation-value for the watershed basin above site 27.

Table 4-22. Landscape-Scale Sediment Indicators for Lap Creek

Site ID	**Site Name**	**% ECA Value** (<25%)	**Stream Crossing Density** (<3 crossings/mi2)	**Road Density** (<3 mi/ mi2)
53	Upper Lap Creek	**25**	**8.0**	**5.4**
28	Middle Lap Creek	22	**4.1**	**4.3**
27	Lower Lap Creek (3,483 acres)	22	**4.0**	**4.2**

Percent Equivalent Clearcut Acres: ECA values for the two lower sites met the indicator level of 25%, while the upper site slightly exceeded it. Sixty four percent of the harvest in Lap Creek took place in the 1970s and early 1980s, and the current ECA figures reflect the vegetative recovery that has taken place since that period.

Stream Crossing Density: The Upper Lap Creek stream crossing density was more than double the threshold value, and the lower two sites exceeded the threshold.

Road Density: The number of roads per square mile exceeded the indicator value of 3.0 miles/ $mile^2$ at all of the sites within Lap Creek.

Road density and stream crossings values are a result of the roads built as part of an aggressive lodge pole pine salvage program of the 1970s and 1980s. Lap Creek has among the highest road crossing densities and total road densities observed in all study streams in the Yaak TPA. Examination of the watershed scale indicators, particularly road density and stream crossings, indicate a strong potential for impaired conditions in this watershed, as no BMP or decommissioning or road decommissioning activity has yet taken place in the Lap Creek watershed.

4.3.2.4 Lap Creek Sediment Source Surveys

Sediment Source Surveys were conducted in Lap Creek by the Yaak Headwaters Partnership Group in the summer of 2006. Survey crews identified and assessed nearly all (22) road/stream crossings in the watershed. 14 of 22 of crossings were in the Upper Lap watershed (above site 53). With the exception of where Lap Creek crosses the main Yaak River road, all road/stream crossing sites were within Grizzly Bear Core Management Area and have been closed to motorized use for more than ten years. Since closure, vegetative growth on many Lap Creek roads has drastically reduced sediment contributed to streams. Survey crews identified a single non-road-related sediment source in the Lap Creek watershed, a hillslope failure that was attributed to natural conditions. Non-road – related sources are not significant sources of sediment to Lap Creek.

4.3.2.5 Lap Creek Water Quality Impairment Summary

Table 4-23 provides a summary of Primary and Supplemental Indicators used for determining impairment condition for Lap Creek.

Table 4-23. Sediment Impairment Data Evaluation - Lap Creek

Sediment Impairment Indicator	Threshold Value	Available Data or Information
In-Stream Sediment Indicators		
Width to Depth Ratio	Variable (**Table 4-2**)	5 of 7 sites evaluated met threshold values
Entrenchment	Variable (**Table 4-3**)	3 of 4 sites evaluated met threshold values
% of Surface Fines <6 mm	**<20%**	4 site/date combinations evaluated- 3 of 4 met threshold values; 2003 sample exceeded threshold values
% of Surface Fines <2 mm	**<20%**	4 site/date combinations evaluated- 3 of 4 met threshold values; 2003 sample exceeded threshold values
% of Subsurface Fines <6mm	**<28%**	No data
Pfankuch Stream Channel Stability	≥ “fair”	3 sites evaluated in 2003 2 of 3 sites evaluated met threshold
Stream Channel Stability-Scouring/Deposition	≥ “fair”	3 sites evaluated in 2003 All sites met thresholds
Stream Channel Stability- Distribution and Stability of Channel Bottom Materials	≥ “fair”	3 sites evaluated in 2003 All sites met thresholds
Biological Indicators		
MMI	**≥63**	Only site sampled met threshold.
RIVPACS	**≥0.80**	Only site sampled exceeded threshold.
Fine Sediment Index-EPT	≥17	Only site sampled exceeded threshold.
Percentage of FSI-Sensitive Taxa	≥40%	Only site sampled exceeded threshold.
FSI	≥ 205	Only site sampled exceeded threshold.
Landscape-Scale Sediment Indicators		
% Equivalent Clear-Cut Area	<25%	2 of 3 sites met thresholds
Stream Crossing Density (#/mi2)	<3.0	All three sites exceeded thresholds
Total Road Density (miles/mi2)	<3.0	All three sites exceeded thresholds
Sediment Source Survey	Qualitative	22 road/stream crossing sites

Information contained in Table 4-23 was used to answer the four key questions relating to a sediment-impairment determination.

1. ***Are the fish/aquatic life beneficial uses impaired?***
   Lap Creek was outside the threshold values for multiple macroinvertebrate metrics and had the lowest FSI score, 120, of all streams in the Yaak TPA study. However, low taxa counts and /or multiple stressors may limit interpretation of biometrics. Exceedences of surface fine thresholds at upper Lap Creek site 53 also indicate possible impacts to fish and associated aquatic life.

2. ***Have anthropogenic sources increased sediment erosion and/or delivery, contributing to or causing impairment?***
   Percent equivalent clear-cut area of the watershed, stream crossing density (#/mi2), and the total road density (miles/mi^2) information evaluated in the Lap Creek watershed suggests a strong potential for impaired conditions in this watershed. Road and stream crossing densities are high at all sites, in all cases well above the threshold values. It

appears that historic forest management has caused conditions that have led to impacts within the watershed, possibly contributing to impairment (see item 1).

3. ***Is there a sediment supply problem contributing to impairment (i.e., is there too much or too little sediment in the stream)?***
Surface fines <6 mm and <2 mm and the bankfull width-to-depth ratio information are not definitive in supporting an impairment call. However, there were some exceedences among the data, particularly the high sediment values (22%) at the upper site. Field notes indicate that the channel goes dry at the middle site (28) as a result of bedload sediment filling the channel, forcing the water to go sub-surface. At the lower site (27), dense riparian vegetation keeps the stream width from increasing, but bedload deposition is evident throughout the reach. Channel-gradient begins to drop here (3.2% vs. 5.4% and 9.3% upstream) and the channel has filled with bedload. The small number of pools compared to reference B stream types (4.2 vs. 21.8) indicates that the deposition is filling pools and altering habitat conditions. It appears there is a sediment supply problem contributing to impairment.

4. ***Is there an indication of an in-channel sediment transport problem contributing to or causing impairment?***
The data and the field-information strongly suggest that channel incision has occurred at the upper site, and extreme channel widening has occurred at the middle site. It appears that little recovery has taken place, as gravel bars throughout the channel are both abundant and un-vegetated with few pools. It appears that pools have been filled in by the migration of the bedload sediment. Levels of fine sediment do not necessarily reflect impairment, but the steep gradient of the stream throughout the watershed generally precludes deposition of fines in these channels. Information relating to bedload sediment quantities and locations within the basin suggest a sediment transport concern: it appears that Lap Creek has a sediment transport problem that is contributing to an impaired condition.

In summary, it appears that the historical activities within the basin have left a legacy of sediment that is still affecting beneficial uses. Channel morphology and condition has been altered throughout the length of the channel. Although the B stream type is present at all 2003-sites, channel erosion has led to incision at the upper site, widening at the middle site, and pool filling at the lower site. Macro invertebrate information strongly suggests impairment of aquatic uses, and bedload sediment information identifies sediment transport concerns. Sediment Source Surveys identified very few non-natural instream sediment sources, but identified over 22 crossings that were contributing sediment to some degree. **Based on this information, Lap Creek was listed as impaired from sediment on the 2006 303(d) List. A sediment TMDL for Lap Creek is presented in Section 6.**

4.3.3 South Fork Yaak River

The South Fork Yaak River (40,130 acre watershed) is a fourth order stream that originates in the eastern portion of the Yaak watershed, flowing north until it joins the mainstem Yaak River near the town of Yaak (Figure 4-13). Major tributaries to the South Fork Yaak include Beaver

Creek (6,751 acre watershed), Fowler Creek (6,330 acre watershed), Dutch Creek (7,400 acres), and Zulu Creek (3,400 acres).

Land ownership in the watershed consists of private (1%) and Forest Service (99%) ownership. The upper basin is an old glacial lakebed, and bank materials are silt and sand. Channel types in the upper most watershed alternate between Rosgen B, E and F. Most of the basin is forested, although there are non-forested riparian sections of shrub-meadow. Eight percent of the watershed was burned by wildfire in 1994, primarily in the Zulu and Fowler tributaries. Sixteen percent was burned by wildfire in 2000 primarily in Kelsey, Can, Fowler and Beaver Creek tributaries.

Forest harvest has been conducted periodically in the South Fork Yaak River Watershed (Figure 4-13), with the most recent salvage and harvest activity occurring in the Kelsey and Fowler Creek drainages. GCMA designation has resulted in the closure of forest roads within GCMA in the South Fork Yaak River watershed. Roads within GCMA have been closed for at least ten years (more in some areas). Considerable BMP activity and road decommissioning work has recently been accomplished in the South Fork Yaak River watershed.

The cold-water fishery beneficial use was listed as impaired on the 1996 303(d) List for flow alteration, other habitat alteration, siltation, and suspended solids. The basis for the 1996 listing was unknown. DEQ lacked sufficient credible data to include this water body on the 2000 303(d) List. As a result, reassessment sampling was completed for the South Fork Yaak River in August 2003 and updated impairment determinations were included on the 2006 303(d) List.

Data was collected at four sampling locations on the South Fork Yaak in 2003 (Figure 4-13): South Fork River below Smoot Creek, site 50; South Fork River below Zulu Creek, site 68; South Fork River below Fowler Creek, site 18; and the South Fork River below Beaver Creek, site 16. Sites were also established on Smoot, Zulu, Clay, Fowler and Beaver Creeks. One of the sites, #16, South Fork below Beaver, had been sampled from 1991-1995 by the Forest Service as a Cumulative Effects Analysis Station (CE-11). Data from another FS site sampled in 1992 was also used in the analysis.

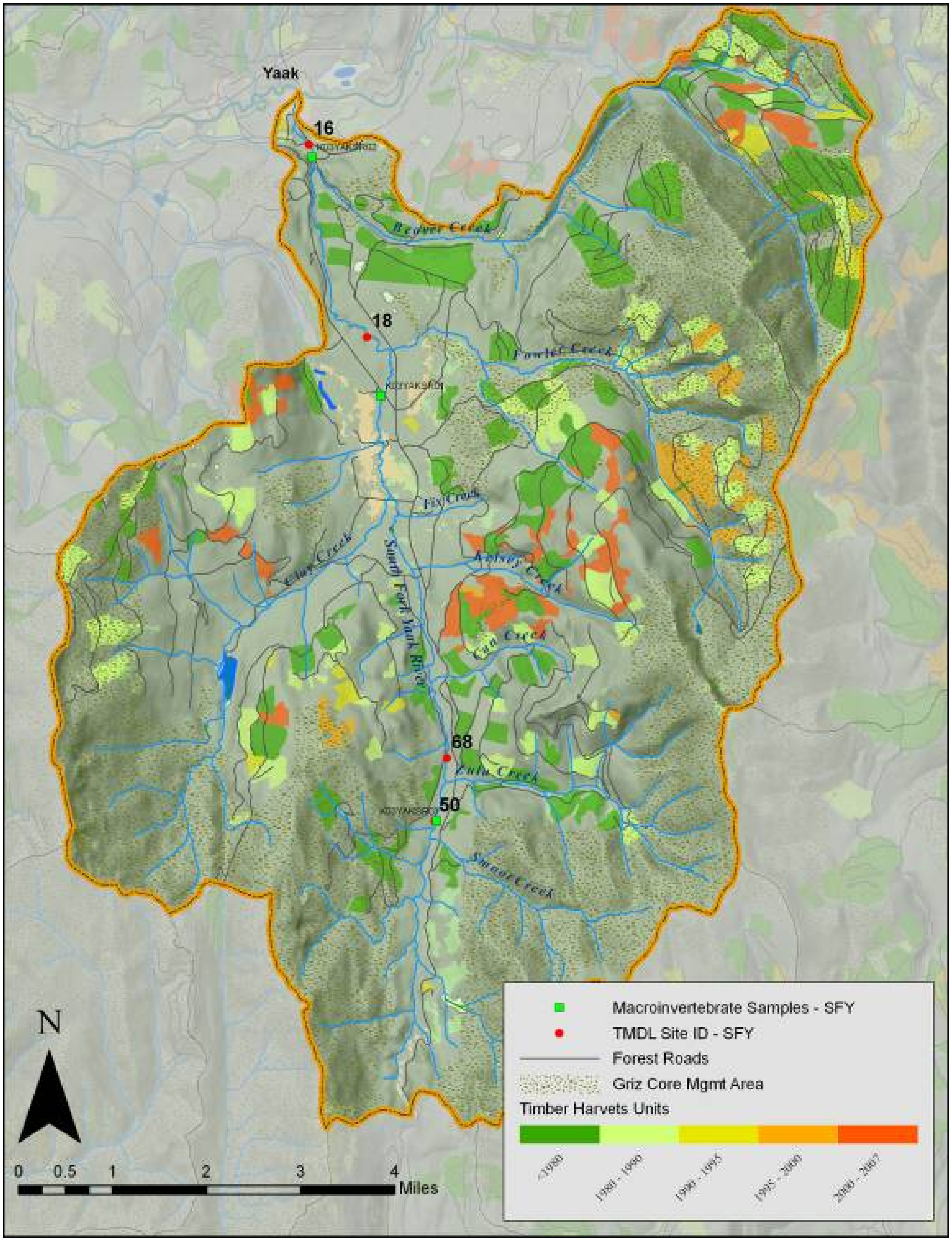

Figure 4-12. South Fork Yaak River watershed: 2003/2004 sample sites

The main channel of the South Fork Yaak flows through a Type II valley bottom. Typical of Type II valleys, the South Fork Yaak channel is predominately a Rosgen "B" stream type with C inclusions. Figures 4-14 through 4-17 display channel conditions at the four sites established and evaluated on the South Fork Yaak River in 2003.

Figure 4-13. South Fork Yaak River below Smoot Creek, site 50

Figure 4-14. South Fork Yaak River below Zulu Creek, site 68

Figure 4-15. South Fork Yaak River below Fowler Creek, site 18

Figure 4-16. South Fork Yaak River below Beaver Creek, site 16

4.3.3.1 South Fork Yaak River In-Stream Sediment Indicators

A review of the available data is presented here, including channel morphology information, channel substrate (Wolman pebble counts), Pfankuch Channel Stability Items, RSI, Mc Neil core samples, and potential sediment sources.

Cross-section channel morphology data was collected at four sites on the South Fork Yaak River in 2003. The same information was also available for the two historic sites. These data were analyzed to determine width-to-depth ratios and entrenchment for each sampling location and the results were compared to reference data. The results for each site are presented in Table 4-24. Bolded values indicate exceedences of threshold values.

Table 4-24. South Fork Yaak River Channel Morphology Values, 2003

Site ID	Site Name	Stream Type	Entrenchment	Width/Depth Ratio
50	South Fork Yaak below Smoot	F4	1.2	21.9
68	South Fork Yaak below Zulu	F4b	1.2	14.8
18	South Fork Yaak below Fowler	B4c	1.7	14.7
16	South Fork Yaak below Beaver	B3c	1.7	19.2
Yaak SF-CE11	South Fork Yaak below Beaver (near site 16)	B3	1.6	24.1

Width-to-depth ratios for all five sites meet the threshold range; five meet the entrenchment thresholds. Channel morphology for all sites on the mainstem South Fork Yaak River seem to be stable and reflect the continuing maintenance of the stream type, given the geology, slope, etc., which should exist at the given sites.

Channel Surface Fine Sediment Less than 2 mm and 6 mm: Channel substrate information was collected using Wolman pebble count data at four sampling sites on the South Fork Yaak River in 2003 (Table 4-25). Pebble count information from the other two Forest Service sites, one of which had data for five years, is also displayed and analyzed.

Table 4-25. South Fork Yaak Channel Surface Fine Sediment (% <2mm and % <6mm)

Site ID	Site Name	1991		1992		1993		1994		1995		2000		2003	
		<2	<6	<2	<6	<2	<6	<2	<6	<2	<6	<2	<6	<2	<6
50	SF Yaak													**42**	**42**
68	SF Yaak													16	17
SF-01	SF Yaak			11	13										
18	SF Yaak													**31**	**32**
16	SF Yaak													6	7
SF- CE11	SF Yaak (~site 16)	9	15	4	6	6	10			14	**20**				

In 2003, two of the four sampling sites (site 50, South Fork Yaak below Smoot Creek and South Fork Yaak below Fowler (18)) were well above the 20% threshold, indicating a fine sediment problem.

Site 50 below Smoot Creek is located immediately adjacent to a harvest unit that had riparian harvest, and this is likely the source of the fine sediment. Field notes also describe mid-channel bars and many root wads and downed trees along the stream banks. The gradient of this reach is fairly flat (1.1% gradient), so much of the material remains in this portion of the channel. Field surveys to identify sediment sources in 2004 identified a road crossing above site 50 that was producing substantial sediment.

Site 68 below Zulu has a gradient of over 5%, so it is unlikely that fine sediment would be deposited there. Given the gradient, the amount of surface fines <2% at that location (16%) is a fairly high percentage. Although not over the threshold level of 20%, it is significantly elevated above reference conditions.

Site 18 is immediately below Fowler Creek, which had a recorded value of 48% <2mm in 2003. Natural glacial deposits in this area contribute fine material to the substrate in some areas and may be responsible for higher fines throughout this reach.

McNeil core data were collected in the early to mid-1990s at the CE-site near site 16 (below Beaver Creek). While not the same as surface fines, these do represent the amount of subsurface fines, another measure of instream sediment concentrations. Between 1991 and 1995, subsurface fines fluctuated between 35% and 15% with an average of 25%, slightly below the reference criteria of 28%.

The very high levels of fines at two of the four sites, plus the Fowler Creek fine-sediment value suggests possible sediment impacts to the South Fork Yaak.

Stream Channel Stability measurements were collected at four sampling locations in 2003, and data was available from one of the older sites for 1992 (Table 4-26).

Table 4-26. South Fork Yaak Stream Channel Stability Ratings

Site ID	Stream Name	Channel Stability		Scouring And Deposition	Stable Channel Bottom Materials
		Threshold value	Overall SCORE		
50	SF Yaak	<125	94 / Good	Fair	Fair
68	SF Yaak	<125	59 / Good	Good	Good
SF-01	SF Yaak	<78	65/Fair	----	-----
18	SF Yaak	<84	56 / Good	Good	Good
16	SF Yaak	<78	52 / Good	Good	Good

The channel stability data document that overall channel stability, scouring and deposition, and percent stable bottom materials were within thresholds at all sites for all sampling times.

4.3.3.2 South Fork Yaak River Biological Indicators

Macroinvertebrate samples were collected at three sites on the South Fork Yaak in 2003: South Fork Yaak River below Smoot (K03YAKSR03, near site 50), South Fork Yaak mid-section near site 18, between Fix and Fowler Creeks (K03YAKSR01), and the South Fork Yaak below Beaver Creek near site 16 (K03YAKSR02) (Figure 4-13). The data is display and summarized in Tables 4-27a and 4-27b. A major tributary to the South Fork Yaak, Beaver Creek was also sampled, but is not displayed in this table. Bolded values indicate exceedences of threshold values (threshold values indicated in parentheses).

Table 4-27a. South Fork Yaak River RIVPACS and MMI Results

Site Name	RIVPACS (>0.80)	MMI (≥63)
Upper South Fork Yaak River (K03YAKSR03) 50	0.92	76.2
Middle South Fork Yaak River (K03YAKSR01) 18	1.01	66.4
Lower South Fork Yaak River (K03YAKSR02) 16	1.03	67.1

Table 4-27b. South Fork Yaak River FSI Summary

Site Name	FSI- EPT (>17)	% FSI Sensitive (>40)	FSI (>205)
Upper South Fork Yaak River (K03YAKSR03)	12	87	155
Middle South Fork Yaak River (K03YAKSR01)	11	37	155
Lower South Fork Yaak River (K03YAKSR02)	10	10	150

All three South Fork Yaak mainstem sections met primary biological indicator thresholds (RIVPACS and MMI), but scored below thresholds for most supplemental indicators. There were however, differences among the segments with some more impaired than others.

Upper South Fork Yaak River (K03YAKSR03)
South Fork Yaak below Smoot appears to be the least impaired of the group as it has a large percentage of sediment sensitive taxa (87%). However, the FSI and FSI-EPT are below the 50th percentile for streams in this ecoregion. Overall taxa richness and abundance are very low which could explain differences in the bioassessment metrics. This section has a taxa richness of 26 which is the lowest of all streams in the study. Fifty-two percent of the community is dominated

by three organisms, but all of these are somewhat sediment sensitive. Four taxa are very sediment sensitive and three of these have over 10 individuals present in the sample. Because this is the uppermost site in the watershed it is probable that the low sediment scores are a reflection of the very low taxa richness collected at this site.

Middle South Fork Yaak River (K03YAKSR01)
While this site met RIVPACS and MMI indicator thresholds, the FSI and FSI-EPT are below the 50th percentile for streams in this ecoregion. Only 37% of the community is sediment sensitive which is a decline from the upper Yaak site of 87% sediment sensitive. Taxa richness was below average for streams in this study but not as low as the upper South Fork Yaak section. Fifty-nine percent of the community is dominated by three organisms. One of these is somewhat sediment sensitive. This is the highest percent dominance for the streams in this study. There are 6 very sediment sensitive taxa and two of these, Claassenia sabulosa and Hesperoperla pacifica are semivoltine requiring more than one year for their life cycle.

Lower South Fork Yaak River (K03YAKSR02)
The lower South Fork Yaak met RIVPACS and MMI indicator thresholds, yet scored the lowest in all FSI metrics, indicating potential impairment most likely by sediment and other stressors such as organic enrichment and warmer water temperatures. The Hilsenhoff Index of Biological Integrity (HIBI) score, an indicator of nutrient enrichment, was the second highest when compared to all streams in this study and nearly double that of any of the other South Fork segments. The FSI score was below the 50th percentile for streams in this ecoregion and the FSI-EPT score was one taxon away from being below the 25th percentile for streams in this ecoregion. Only 10% of the community was sediment sensitive which is the lowest percent of any stream in the study. Fifty-three percent of the community is dominated by three organisms none of which are sediment sensitive, all belonging to the Chironomidae family. There appears to be a cumulative watershed effect of stressors with the lowest segment impacted by multiple stressors including fine sediment.

4.3.3.3 South Fork Yaak River Landscape-Scale Sediment Indicators

Supplemental indicators (%ECA, road and stream crossings – variables) were calculated at each sampling location using GIS derived data from the forest record. Table 4-28 displays the Landscape-Scale Sediment Indicators analyzed for South Fork Yaak River.

Table 4-28. Landscape-Scale Sediment Indicators for South Fork Yaak River

Site ID	**Stream Name**	**% ECA Value** (<25%)	**Stream Crossing Density** (<3 crossings/mi2)	**Road Density** (<3 mi/ mi2)
50	South Fork Yaak	2	1.3	0.8
68	South Fork Yaak	6	1.9	1.3
18	South Fork Yaak	23	2.1	2.0
16	South Fork Yaak (40,133 acres)	20	2.0	2.6

Percent Equivalent Clearcut Acres: ECA values for all sites met the indicator level of 25%, reflecting recovery that has occurred since timber harvest in the 1970s.

Stream Crossing Density: Stream crossing density did not exceed the indicator value in any of the basins above the sample points.

Road Density: Road densities did not exceed the indicator value in any of the basins above the sample points.

Road density and stream crossings values are a result of the roads built for timber harvest in the 1970s. ECAs, while approaching threshold levels in the lower watershed, are lower than historic levels and reflect recovery that has occurred. High substrate fines may indicate existing and legacy effects of roads and past harvest activity.

4.3.3.4 South Fork Yaak River Sediment Source Surveys

Sediment Source Surveys were conducted in the South Fork Yaak River watershed by the YHRP in the summer of 2004. Survey crews identified and assessed nearly all (118) road/stream crossings in the watershed. Thirty percent of all road/stream crossing sites were within GCMA and will be closed to motorized use for at least ten years. Survey crews also identified several sediment sources related to natural hillslope failure of glacial deposits and bank slumping and sloughing that was attributed to natural conditions. Anthropogenic non-road-related sediment sources identified by the YHRP do not appear to be significant sources of sediment to the South Fork Yaak River.

4.3.3.5 South Fork Yaak River Water Quality Impairment Summary

Table 4-29 provides a summary of Primary and Supplemental Indicators used for determining impairment condition for South Fork Yaak River.

Table 4-29. Sediment Impairment Data Evaluation – South Fork Yaak River

Sediment Impairment Indicator	Threshold Value	Available Data or Information
In-Stream Sediment Indicators		
Width to Depth Ratio	Variable (**Table 4-2**)	All six sites evaluated met thresholds
Entrenchment	Variable (**Table 4-3**)	Five of six sites met thresholds, only 1992 sample-site slightly exceeded
% of Surface Fines <6 mm	**<20%**	Two of four 2003 sites exceed thresholds
% of Surface Fines <2 mm	**<20%**	Two of four 2003 sites exceed thresholds
% of Subsurface Fines <6mm	**<28%**	
Pfankuch Stream Channel Stability	≥ "fair"	All five sites evaluated met thresholds
Stream Channel Stability- Scouring/Deposition	≥ "fair"	Four sites evaluated met thresholds
Stream Channel Stability- Distribution and Stability of Channel Bottom Materials	≥ "fair"	Four sites evaluated met thresholds
Biological Indicators		
MMI	**≥63**	All three sites met thresholds
RIVPACS	**≥0.80**	All three sites met thresholds
Fine Sediment Index-EPT	≥17	All three sites exceeded thresholds
Percentage of FSI-Sensitive Taxa	≥40%	All three sites exceeded thresholds
FSI	≧ 205	All three sites exceeded thresholds
Landscape-Scale Sediment Indicators		
% Equivalent Clear-Cut Area	<25%	Basins above all sites met thresholds
Stream Crossing Density (#/mi2)	<3.0	Basins above all sites met thresholds

Table 4-29. Sediment Impairment Data Evaluation – South Fork Yaak River

Sediment Impairment Indicator	Threshold Value	Available Data or Information
Total Road Density (miles/mi2)	<3.0	Basins above all sites met thresholds
Sediment Source Survey	Qualitative	118 road/stream crossing sites

Information contained in Table 4-29 was used to answer the four key questions relating to a sediment-impairment determination.

1. ***Are the fish/aquatic life beneficial uses impaired?***
   All three South Fork Yaak mainstem sections met primary biological indicators (RIVPACS, MMI) but exceeded FSI thresholds. The Lower South Fork Yaak below Beaver (near site 16) may also be impacted by nutrient enrichment or other reach-scale stressors, as evidenced in high HIBI score (4.01) and elevated RIVPACS score (1.03).

   The percentage of surface fines <6mm and <2mm was well above the thresholds at two of the four sites on the South Fork Yaak mainstem channel (sites 50 and 18). Site 18 is immediately below Fowler Creek, which had a recorded value of 48% <2mm in 2003. At 17% fine sediment, the site below Zulu Creek (site 68) meets threshold levels, but the gradient at this site is over 5%, making it unlikely that deposition of fines would occur. Only at the lowest reach, at site 16, below the Beaver Creek confluence is the channel surface fines in a low range. It would appear that most of the South Fork has a fine sediment problem.

2. ***Have anthropogenic sources increased sediment erosion and/or delivery, contributing to or causing impairment?***
   None of the landscape-scale sediment indicators exceeded thresholds for the mainstem South Fork Yaak River, however sediment delivery at crossings has been documented by the YHRP sediment surveys and may be significant enough to result in an aquatic response. The watershed response variables bankfull width-to-depth and the entrenchment ratios are predominantly within thresholds.

   South Fork site 50 below Smoot, that had the highest fine-sediment value (42% <2mm), is located immediately adjacent to a harvest unit that had riparian harvest. Field notes describe unstable banks where root wads have washed out or blown over as a result of the adjacent trees being harvested. This is the probable source of the excessive fine sediment. Field notes also describe mid-channel bars and many root wads and downed trees along the stream banks. The gradient of this reach is fairly flat (1.1% gradient), so much of the material remains in this portion of the channel. From this information it appears that forest management and historic timber harvest are at least contributing to an apparent impairment.

3. ***Is there a sediment supply problem contributing to impairment (i.e., is there too much or too little sediment in the stream)?***
   The percentage of surface fines <6mm and <2mm was well above the thresholds at sites 50 and 18 on the South Fork Yaak mainstem, with Fowler Creek potentially providing fine sediment to the South Fork site 18. The site below Zulu Creek (site 68) was within the threshold at 17%, but above reference conditions. The gradient at site 68 would

normally preclude this level of fine sediment. Only at the lowest reach, at site 16, below the Beaver Creek confluence is the channel surface fines in a low range. Even though the channel morphology variables evaluated in 2003 were within expected thresholds, surface fine sediment provides supporting evidence for an apparent sediment supply problem.

4. ***Is there an indication of an in-channel sediment transport problem contributing to or causing impairment?***
   As detailed in items 2 and 3 above, channel morphology information in itself does not suggest a sediment transport problem. The Pfankuch Stream Channel Stability Information, Stream Channel Stability – Scouring and/or Deposition Item, and the Stream Channel Stability- Distribution and Stability of Channel Bottom Materials Items also do not indicate sediment transport problems.

In summary, it appears that the historical activities within the basin have left a legacy of sediment that is still affecting beneficial uses. High channel surface fines at several locations and evidence of impacted biological communities provide evidence of impairment. Sediment Source Surveys identified very few non-natural instream sediment sources, but identified over 100 crossings that were contributing sediment to some degree. **Based on this information, the South Fork Yaak River was listed as impaired from sediment on the 2006 303(d) List. A sediment TMDL for the South Fork Yaak River is presented in Section 6.**

SECTION 5.0
YAAK TPA SEDIMENT SOURCE CHARACTERIZATION AND ASSESSMENT

As identified on Montana's *2006 Integrated 305(b)/303(d) Water Quality Report* and summarized in Section 4.0, water bodies requiring sediment TMDLs include Seventeenmile Creek, Lap Creek, and South Fork Yaak River. Section 5.0 provides a description of natural and anthropogenic sediment sources within the Yaak TPA, explains assessment methods employed, and estimates numeric loads for all significant sediment source categories in Seventeenmile Creek, Lap Creek, and South Fork Yaak River.

5.1 Sediment Source Assessment and Load Estimates Summary

5.1.1 Natural Sources

Natural sources of sediment assessed in the Yaak TPA include those derived from bank erosion, mass wasting/hillslope failure, and natural upland erosion.

Sediment loads from natural sources were assessed using a variety of methods. WATSED modeling conducted by the KNF on South Fork Yaak River and Quartz Creek was used to provide estimates of natural background sediment loading for impaired water bodies, Seventeenmile Creek, Lap Creek, and South Fork Yaak River. Qualitative field reconnaissance (field photos and notes) data and observations by USFS, U.S. EPA, and Montana DEQ personnel were used in evaluating natural sediment loading conditions, and Field Sediment Source Surveys conducted by personnel under direction of the YHRP were used to further verify conditions and qualitative assessments.

Seventeenmile Creek, Lap Creek, and South Fork Yaak River and their tributaries were assessed for sediment sources in 2004, 2005, and 2006, respectively. All streams and tributaries were surveyed for sediment sources by walking streams from mouth to headwaters. In addition to stream crossing assessments, survey crews noted and surveyed all potentially significant near-stream sediment sources (bank erosion, hillslope failure/mass wasting) encountered. Detailed field notes provide descriptions, drawings, and measurements (where appropriate) of all sediment sources observed (see example field sheets in Appendix A).

5.1.2 Anthropogenic Sources

Anthropogenic sources of sediment assessed in the Yaak TPA include those derived from the following.

- Bank erosion
- Mass wasting/hillslope failure
- Upland erosion from management activities (timber harvest)
- Forest roads (stream crossings, parallel road segments, culvert failure)

Sediment loading derived from forest roads was estimated using the WEPP:Road model. Appendix B provides road sediment methods and results using WEPP. In addition to estimates of sediment loads from road crossings and road networks, sediment load at risk due to culvert failure at crossings was also evaluated.

Field Sediment Source Surveys and follow-up field reconnaissance visits by DEQ, EPA, and USFS were the predominant data sources used to assess not only the degree and extent of sediment loading from bank erosion but also mass wasting/hillslope failure. Field Sediment Source Surveys were conducted on Seventeenmile Creek, Lap Creek, and South Fork Yaak River and their tributaries in 2004, 2005, and 2006 respectively. All streams and tributaries were surveyed for sediment sources by walking streams from mouth to headwaters. In addition to stream crossing assessments, survey crews noted and surveyed all potentially significant near-stream sediment sources (bank erosion, hillslope failure/mass wasting) encountered. Detailed field notes provide descriptions, drawings, and measurements (where appropriate) of all sediment sources observed (see example field sheets in Appendix A).

While upland sediment sources were not specifically assessed through Field Sediment Source Surveys, delivery of sediment to streams from upland sources (skid trails, etc.) was noted where encountered and provides evidence of the significance of upland sediment inputs to streams. Additional information regarding age and distribution of timber harvest units, vegetative recovery rates, and present ECA was used to supplement upland sediment assessments.

5.1.3 Source Assessment Summary

A sediment loading summary for Seventeenmile Creek, Lap Creek, and South Fork Yaak River Watersheds is given in Table 5-1. Sediment derived from forest roads is the predominant anthropogenic sediment source throughout these watersheds. Sediment loads from upland erosion of forest soils, bank erosion, and mass wasting appear to be within naturally occurring levels and do not contribute significantly to anthropogenic sediment-related impairments. Section 5.2 below provides details regarding the source assessments and loading estimates given below in Table 5-1.

Table 5-1. Annual Sediment Loading Summary: Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds

Watershed	Natural Sediment Loads	Anthropogenic Sediment Loads	
	Upland Erosion Bank Erosion Mass Wasting	Stream Crossings (tons/yr)	Parallel Road Segments
Seventeenmile Creek	443	23.7	Not significant
Lap Creek	62	2.4	Not significant
South Fork Yaak River	445	21.3	Not significant

5.2 Sediment Source Assessment and Loading Estimates

The following section provides specific sediment loading assessment results for sediment-impaired water bodies, Seventeenmile Creek, Lap Creek, and South Fork Yaak River. Section 5.2 provides a description of natural and anthropogenic sediment sources for each impaired stream and their relative contribution to sediment impairment conditions.

5.2.1 Sediment Sources

Potentially significant sediment sources assessed in the Seventeenmile Creek watershed include:

- Bank erosion
- Mass wasting/hillslope failure
- Upland erosion
- Forest roads

5.2.1.1 Bank Erosion

Bank erosion refers to actively eroding stream banks and, for the purposes of this assessment, includes stream banks formed by bankfull processes as well as actively eroding hillslopes adjacent to streams. Bank erosion typically results in a variety of sediment size fractions delivered to the stream, which contribute to both suspended sediment load and bedload.

Field reconnaissance and cursory aerial photography review of Seventeenmile Creek, Lap Creek, and South Fork Yaak River conducted by EPA, USFS, and DEQ shows that, in general, riparian areas are well vegetated and functioning properly. Field Sediment Source Surveys document the preponderance of beaver dams, heavy vegetation, undercut banks, and large woody debris, good indicators of habitat complexity and functioning riparian conditions throughout Seventeenmile Creek, Lap Creek, and South Fork Yaak River Watershed. Lands within the Yaak TPA are predominantly managed as forest. However some livestock grazing does occur in the flatter lowlands of South Fork Yaak. With the exception of those impacts associated with forest roads, legacy effects to water quality from historic harvest activity were not evident.

Data on the extent and degree of bank erosion in the Yaak TPA was collected by the YHRP in the summers of 2004, 2005, and 2006. The entire lengths of Seventeenmile Creek, South Fork Yaak, and Lap Creek were surveyed for sediment inputs (bank erosion, hillslope failure, and mass wasting). In addition to mainstem segments, all tributaries that included road crossings were surveyed from the mouth upstream to the furthest road crossing. Tributaries without road crossings (North Fork Seventeenmile Creek, most of Flattail Creek, etc) were not surveyed.

Observations of bank erosion and hillslope erosion in Seventeenmile Creek, Lap Creek, and South Fork Yaak River were limited, and most occurrences appeared to be due to natural conditions. Of all the stream and tributary miles surveyed in the Seventeenmile Creek watershed (Figure 5-1), seven bank/hillslope erosion sites were recorded. Field notes at these locations indicate that these conditions are predominantly natural, resulting from sloughing of steep banks into the stream channel and undercutting of stream banks, natural conditions observed and verified in the field by DEQ and USFS personnel at several sites. The South Fork Yaak River

Watershed (Figure 5-2) contained six bank/hillslope erosion sites, four of which could be attributable to natural causes and two of unverified causes. Lap Creek contained no observed significant bank or hillslope erosion sites.

Bank erosion encountered in Seventeenmile Creek, Lap Creek, and South Fork Yaak River appears be naturally occurring. Figures 5-3 through 5-6 represent typical bank and hillslope erosion conditions identified in Field Sediment Source Surveys and found throughout these watersheds. Given the extensive coverage of Field Sediment Source Surveys and the relatively small number of bank and hillslope erosion sites encountered, it is concluded that erosion on streams and tributaries does not appear to be significantly elevated above naturally occurring levels. WATSED modeling estimates given below in Section 5.2.1.3 accommodate for a variety of hillslope erosion processes identified through Field Sediment Source Surveys, as the WATSED model estimates *"natural sediment yields"* from forested landscapes.

> *"Natural sediment yields of undisturbed watershed systems are derived primarily from streambank erosion of material supplied by creep and mass erosion processes inherent in the system…"* (USFS, 1981)

For this reason, it is assumed that the natural sediment load derived from hillslope and bank erosion observed in Seventeenmile Creek, Lap Creek,13.26*.06 and South Fork Yaak River is incorporated within the upland erosion estimates provide by the WATSED modeling results, and a specific sediment load estimate from bank erosion is not calculated.

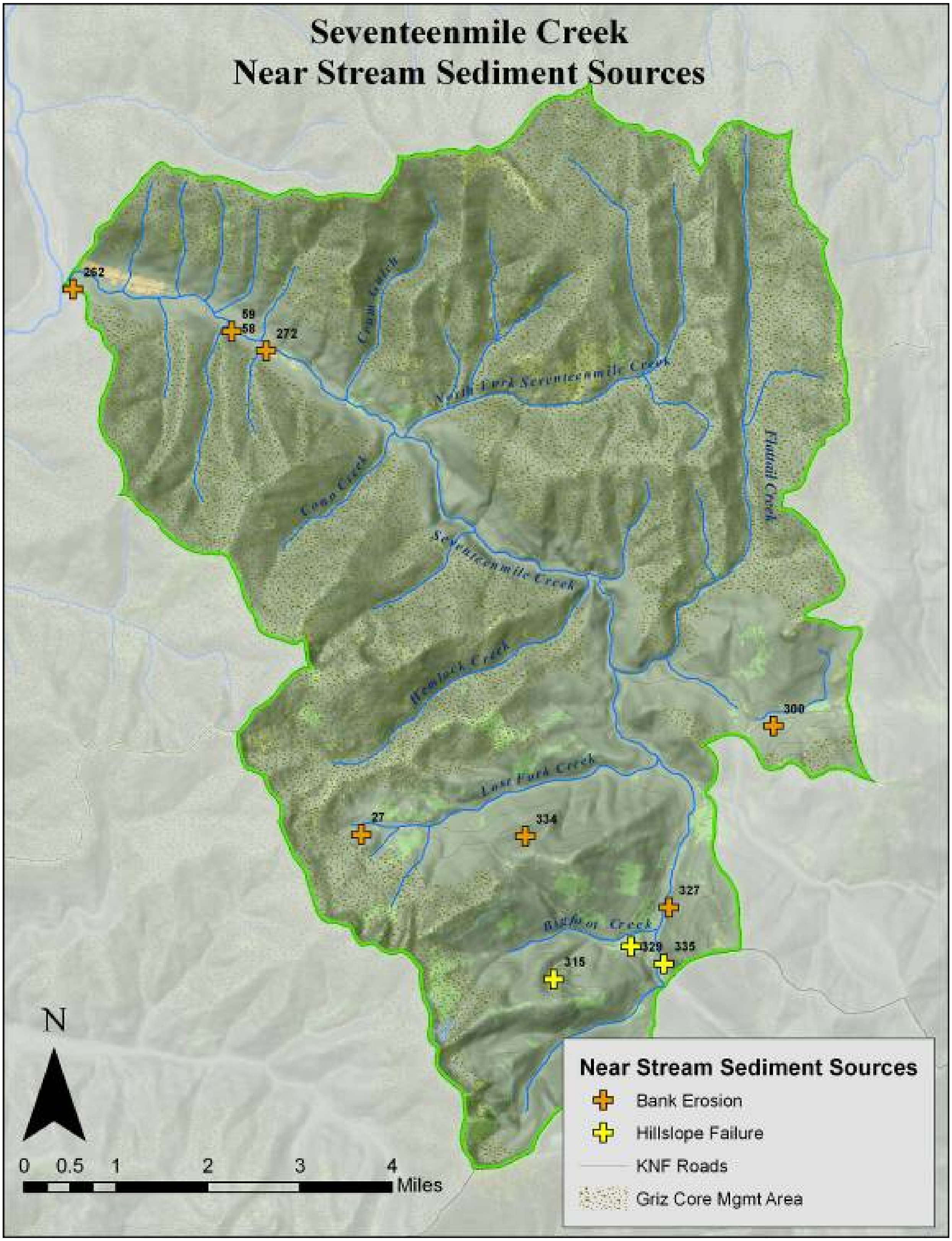

Figure 5-1. Seventeenmile Creek - Bank Erosion and Hillslope Failure Sites

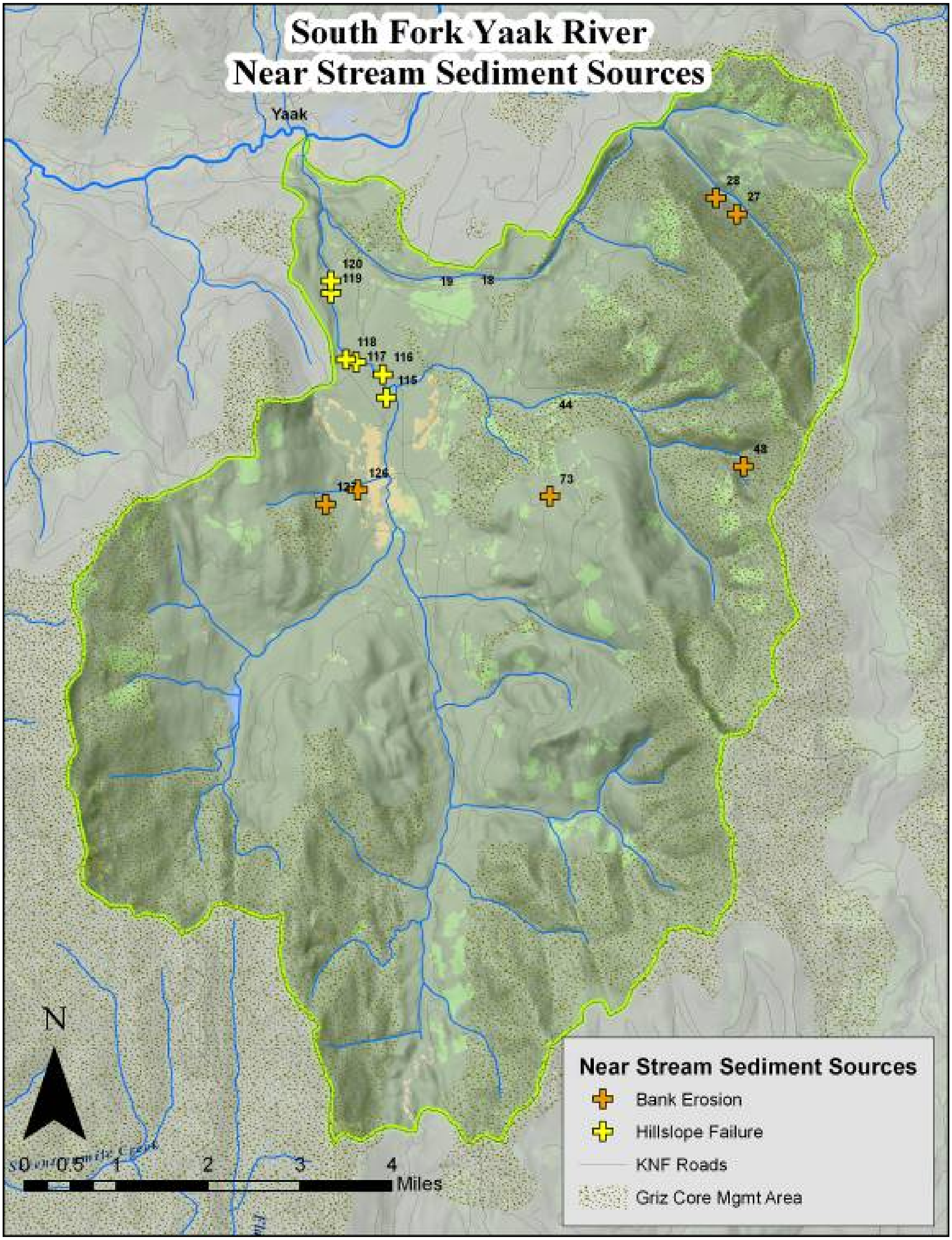

Figure 5-2. South Fork Yaak River - Bank Erosion and Hillslope Failure Sites

Figure 5-3. Natural Bank Erosion

Figure 5-4. Natural Bank Erosion

5.2.1.2 Mass Wasting /Hillslope Failure

Mass wasting and hillslope failure are used synonymously in this document and refer to bulk failure of adjacent streamside hillslopes. Mass wasting and hillslope failure typically result in a variety of sediment size fractions delivered to the stream. This contributes to both suspended sediment load and bedload.

Observations of hillslope failure/mass wasting were included in the YHRP Field Sediment Source Surveys. Locations of observed hillslope failure/mass wasting sites for Seventeenmile Creek and South Fork Yaak River are shown in Figures 5-1 and 5-2. Three hillslope failure sites within the Seventeenmile Creek watershed were identified. Two of those (315 and 329) were associated with steep unstable stream banks that are slumping into the creek, natural conditions throughout the Yaak TPA. Specifically, site 329 exhibited a "*slumped load of angular rock into channel*" and that streambanks were "*composed of unstable crumbling bedrock*." It was also noted that bank cutting was common in the area (YHRP, 2005). Six hillslope failure sites in the Lower South Fork Yaak River Watershed were identified. Sites are associated with failure of glacial till deposits and have been identified as natural sediment sources in sediment survey field notes (YHRP, 2004). Figures 5-5a and 5-5b show representative hillslope failure sites verified in Lower South Fork Yaak Watershed. Only a single hillslope failure site was encountered in the Lap Creek Watershed, and, according to field notes, was a natural occurrence associated with an uprooted tree that resulted in a minor local hillslope failure.

Agency personnel (USFS, EPA, DEQ) toured Seventeenmile Creek and South Fork Yaak River to ascertain the extent and degree of hillslope failure and mass wasting in the watershed, and, while agency personnel did not visit or verify all sites identified through Field Sediment Source Surveys, due to time constraints and difficulties accessing some sites, anthropogenic mass wasting and hillslope failure loads were not identified. Based on spatial extent of field data and professional judgment of agency resource managers, it is concluded that sediment loads to streams from hillslope failure or mass wasting events are not significantly elevated above naturally occurring conditions, and specific numeric loads associated with this source category have not been calculated. WATSED modeling estimates presented in the following section include natural sediment loads from mass erosion (USFS, 1981).

Figure 5-5a. Hillslope Failure: Lower South Fork Yaak River

Figure 5-5b. Hillslope Failure: Lower South Fork Yaak River

5.2.1.3 Upland Erosion

Upland erosion refers to processes that deliver sediment to streams from upland areas and can be elevated above naturally-occurring conditions through management activities (road building, resource extraction, etc) that disturb forest floors and soils. Upland erosion estimates do not include sediment generated and delivered to streams from forest roads. Forest road sediment loads are addressed separately in Section 5.2.1.4 and detailed in Appendix B. Upland erosion estimates do, however, include mass erosion (USFS, 1981), and therefore modeled sediment yield estimates include natural mass wasting and hillslope failure processes described in the previous section.

Historically, the predominant land management activity within the Yaak TPA has been timber harvest and road building associated with timber harvest activities. Typically, the attenuation of sediment loads derived from post-harvest disturbed conditions to pre-harvest conditions occurs over a relatively short time frame. Disturbed areas (whether from natural forest fire or management activities) are vegetated relatively quickly by pioneer species (Rice et al, 1972, Elliot and Robichaud, 2001). Following a wildfire in eastern Oregon, Robichaud and Brown (1999) demonstrated that land surface erosion rates dropped ~90% the first year; after 4 years, surface erosion rates had returned to natural.

Major timber harvest and related road building activities in the Yaak TPA watershed occurred during the 1950s through the early 1990s. In the Seventeenmile Creek and Lap Creek Watersheds, over twenty years of vegetative recovery of forest floors and soils have effectively returned sediment loading from upland forest floor erosion to naturally occurring levels. More recent harvest has occurred within the South Fork Yaak Watershed (see Section 2.0).

Estimates of naturally occurring sediment loads from upland erosion were derived by utilizing WATSED (USFS, 1991) modeling results conducted by the Kootenai National Forest on adjacent watersheds (Quartz Creek, South Fork Yaak River) of varying sizes. Average annual unit loading results of these WATSED modeling runs are presented in Table 5-2.

Table 5-2. Estimated Annual Natural Upland Erosion Sediment Yield for WATSED-modeled Streams in the Yaak TPA

Watershed Name	Watershed Area (mi^2)	Modeled natural annual average sediment yield ($tons/mi^2/yr$)
Lamoka Creek	1.66	13.8
Quartz Creek	34.07	8.1
Lower Quartz Creek	13.47	10.7
Lower Quartz Creek Trib	0.97	18.6
W Fork Quartz Creek	13.7	9.0
Hennesy Creek	1.36	13.2
Upper Quartz Creek	1.33	12.8
Upper Quartz Creek Trib	2.18	11.6
WF Quartz Creek Trib	7.68	11.4
WF Quartz Creek Trib upper	4.36	7.8

As geology, topography and climactic regimes are similar among WATSED-modeled watersheds and watersheds of concern (Seventeenmile, South Fork Yaak, Lap), a regression equation was generated that related watershed size to estimated natural unit loading ($tons/mi^2/yr$). Estimates of natural background unit loads for Seventeenmile Creek, South Fork Yaak River, and Lap Creek were generated from this regression equation (Figure 5-6, Table 5-3). ***Because modeling and validation of modeling results have not been conducted at a watershed scale for Seventeenmile Creek, Lap Creek, and South Fork Yaak River, values presented in Tables 5-2 and 5-3 should be considered only as relative estimates, and not actual loading values.*** As stated in previous sections, WATSED loading estimates have not separated out sediment loads from mass wasting and hillslope processes, but rather include them in the total estimate of natural sediment loading.

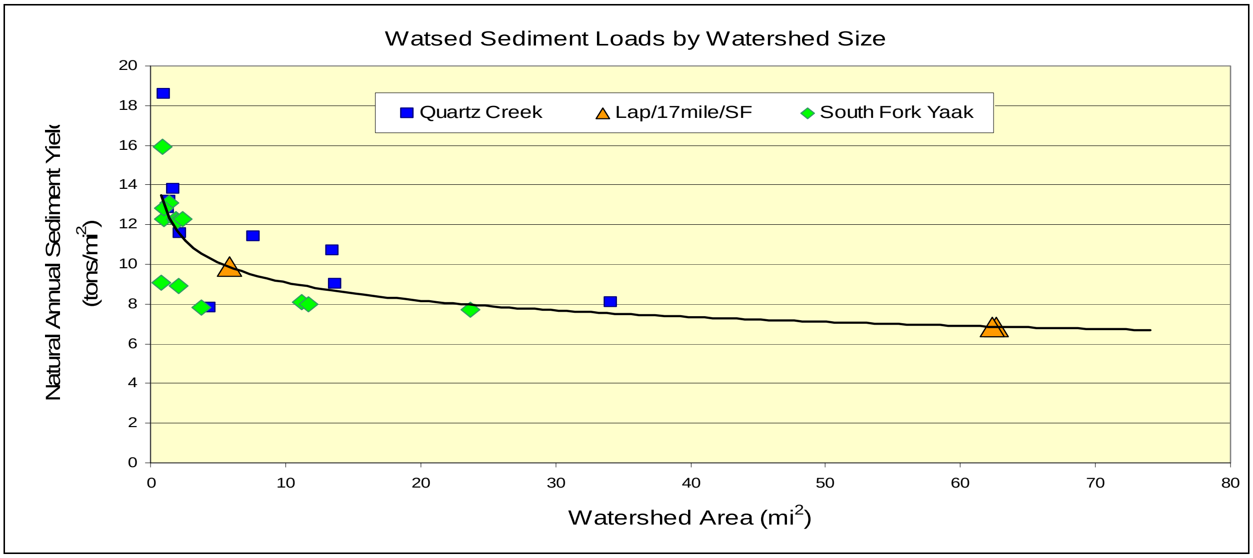

Figure 5-6. Natural Annual Sediment Yield vs. Watershed Size: Yaak TPA

Table 5-3. Estimated Annual Upland Erosion Sediment Loads: Lap Creek, South Fork Yaak River, Seventeenmile Creek

Watershed	Watershed Area (mi^2)	Natural annual average sediment yield ($tons/mi^2/yr$)	Estimated Annual Sediment Load (tons/yr)
Lap Creek	5.8	10.7	62
South Fork Yaak River	62.7	7.1	445
Seventeenmile Creek	62.4	7.1	443

5.2.1.4 Forest Roads

Sediment loads from forest roads include sediment derived from the following.

- Erosion of road surfaces, ditches and cut slopes delivered to streams at stream crossings (sediment loading at stream crossings).
- Erosion of road surfaces and fill slopes delivered to streams via overland flow along roads parallel to streams (sediment loading at parallel road segments).
- Erosion of road-fill sediment due to failure, improper sizing, installation or maintenance of culverts and culvert crossings.

Sediment Loading at Stream Crossings

Within the Yaak TPA, the character and condition of forest roads vary greatly. Motorized access has been restricted in many areas primarily in order to protect grizzly bear habitat. As a result, road conditions within the Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds vary considerably due to amount of travel and vegetative recovery on road segments under access restrictions.

Many areas in the Yaak TPA have been designated as Grizzly Bear Core areas (Core), and motorized travel on these road networks is prohibited. Some Core areas have been closed for over a decade while other areas have recently been added to Core. Due to closures and the absence of motorized travel within Core and other travel-restricted areas, roads are typically well vegetated and in some instances have become overgrown with woody shrubs and trees. Several Core-area roads visited during field assessments were fully vegetated with a developing duff layer. Other closed roads had varying amounts of vegetative recovery that limited road erosion and delivery of sediment to streams. Figures 5-7 through 5-12 show the variety of road surfaces encountered during field assessments in the Yaak TPA.

The KNF maintains a roads database of USFS maintained roads within the forest boundary that categorizes road closures by Interagency Grizzly Bear Community (IGBC) classification of 1, 2, 3, or 4. Roads within Core areas generally fall into IGBC codes 1 and 3. IGBC code 2 roads were closed to public use, but accessible to USFS administrative and management use. IGBC code 4 roads are typically open to public use as the season permits. Consequently, sediment loading analysis must take into account the variability of factors influencing sediment generation and delivery from road surfaces to streams.

Sediment loads from road surfaces were modeled using the WEPP: Road model (see Appendix B). Based on a random sub-sample of ~17% of all road crossings in Seventeenmile Creek, Lap Creek, and South Fork Yaak River Watersheds, average sediment loads were developed for each road type (Table 5-4). Roads that are open for public use (IGBC code 4) deliver the highest sediment loads to streams. Sediment delivery from closed roads (IGBC code 1, 2, 3) varies according to the amount of vegetative recovery on road surfaces and is substantially less than that from open traveled roads (IGBC code 4). Mean sediment loads for each IGBC classification were extrapolated to all crossings in Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds to estimate annual sediment loading from road crossings. Results by watershed and 7th code Hydrologic Unit Code (HUC) are given in Tables 5-5, 5-6, and 5-7.

Table 5-4. Mean Sediment Loads by IGBC Road Classification

KNF Road Classification (IGBC)	Number of Sites Assessed	Mean Sediment Load (tons/yr)
1 – Impassible to Motorized Vehicles	4	0.001
2 – Restricted/Legally Gated Admin Use	15	0.06
3 – Barriered/Legally No Admin Use	10	0.11
4 – Open During Bear Season	18	0.60

Table 5-5. Seventeenmile Creek: Existing Annual Sediment Loads from Road Crossings

Seventeen Mile Creek Watershed		No. of crossings by IGBC Code				Existing Annual Sediment Load by IGBC Code (tons/yr)				
HUC7_Name	Area (mi2)	1	2	3	4	1	2	3	4	TOTAL LOAD
Bridle Cr	1.7	1	0	0	0	0.001	0	0	0	0.00
Conn Cr	2.3	13	0	0	0	0.013	0	0	0	0.01
Crum Gulch	2.1	0	0	0	1	0	0	0	0.6	0.60
Grush Gulch	2.3	0	0	0	0	0	0	0	0	0.00
Mule Cr	1.7	6	0	0	0	0.006	0	0	0	0.01
Papoose Cr	2.5	0	0	0	0	0	0	0	0	0.00
Pelham Cr	0.5	4	0	0	0	0.004	0	0	0	0.00

Table 5-5. Seventeenmile Creek: Existing Annual Sediment Loads from Road Crossings

Seventeen Mile Creek Watershed		No. of crossings by IGBC Code				Existing Annual Sediment Load by IGBC Code (tons/yr)				
HUC7_Name	Area (mi2)	1	2	3	4	1	2	3	4	TOTAL LOAD
Saddle Cr	1.2	0	0	0	0	0	0	0	0	0.00
Seventeenmile Cr L	10.3	4	0	0	13	0.004	0	0	7.8	7.80
Seventeenmile Cr NF	4.2	0	0	0	1	0	0	0	0.6	0.60
Sheepherder Cr	1.8	0	0	0	0	0	0	0	0	0.00
Big Foot Cr	3.0	0	5	0	5	0	0.3	0	3	3.30
Flattail Cr	10.3	0	2	6	6	0	0.12	0.66	3.6	4.38
Hemlock Cr	3.7	2	0	0	0	0.002	0	0	0	0.00
Lost Fork Cr-1	3.4	6	9	0	0	0.006	0.54	0	0	0.55
Lost Fork Cr-2	2.4	1	2	0	0	0.001	0.12	0	0	0.12
Seventeenmile Cr U-1	3.4	0	4	0	2	0	0.24	0	1.2	1.44
Seventeenmile Cr U-2	5.6	0	4	4	7	0	0.24	0.44	4.2	4.88
TOTALS	62.4	37	26	10	35	0.037	1.56	1.1	21	**23.70**

Table 5-6. South Fork Yaak River: Existing Annual Sediment Loads from Road Crossings

South Fork Yaak River Watershed		No. of crossings by IGBC Code				Existing Annual Sediment Load by IGBC Code (tons/yr)				
HUC7_Name	Area (mi2)	1	2	3	4	1	2	3	4	TOTAL LOAD
Beaver Cr-1	3.9	1	0	1	0	0.001	0	0.11	0	0.11
Beaver Cr-2	4.4	1	0	1	4	0.001	0	0.11	2.4	2.51
Browning Cr	1.0	0	0	0	1	0	0	0	0.6	0.60
Can Cr	1.4	3	2	0	0	0.003	0.12	0	0	0.12
Clay Cr-1	4.3	0	0	1	0	0	0	0.11	0	0.11
Clay Cr-2	5.0	2	9	0	4	0.002	0.54	0	2.4	2.94
Dutch Cr	2.4	3	5	0	0	0.003	0.3	0	0	0.30
Fix Cr	0.9	0	1	1	0	0	0.06	0.11	0	0.17
Fowler Cr-1	3.7	2	0	4	0	0.002	0	0.44	0	0.44
Fowler Cr-2	5.3	0	0	8	2	0	0	0.88	1.2	2.08
Hartman Cr	1.3	0	0	3	1	0	0	0.33	0.6	0.93
Kelsey Cr	2.0	3	3	3	3	0.003	0.18	0.33	1.8	2.31
Smoot Cr	2.3	0	0	0	0	0	0	0	0	0.00
Yaak R SF	1.9	0	0	0	0	0	0	0	0	0.00
Yaak R SF-2	10.2	4	3	1	7	0.004	0.18	0.11	4.2	4.49
Yaak R SF Trib-1	1.5	0	0	0	0	0	0	0	0	0.00
Yaak R SF Trib-2	1.6	0	0	0	0	0	0	0	0	0.00
Yaak R SF Trib-3	1.1	9	0	0	0	0.009	0	0	0	0.01
Yaak R SF Trib-4	1.3	0	0	0	1	0	0	0	0.6	0.60
Yodkin Cr*	1.9	1	1	6	0	0.001	0.06	0.66	0	0.72
Zulu Cr-1	2.0	1	4	0	2	0.001	0.24	0	1.2	1.44
Zulu Cr-2	3.3	6	3	0	2	0.006	0.18	0	1.2	1.39
Totals	62.7	36	31	29	27	0.036	1.86	3.19	16.2	**21.29**

*Recent (2007) road decommissioning has reduced the number of road crossings in Yodkin Creek watershed. The figures given here do not reflect this recent activity

Table 5-7. Lap Creek Existing Annual Sediment Loads from Road Crossings

South Fork Yaak River Watershed		No. of crossings by IGBC Code				Existing Annual Sediment Load by IGBC Code (tons/yr)				
HUC7_Name	**Area (mi2)**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**TOTAL LOAD**
Lap Cr	5.8	6	0	16	1	0.006	0	1.76	0.6	**2.37**
Totals	5.8	6	0	16	1	0.006	0	1.76	.06	**2.37**

Figure 5-7. Closed Road (Core)

Figure 5-8. Closed Road (Core)

Figure 5-9. Closed Road (Core)

Figure 5-10. Closed Road (non-Core)

Figure 5-11. Open Road

Figure 5-12. Open Road

Sediment Loading at Parallel Road Segments

In the field, parallel road segments were selected based on best professional judgment while traveling roads on which specific crossings were selected for evaluation. Parallel segments were selected in a manner where road segments would not be duplicated in both the crossing and parallel sediment load calculations. It was determined in the field that parallel road segments were not a significant source of sediment loading unless the stream buffer was very small (less than 20 feet) due to the extremely dense forest vegetation and stream buffers. As a result, parallel segments were only assessed if located very near a stream and if evidence of sediment delivery was noted. Only two parallel segments were identified and assessed in the Yaak TPA, one in the South Fork of the Yaak River (Figure 5-13) and one in Upper Seventeenmile Creek (Figure 5-14). One parallel segment representative of the dense vegetation conditions and low sediment delivery was measured (SFY-4A-P). As well, one segment where the road was located very near the stream and delivery was comparatively high (USC-2A-P). The majority of parallel sites observed in the field contained buffer distances greater than 50 feet and were heavily vegetated with no evidence of sediment delivery to the stream. USC-2AP was the only parallel site where evidence of sediment loading was noted. Figures 5-13 and 5-15 are included to show differences in the typical buffer conditions of the two parallel segments.

Figure 5-13. Parallel Segment SFY-4A-P – Average Buffer Distance 70 feet

Figure 5-14. Parallel Segment USC-2A-P – Average Buffer Distance 10 feet

Field observations indicated that the vast majority of parallel road segments do not contribute sediment to streams, and buffer distances must be very small for sediment to reach adjacent stream channels. This conclusion was drawn based on observations in the three assessed subwatersheds only, the fact that nearly the entire road network (open roads) within these areas was traveled during fieldwork, and site USC-2A-P was the only site where evidence of delivery was noted. Also, a large portion of parallel road distance calculated in the GIS layers is present at road crossing locations and is accounted for in the crossing load calculations. As a result, parallel road segments are likely an insignificant contributor to overall sediment loading from the unpaved road network with isolated locations where roads are very close to streams. Because of the observed non-significance of sediment loading from parallel road segments, loads from parallel road segments were not calculated.

Culvert Assessment

'Culvert failure' is typically associated with rerouting of stream channels away from or out of culverts as a result of high flow events, and can result in the delivery of significant sediment loads to streams. For the purposes of this assessment, both culvert failure and lesser amounts of chronic sediment delivery to stream channels as a result of improper sizing, placement, or maintenance of road crossing culverts are considered. It is assumed that properly sized, installed, and maintained culverts are capable of passing flow and debris of all but the most severe events, and do not contribute sediment loads above what would be deemed 'naturally occurring.' Culvert conditions may range from 'failure' and associated acute road fill delivery to stream channels , or (more likely) culvert conditions may result in lesser amounts of chronic sediment delivery due to channel scour, road scour from overtopping, culvert undercutting, or road fill failure due to improper placement, undersizing, and/or lack of maintenance of culverts.

Evidence of chronic problems such as constriction, blockage, overtopping, misalignment, outlet drops, and undercutting is not uncommon at culvert crossings in the Seventeenmile, Lap and South Fork Yaak Watersheds (YHRP 2004-2006, Newgard pers comm). In some cases[3] culvert

[3] Lap Creek site 200, South Fork Yaak sites 55, 74 & 90, and Seventeenmile Creek sites 33, 37 & 61

failures in the Yaak TPA have resulted in road washouts that have delivered significant sediment loads to adjacent streams. In other cases, debris blockages at culvert inlets and evidence of culvert overtopping, undercutting, and scour demonstrate sediment delivery and the potential for more significant failure if culvert deficiencies and maintenance issues are not addressed. Ten percent of culverts assessed by the YHRP (n >200) had blockages of 25% or greater at the culvert inlet, and nearly half of these showed evidence of culvert overtopping (Figures 5-15 -5-17).

Constriction ratio (the ratio of culvert width to channel width) is used to evaluate the capabilities of culverts to pass high flows and associated debris. Culverts with widths less than bankfull stream widths were considered undersized and pose a potential risk of acute and chronic sediment delivery, channel scour, and debris accumulation, particularly under high flow conditions. Of the more than 180 culverts assessed for constriction, 67% had constriction ratios <0.7 and 24% had constriction ratios of <0.4.

As sediment delivery due to deficient culvert consists of a variety of processes, and is influenced by historical sizing and placement, and past and present maintenance and management, the development of sediment loading estimates due to culvert failure (chronic and acute) is problematic. Sediment load estimates from culvert failure, therefore, are not calculated. Rather, allocations provided to culvert failure in Section 6.0 reply on a performance-based approach following guidelines provided in the Inland Native Fish Strategy (INFISH, 1995).

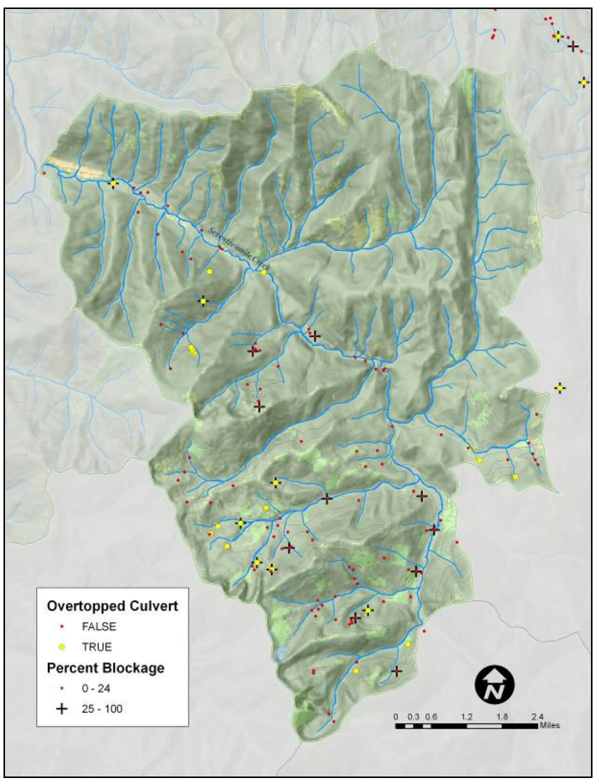

Figure 5-15. Seventeenmile Creek – Overtopped and Blocked Culverts

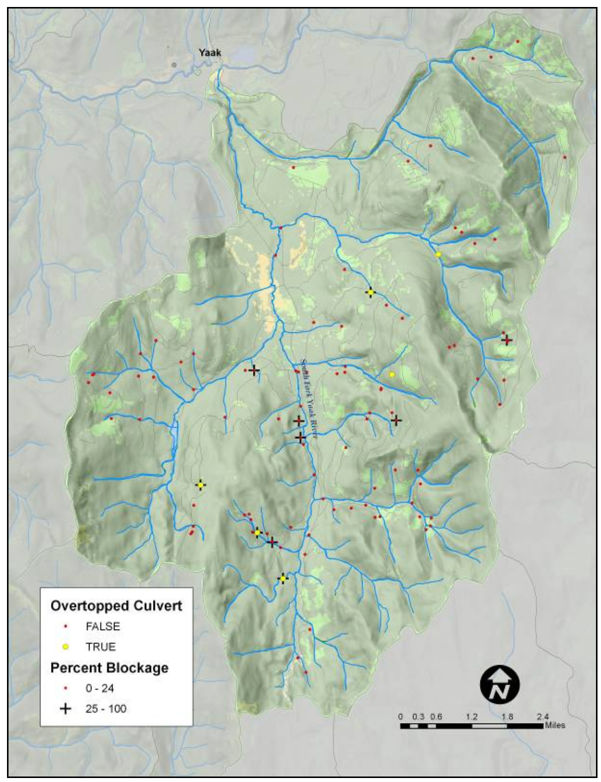

Figure 5-16. South Fork Yaak River - Overtopped and Blocked Culverts

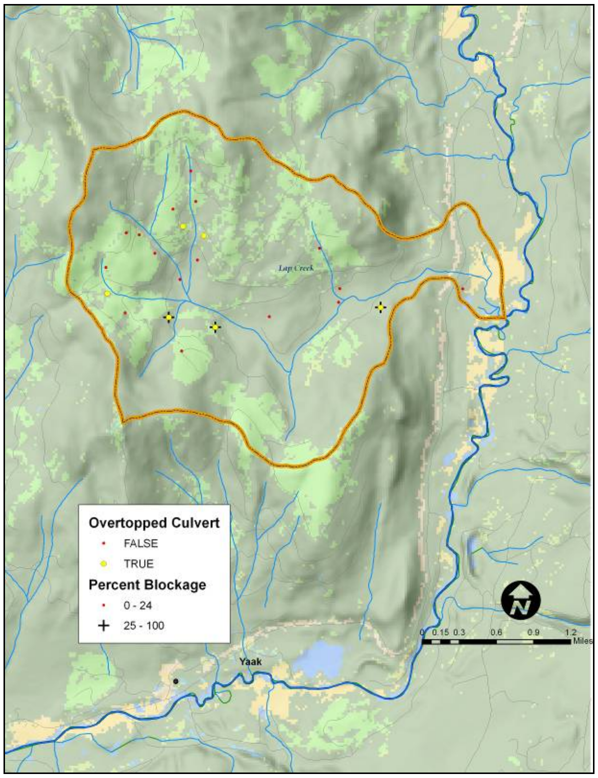

Figure 5-17. Lap Creek - Overtopped and Blocked Culverts

5.2.1.5 Water Yield and Peak Flow Increase

While not a specific ‘source’ of sediment, increases in water yields and peak flows due primarily to timber removal and road building, can influence sediment impairment conditions through increases in bedload movement and bank instability. The Forest Plan Water Yield Guidance (FPWYG) establishes an allowable peak flow increase based on the KNF Clearcut Equivalent Area Model (USFS, 1987, Appendix 18).

Peak flow increases in the Lap Creek, and South Fork Yaak met FPWYG thresholds (USFS, 1990) in 1990. Since 1990, no additional harvest has taken place in the Lap Creek Watershed, and harvest activity in the South Fork Yaak River watershed since 1990 has been in accordance with FPWYG. Recent PFI has not been calculated for the Seventeenmile Creek. However, little harvest has been conducted in the watershed since the early 1980s allowing vegetative recovery of past timber stands. As vegetative recovery of historic timber harvest areas continues, peak flow increases will attenuate.

Peak flow increases in the Seventeenmile Creek, Lap Creek, and South Fork Yaak River are due to legacy effects of past timber harvest, wildfire and road building. Recovery will continue to proceed in these areas. Maintaining PFI within the FPWYG constitutes a *‘reasonable land, soil and water conservation practice”* and will ensure that water yield increases from timber harvest activities do not impact beneficial uses.

In addition to calculated peak flow increases using the KNF Clearcut Equivalent Area Model, additional uncalculated PFI as a result of flow routing due to alterations in hillslope hydrology from forest roads has the potential to contribute to chronic conditions that are not mitigated through normal upland vegetative recovery. Forest roads have the potential to modify hydrology through the interception and rerouting of shallow subsurface flows (Megahan, 1972; Megahan & Clayton, 1983), potentially resulting in the capture of subsurface flows at roadcuts and subsequent routing of these flows to surface waters through roadside ditch systems (Megahan, 1972). Modification of natural flowpaths in the Yaak TPA due to high road densities in some subwatersheds (7th Code HUC) may contribute to channel alterations and increased sediment loading as a result of interception and rerouting. Subwatershed road densities provide an indicator as to the potential for significant road routing of shallow subsurface flows.

Several subwatershed road densities within Seventeenmile Creek, Lap Creek, and South Fork Yaak River are above 3.0, with the highest road densities present in Lost Fork Creek, Big Foot Creek, and Fix Creek (4.9, 4.5, and 4.5 miles/mile^2 respectively). Table 5-8 shows existing road densities for all 7th Code HUC subwatersheds in Seventeenmile Creek, Lap Creek, and South Fork Yaak River Watersheds, and may be used to further evaluate potential water routing and PFI concerns in these watersheds.

Table 5-8. Road Densities in the Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds by 7th Code HUC

HUC 7 Name	Watershed	Road Density (mi/mi^2)
Lap Cr	Lap Creek	4.2
Seventeenmile Cr Upper 1	Seventeenmile Creek	3.4
Big Foot Cr	Seventeenmile Creek	**4.5**
Lost Fork Cr	Seventeenmile Creek	2.9
Lost Fork Cr	Seventeenmile Creek	**4.9**
Hemlock Cr	Seventeenmile Creek	1.4
Seventeenmile Cr Upper 2	Seventeenmile Creek	3.0
Flattail Cr	Seventeenmile Creek	1.5
Mule Cr	Seventeenmile Creek	2.0
Pelham Cr	Seventeenmile Creek	2.3
Conn Cr	Seventeenmile Creek	2.7
Bridle Cr	Seventeenmile Creek	0.1
Saddle Cr	Seventeenmile Creek	0.0
Seventeenmile Cr NF	Seventeenmile Creek	0.0
Seventeenmile Cr L	Seventeenmile Creek	1.0
Crum Gulch	Seventeenmile Creek	0.0
Grush Gulch	Seventeenmile Creek	0.0
Sheepherder Cr	Seventeenmile Creek	2.3
Papoose Cr	Seventeenmile Creek	0.0
Yaak R SF	South Fork Yaak River	1.0
Yaak R SF Trib	South Fork Yaak River	0.2
Yaak R SF Trib	South Fork Yaak River	0.7
Smoot Cr	South Fork Yaak River	0.0
Yaak R SF Trib	South Fork Yaak River	2.7
Clay Cr	South Fork Yaak River	0.9
Zulu Cr	South Fork Yaak River	3.4
Zulu Cr	South Fork Yaak River	1.0
Can Cr	South Fork Yaak River	3.6

Table 5-8. Road Densities in the Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds by 7th Code HUC

HUC 7 Name	Watershed	Road Density (mi/mi^2)
Kelsey Cr	South Fork Yaak River	3.6
Clay Cr	South Fork Yaak River	3.4
Dutch Cr	South Fork Yaak River	4.2
Fix Cr	South Fork Yaak River	**4.5**
Yaak R SF Trib	South Fork Yaak River	2.1
Fowler Cr	South Fork Yaak River	3.4
Hartman Cr	South Fork Yaak River	3.4
Fowler Cr	South Fork Yaak River	3.0
Browning Cr	South Fork Yaak River	1.9
Yaak R SF	South Fork Yaak River	3.4
Beaver Cr	South Fork Yaak River	3.7
Beaver Cr	South Fork Yaak River	3.0
Yodkin Cr	South Fork Yaak River	1.7

SECTION 6.0
TOTAL MAXIMUM DAILY LOAD & LOAD ALLOCATIONS

6.1 Total Maximum Daily Load

A Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the CWA and Montana state law (MCA 75-5-703). To meet this requirement, DEQ must identify water bodies not meeting water quality standards and then establish TMDLs for those pollutants responsible for water quality impairment. A TMDL Plan is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL Plan specifies the amount of pollutant that must be reduced to meet water quality standards, allocates pollution control or management among sources in a watershed, and recommends a framework for taking actions needed to restore a water body.

The TMDL is defined as the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background sources, and a margin of safety that considers seasonal variation and accounts for the uncertainty in the relationship between the pollutant loads and the quality of the receiving waterbody (40 Code of Federal Regulations [CFR] 130.2). Numerically, this definition is represented by the equation:

$$\boldsymbol{TMDL} = \boldsymbol{\Sigma}\text{WLA} + \boldsymbol{\Sigma}\text{LA} + \text{MOS}$$

Where appropriate, allocations may be expressed by measures other than allowable numeric loads. Alternative approaches for the expression of load allocations are justified in EPA guidance, *Protocol for Developing Sediment TMDLs*.

> *"Although there are many ways to express TMDLs, the concept of allocation is central to the TMDL process because it reinforces the importance of identifying what sources need to be addressed to attain water quality standards. Therefore, sediment TMDLs should clearly provide for allocations by source of maximum allowable loads,* ***needed load reductions****, or, in some cases, source control actions."* (EPA, 1999)

For waterbodies requiring TMDLs in the Yaak TPA (Seventeenmile Creek, Lap Creek, and South Fork Yaak River) TMDLs are expressed as a percent reduction of sediment loads from controllable anthropogenic sources. Percent reductions are based on estimates of anthropogenic sediment loading above 'naturally occurring' (ARM 17.30.602 (19)) conditions and are based on a combination of field assessments, sediment modeling, and best professional judgment of resource professionals.

As there are no point sources of sediment in the Yaak TPA, no wasteload allocations (WLA) are presented. Therefore, the TMDL is expressed as the sum of the load allocations (LAs) to natural background and forest roads - also represented as the percent reductions of all anthropogenic non-point sources (Table 6-1). Note that natural background loads presented in Table 6-1 are modeled estimates and incorporate natural bank & hillslope erosion and mass wasting/hillslope failure. While not expressed separately in Table 6-1, individual allocations to these sediment source categories are provided below in Section 6.2. Allocations. Margin of safety considerations are addressed below in Section 6.3.

Table 6-1. Total Annual Sediment Loads: Seventeenmile Creek, Lap Creek, South Fork Yaak River

Watershed	Sediment Source Category	Existing (tons/yr)	TMDLs & Allocations (tons/yr)	Percent Reduction to meet TMDL
Seventeenmile Creek	Natural Background	443	443	0.0%
	Forest Roads	24	12	48.7%
	Total Load	**467**	**455**	**2.6**
Lap Creek	Natural Background	62	62	0.0%
	Forest Roads	2.4	1.1	52.3%
	Total Load	**64.4**	**63.1**	**2.0**
South Fork Yaak River	Natural Background	445	445	0.0%
	Forest Roads	21	12	42.6%
	Total Load	**466**	**457**	**1.9**

It must be noted that the natural background loads presented in Table 6-1 are estimated from similar adjacent watersheds using modeled approaches, and forest road loads are derived from extrapolation of field-assessment data. The difference in assessment methodologies used to estimate loads from these two source categories make cumulative load estimations and relative loading comparisons between the two sources difficult to verify without more extensive field data collection and validation. Regardless of the veracity of cumulative loading estimations, source assessments (Section 5.0) do confirm that the primary anthropogenic sediment source affecting sediment-impairment conditions in the Yaak TPA is sediment derived from unpaved forest roads. Consequently, reducing and controlling sediment and associated impacts from the forest road network using all reasonable conservation practices and BMP technologies will ensure that forest road loads are not elevated above 'naturally occurring' conditions (see Section 6.2.1).

The following sections provide allocations, in terms of percent reductions in sediment loading, to anthropogenic sources for sediment-impaired waterbodies, Seventeenmile Creek, Lap Creek, and South Fork Yaak River.

6.2 Load Allocations

This section identifies allocations required for the establishment of TMDLs in Seventeenmile Creek, Lap Creek, and the South Fork Yaak River. The goal is to ensure that the water quality targets (Section 4.0) are met and maintained through the allocation and reduction of anthropogenic sediment loads. By meeting load allocations, it is expected that standards will be met and, more importantly, beneficial uses are restored and/or protected. Load allocations are presented by sediment source category (forest roads, upland management, bank erosion, mass wasting) and should be applied at the 7th-Code HUC scale watersheds given in Appendix B in order to provide adequate beneficial use protection for tributary and mainstem waterbodies.

As defined in the Administrative Rules of Montana:

> *"…no increases are allowed above **naturally occurring** concentrations of sediment or suspended sediment (except as permitted in 75-5-318 , MCA) , settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife." (ARM 17.30.623 (f))*

Additionally, **'Naturally occurring'** is defined as:

> *"conditions or material present from runoff or percolation over which man has no control or from developed land where **all reasonable land, soil, and water conservation practices have been applied**" (ARM 17.30.602 (19)).*

Load allocations from anthropogenic sources are therefore based on the premise that some sediment from anthropogenic activity is acceptable as long as beneficial uses are maintained through the application of '*all reasonable land, soil, and water conservation practices*.' Load allocations presented below provide percent reductions (where applicable) based on the application of reasonable and accepted conservation practices (DEQ, 2007, USDA, 1995) believed to maintain water quality to support all beneficial uses.

It is acknowledged that the numeric allocations presented herein are watershed-scale estimates. Site specific conditions are expected to vary from average loading values given in Section 5.0. As such, further site-specific analysis may show that road-sediment loading from some 7th-code watersheds are meeting their numeric allocation, while others are not. Where further analyses (consistent with methods employed herein) improve on existing knowledge of site-specific conditions, updated and site-specific data and information should be employed in refining loading estimations and/or pursuing management decisions regarding attainment and maintenance of TMDLs.

Meeting all allocations assumes that TMDLs are met, and the waterbody is subsequently meeting water quality standards for the pollutant of concern (sediment). However, due to the inherent uncertainties in watershed-wide loading estimates and their relative influence on water quality target attainment, long-term monitoring is required in order to evaluate the effectiveness of allocation implementation on the attainment of water quality standards (MCA 75-5-703 (7)). A framework long-term monitoring and implementation plan is given in Section 7.0.

Section 6.2 provides load allocations for anthropogenic sediment source categories identified in Section 5.0.

- Forest roads (stream crossings, parallel road segments, culvert failure)
- Upland erosion from forest management activities
- Bank erosion & mass wasting/hillslope failure
- Future development

6.2.1 Forest Roads Allocation

In the case of sediment derived from forest roads, a surrogate sediment loading condition is established that represents the application of 'all reasonable conservation practices', and is based on the following criteria:

- Contributing road length at BMPed crossings ≤ 200 feet on open roads
- Road crossing density ≤ 1.5 crossings/mi^2 at the 7th Code HUC scale
- New culverts on unpaved forest roads are sized and installed to pass the 100-year flow (Q100) and associated debris (INFISH, 1995)
- Existing culverts are maintained, upgraded or removed (consistent with INFISH guidance) to limit sediment contributions from chronic failure.
- Road segments parallel to streams maintain all appropriate BMPs to minimize sediment loading to streams

The resultant numeric sediment load from the forest road network, (considering a contributing road length on open, traveled roads of ≤ 200 ft at BMPed stream crossings, a road crossing density ≤ 1.5 crossings/mile^2, culverts capable of passing the 100-year flow event, and application of all appropriate BMPs along parallel road segments) is considered a 'naturally occurring' (ARM 17.30.602 (19)) condition and provides a numeric basis for sediment allocations to forest road networks in the Yaak TPA. Based on these criteria, the **modeled numeric allowable unit load from the forest road network is 0.20 tons/year/mi2.**

It must be noted that the numeric allocation (allowable load) to forest roads is based on surrogate criteria and does not mandate specific management practices that must be employed for sediment reduction and management. For instance, it is not required that management actions adhere to specific contributing lengths or road densities, if it can be shown through site-specific analysis that numeric load allocations will not be exceeded.

Presently, there several 7th-code watersheds in the Yaak TPA with road crossing densities that exceed 1.5 that are meeting numeric allocations (Tables C-17-C-19, Appendix B), due to improved or revegetated roads. Likewise, there are also several 7th-code watersheds with low road crossing densities that exceed numeric allocations due to improperly maintained roads. As site-specific information in these watersheds is collected, existing loading determinations may be modified based on empirical site-specific data.

In order to estimate the acceptable sediment loading and subsequent load allocations from forest roads based on the above bulleted criteria, the criteria were applied to the existing modeled sediment loads given in Section 5.0 (see Tables 5-5, 5-6, 5-7, 5-8, and Appendix B). Tables 6-2, 6-3, and 6-4 present the subsequent load allocations, expressed as percent reductions, for sediment derived from unpaved forest roads.

Table 6-2. Forest Road Allocation: Stream Crossings

Watershed	Existing Stream Crossing Load (tons/yr)	Performance-based Stream Crossing Load (tons/yr)	Stream Crossing Allocation (Percent Reduction)
Seventeenmile Creek	23.7	12.16	49%
Lap Creek	2.37	1.13	52%
South Fork Yaak River	21.3	12.23	43%

Table 6-3. Forest Road Allocation: Culvert Failure

Watershed	Existing Culvert Failure Load	Performance-based Culvert Failure Allocation
Seventeenmile Creek	Not quantified	No loading from culvert failures (chronic and acute) where failure is a result of undersizing (100-year flow), or improperly installed or maintained culverts.
Lap Creek		
South Fork Yaak River		

Table 6-4. Forest Road Allocation: Parallel Road Segments

Watershed	Existing Parallel Segment Load	Performance-based Parallel Segment Allocation
Seventeenmile Creek	Not quantified	No sediment loading increases other than potential minor predicted short-term increases associated with full implementation of applicable BMP standards for forest road maintenance.
Lap Creek		
South Fork Yaak River		

6.2.2 Upland Erosion from Management Activities Allocation

As presented in Section 5.2.1.3, with the exception of road-related sediment loading, present sediment loading from upland management activities does not appear to be elevated significantly above 'naturally occurring' conditions, therefore no percent reduction allocation is given for these sources. It is not reasonable to assume that there will be no future upland management activities within the Yaak TPA that produce sediment, therefore an allocation is required to account for existing and potential future sediment loading from this source category.

The allocation to sediment derived from upland erosion (from management activities) proposes no sediment loading increases associated with harvest or other upland management activities without implementation of applicable BMPs (DEQ, 2007, USDA, 1995), and all reasonable land, soil and water conservation practices. Application of BMPs and 'all reasonable land, soil, and water conservation practices' on existing and future management activities will ensure that sediment loading will remain within 'naturally occurring' conditions.

In addition to application of applicable BMPs, 'reasonable land, soil, and water conservation practices' applied to upland management activities include maintaining peak flow increases (PFI) within the Kootenai National Forest's FPWYG. Where natural conditions resulting from forest fire or other events increase peak flows above FPWYG, management actions that would result in further increases in peak flows should be severely restricted unless further analysis demonstrates that such increases would not be detrimental to stream channels, aquatic life, or result in further increases in sediment loading. It is incumbent on forest resource managers to demonstrate non-significance of such activities at a subwatershed (7^{th}-Code HUC) scale for the protection of stream channels and aquatic resources.

Table 6-5. Upland Erosion Allocation: Forest Management Activities and Water Yield

Watershed	Existing Load (tons/yr)	Performance-based Load (tons/yr)	Allocation
Seventeenmile Creek	443	443	No sediment loading increases associated with harvest or other upland management activities without full implementation of applicable BMP standards, and all reasonable land, soil and water conservation practices Maintain PFI within FPWYG
Lap Creek	62	62	No sediment loading increases associated with harvest or other upland management activities without full implementation of applicable BMP standards, and all reasonable land, soil and water conservation practices Maintain PFI within FPWYG
South Fork Yaak River	445	445	No sediment loading increases associated with harvest or other upland management activities without full implementation of applicable BMP standards, and all reasonable land, soil and water conservation practices Maintain PFI within FPWYG

6.2.3 Bank Erosion & Mass Wasting/Hillslope Failure Allocation

As presented in Section 5.2.1.1 and 5.2.1.2, present sediment loading from bank erosion and mass wasting/hillslope failure does not appear to be elevated significantly above ‘naturally occurring’ conditions, therefore no percent reduction allocation is given for these sources. As with sediment derived from upland management sources, it is not reasonable to assume that there will be no future activities within the Yaak TPA that produce sediment from bank or hillslope erosion. A sediment allocation is therefore required to account for existing and potential future sediment loading from this source category.

The allocation to sediment derived from bank erosion and mass wasting proposes no future sediment loading increases associated with bank erosion or mass wasting/hillslope failure other than short-term increases that may be predicted and associated with full implementation of all applicable best management practices (DEQ, 2007, USDA, 1995). Full application of BMPs on all existing and future activities that may contribute to bank erosion and/or mass wasting will ensure that sediment loading will be maintained within ‘naturally occurring’ conditions through the application of ‘all reasonable land, soil and water conservation practices’.

Table 6-6. Anthropogenic Bank Erosion and Mass Wasting Allocation

Watershed	Existing Load	Performance-based Load	Allocation
Seventeenmile Creek Lap Creek South Fork Yaak River	Within 'Naturally Occurring' Conditions	Within 'Naturally Occurring' Conditions	No sediment loading increases associated with anthropogenically-derived bank erosion or mass wasting sources without full implementation of all applicable BMP standards and all reasonable land, soil and water conservation practices

6.2.4 Future Development Allocation

It is not reasonable to assume that there will be no future development in the Yaak TPA. An allocation is therefore provided to account for potential future sediment loading related to developed lands not covered under previously addressed sediment source categories. This includes commercial and residential development and associated runoff from stormwater or land clearing activity. Maintenance of riparian buffers and application of all reasonable land, soil and water conservation practices during and after development will ensure that 'naturally occurring' conditions are maintained. This allocation proposes no sediment loading increases associated with future development other than potential minor, short-term increases that may be predicted and associated with full implementation of all applicable riparian BMP standards. Additionally, all applicable construction, storm water, 310 and SPA 124 permitting actions should address no increase above naturally occurring conditions, except for temporary exceedences.

Table 6-7. Future Development Allocation

Watershed	Future Allocation
Seventeenmile Creek Lap Creek South Fork Yaak River	No increase in sediment loading linked to the removal of riparian vegetation buffers or linked to the loss of dynamic equilibrium due to stream encroachment within the stream migration zone. All applicable construction, storm water, and 310 Permitting BMP requirements shall be met.

6.3 Margin of Safety

Applying a margin of safety is a required component of TMDL development. The margin of safety (MOS) accounts for the uncertainty about the pollutant loads and the quality of the receiving water and is intended to protect beneficial uses in the face of this uncertainty. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (EPA, 1999). This plan addresses MOS implicitly in a variety of ways.

- Multiple targets addressing physical channel conditions are developed to address excess fines and other impairments.
- The suite of proposed supplemental indicators, including biological indicators, used to help verify beneficial use support determinations.

- The proposed supplemental indicators may also provide an early warning method to identify pollutant-loading threats, which may not otherwise be identified, if targets are not met.
- A large amount of data and assessment information were considered prior to finalizing any impairment determinations. Impairment determination was based on conservative assumptions that err on the side of keeping streams listed and developing TMDLs unless overwhelming evidence of use support was available.
- Consideration of seasonality (see below).
- The adaptive management approach evaluates target attainment and allows for refinement of load allocation, targets, modeling assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development.
- Application of ‘all reasonable land & soil water conservation practices’ provides a performance-based evaluation of allocation objectives.

6.4 Seasonality

Addressing seasonal variations is an important and required component of TMDL development. Throughout this plan, seasonality is an integral factor. Water quality and habitat parameters such as fine sediment and macroinvertebrates are all recognized to have seasonal cycles.

Specific examples of how seasonality has been addressed are listed below.

- Source assessment of sediment loading inherently incorporates runoff flows when erosion is greatest.
- Targets were developed with seasonality in mind. Fine sediment target data is collected in the summer, after flushing flows have passed. Macroinvertebrate and supplemental indicator data is collected during the summer months when these biological communities most accurately reflect stream conditions.
- Throughout this document, the data reviewed cover a range of years, seasons, and geographic area within the Yaak TPA
- Annual loading reductions presented in Section 6.2 are presented as Total Maximum Daily Loads (Appendix C) as a function of the annual hydrograph.

6.5 Uncertainty and Adaptive Management

Uncertainties in the accuracy of field data, applicable target values, source assessments, loading calculations, modeling assumptions, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. Uncertainties, assumptions, and considerations are addressed throughout this document and point to the need to refine analysis, conduct further monitoring, and address unknowns in order to develop better understanding of sediment impairment conditions and the processes that affect impairment. This process of adaptive management is predicated on the premise that targets, TMDLs, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood.

Adaptive management addresses important considerations such as feasibility and uncertainty in establishment of targets. For example, despite implementation of all restoration activities, the attainment of targets may not be feasible due to natural disturbance such as forest fires, flood events, or landslides. Similarly, it is possible that the natural potential of some streams will preclude achievement of some targets. For instance, natural geologic and other conditions may contribute sediment at levels that cause a deviation from numeric targets associated with sediment. Conversely, some targets may be underestimates of the potential of a given stream, and it may be appropriate to apply more protective targets upon further evaluations. Supplemental indicators are used to help with these determinations. In light of all this, it is important to recognize that the adaptive management approach provides the flexibility to refine targets as necessary to ensure protection of the resource or to adapt to new information concerning target achievability.

Adaptive management also addresses uncertainties associated with allocations (percent reductions). Uncertainties and unknowns associated with sediment derived from forest roads are considerable and addressed thoroughly in Appendix B through the assertion of a variety of assumptions and considerations regarding road sediment load modeling and extrapolation of results. As further monitoring of water quality and source loading conditions is conducted, uncertainties associated with these assumptions and considerations may be mitigated and loading estimates may be refined to more accurately portray watershed conditions.

As part of this adaptive management approach, land use activities should be tracked. Increases in land use may trigger a need for additional monitoring. The extent of monitoring should be consistent with the extent of potential impacts and can vary from basic BMP assessments to a complete measure of target parameters above and below the project area before the project and after completion of the project. Cumulative impacts from multiple projects must also be a consideration. This approach will help track the recovery of the system and the impacts, or lack of impacts, from ongoing management activities in the watershed. Under these circumstances, additional targets and other types of water quality goals may need to be developed to address new stressors to the system depending on the nature of the activity.

Uncertainties in assessments and assumptions should not paralyze but should point to the need to be flexible in our understanding of complex systems and to adjust our thinking and analysis in response to this need. Implementation and monitoring recommendations presented in Section 7.0 provide a basic framework for reducing uncertainty and furthering understanding of these issues.

6.6 Total Maximum Daily Loading Expression

> *"In November 2006 EPA issued the Memorandum "Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015 (April 25, 2006) and Implications for NPDES permits," which recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard"* (EPA, 2007).

In order to satisfy this recommendation from EPA, TMDL expressions have been developed and are presented in Appendix C.

SECTION 7.0
TMDL IMPLEMENTATION AND MONITORING

7.1 TMDL Implementation and Monitoring Framework

This section presents a framework strategy to achieve load allocations and water quality targets through implementation of control actions and monitoring their effectiveness. Montana state law contains provisions that address evaluation of TMDL effectiveness through long-term water quality monitoring. As defined in (MCA 75-5-703 (7) (9):

> *"(7) Once the control measures identified in subsection (6) have been implemented, the department shall…develop a monitoring program to assess the waters that are subject to the TMDL to determine whether compliance with water quality standards has been attained for a particular water body or whether the water body is no longer threatened. The monitoring program must be designed based on the specific impairments or pollution sources. The department's monitoring program must include long-term monitoring efforts for the analysis of the effectiveness of the control measures developed.*
>
> *(9) If the monitoring program … demonstrates that the TMDL is not achieving compliance with applicable water quality standards within 5 years after approval of a TMDL, the department shall conduct a formal evaluation of progress in restoring water quality and the status of reasonable land, soil, and water conservation practice implementation to determine if:*
>
> *a. the implementation of a new or improved phase of voluntary reasonable land, soil, and water conservation practice is necessary;*
> *b. water quality is improving but a specified time is needed for compliance with water quality standards; or*
> *c. revisions to the TMDL are necessary to achieve applicable water quality standards."*

Load allocations provided in Section 6.0 may be achieved through a variety of management and implementation actions. This document provides conceptual recommendations leaving the specific details to local stakeholders and resource managers. A timeframe for implementation and monitoring activities is not included herein because most implementation projects rely upon available funding and resources for such actions.

Allocations presented in Section 6.0 provide the basis for meeting sediment targets, and hence, water quality standards for sediment in the Yaak TPA. Some allocations (forest road allocations) call for reductions of source loads whereas other allocations (upland erosion, bank erosion, mass wasting) call for no increases above naturally occurring conditions through the continued maintenance of '*all reasonable land, soil and water conservation practices' (ARM 17.30.602 (19))* which, by definition, will ensure that water quality standards for sediment will be met.

Application of BMPs forms the foundation of management and implementation recommendations yet is only part of the overall strategy for meeting sediment allocations. The application of '*all reasonable land, soil and water conservation practices*' is also to be followed in order to ensure attainment of sediment water quality standards. Application of BMPs and the application of '*all reasonable land, soil and water conservation practices'* are not necessarily synonymous concepts. For instance, to ensure that water quality standards are achieved and maintained, it is reasonable that all applicable BMPs are applied in order to meet sediment allocations. However, it is not reasonable to increase road densities or stream crossing densities where the sum of sediment loads from a fully 'BMPed' condition exceeds the ability of streams to maintain aquatic beneficial life uses. For this reason, BMPs are considered a *component* of '*all reasonable land, soil and water conservation practices'*, but not an endpoint in itself. In addition to BMP application, maintaining and/or reducing road densities and stream crossing densities at levels that do not cause water yield increases (that would exceed Forest Plan Water Yield Guidance, or cause deleterious impacts to stream channels or aquatic life) are considered '*reasonable land, soil and water conservation practices*.'

> *In most cases, applying applicable BMPs to existing road networks will result in the necessary sediment reductions required to meet water quality standards. In some cases, however, a larger effort than solely implementing new BMPs may be required to address sources of impairment. In these cases BMPs are typically identified as a first effort, and an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve water quality targets and load allocations (see MCA 75-5-703 (9)).*

In addition to application of BMPs to reduce *existing* loads, on-going land management activities should employ 'all reasonable land, soil & water conservation practices' with the intent of meeting sediment allocations set forth in Section 6.0.

Within the Yaak TPA, sediment production and delivery to streams from forest road networks is currently the primary human caused sources of sediment impairment to water quality, and load reductions from forest road sources is the primary focus of implementation efforts. General goals of the following implementation and monitoring recommendations include the following.

- Meet and maintain sediment allocations for all impaired streams identified by the State of Montana within the Yaak TPA.
- Avoid conditions where additional water bodies within the Yaak TPA become impaired.
- Work with land stewards and other stakeholders in a cooperative manner to ensure implementation of water quality protection activities.
- Continue to monitor conditions in the watershed and track progress toward meeting water quality targets.

7.2 Agency and Stakeholder Coordination

Meeting allocations and achieving the targets set forth in this plan will require a coordinated effort between land management agencies and other important stakeholders, including county governments, conservations districts, private landowners, state and federal agency representatives, and individuals from conservation, recreation, and community groups with water quality interests in the Yaak River Watershed. DEQ supports activities that result in the implementation of recommendations contained herein and provides funding for water quality restoration activities through the DEQ's 319 funding program.

7.3 Implementation Strategies and Recommendations

7.3.1 Forest Roads & Culverts

The analyses conducted as part of TMDL development indicate that sediment derived from unpaved forest roads constitutes a controllable, chronic, and significant sediment source to streams. Sediment loads from unpaved forest roads are presently elevated above 'naturally occurring' conditions and pose a chronic impairment to aquatic life beneficial uses. Sediment road allocations are designed to maintain and/or reduce road-related sediment loads to '*naturally occurring*' conditions through the application of '*all reasonable land, soil and water conservation practices*'.

Within the context of this TMDL, a surrogate condition for '*all reasonable land, soil and water conservation practices'* was chosen in order to estimate an allowable numeric sediment load from road networks. An allowable numeric sediment load per 7th code HUC was estimated using the following criteria*.

- Contributing road length at BMPed crossings $\leq$ 200 feet on open roads
- Road crossing density $\leq$ 1.5 crossings/mi^2 at the 7th Code HUC scale
- New culverts on unpaved forest roads are sized and installed to pass the 100-year flow (Q100) and associated debris (USDA, 1995)
- Existing culverts are maintained and upgraded or removed (consistent with Inland Native Fish Strategy guidance) to limit sediment contributions from acute and chronic failure
- BMPs are maintained on all road segments parallel to in order to minimize sediment loading to streams

**The numeric loads calculated as a result of contributing road-length and road crossing density criteria are not a mandate to implement specific forest management practices such as requiring road densities or contributing road lengths. It is not required that management actions adhere to specific contributing lengths or road crossing densities <u>if it can be shown</u> through site-specific analysis that numeric load allocations will not be exceeded. In most instances in the Yaak TPA, it is likely that road allocations can be met through upgrade or improvement of 'problem sites' on existing road networks and stream crossings.*

For instance, many subwatersheds with road crossing densities >1.5 are currently meeting road sediment allocations due to revegetated or improved road networks, while other watersheds with road crossing densities <1.5 are currently not meeting road sediment allocations due to BMP or contributing road-length deficiencies.

Numeric allocations establish allowable loading levels that, if realized, would presumably result in the attainment and maintenance of water quality standards for sediment. As such, the land, soil and water conservation practices above represent surrogate conditions that assist in establishing the potential for sediment reductions from unpaved forest roads through the application of all appropriate BMPs and an understanding of processes that may influence water routing and water yield increases. Standard BMPs and resource management practices designed to maintain water quality can be found in DEQ's Nonpoint Source Management Plan, Appendix A (DEQ, 2007) and in *Water Quality BMPs for Montana Forests* (Montana State University [MSU], 2001).

Achieving sediment load reductions from forest roads and culverts entails site specific assessments that evaluate the feasibility of various BMP methods. Each implementation site (crossing, culvert, etc…) will be unique and may require an approach that may or may not be feasible at other sites, therefore evaluation and implementation of control actions will be at the professional discretion and judgment of local land managers and implementation teams. Prioritization of implementation and load reduction activities should account for a variety of factors including but not limited to the following.

- Availability of resources
- Resource value at risk
- Aquatic resource considerations
- Level of disturbance associated with implementation activity
- Load reduction potential
- Existing management priorities
- Public and stakeholder input
- Other considerations relevant to attainment and maintenance of aquatic life beneficial uses

Detailed implementation plans should be developed that systematically address a variety of necessary components: further information and assessment needs, prioritization of implementation projects, identification of roles and responsibilities of involved partners, development of sampling and analysis plans, project effectiveness monitoring, data management and reporting, public and stakeholder involvement.

7.3.2 Additional Implementation Recommendations

This section includes a discussion of issues that are not currently primary limiting factors to water quality, but are a consideration for long-term watershed management, and attainment and maintenance of beneficial uses. All of the previous and following management issues are interrelated. Therefore, a long-term holistic approach to watershed management will provide the most effective results.

Upland Erosion and Timber Harvest
Excluding associated forest roads and culverts, which are addressed above, timber harvest currently is not significantly affecting water quality in the Yaak TPA. In order to ensure that beneficial uses are maintained, future harvest activities must maintain '*all reasonable land, soil and water conservation practices*' in addition to Forestry BMPs (DEQ, 2007; MSU Extension Service, 2001). Additionally, peak flow increases should be maintained at levels within the KNF Forest Plan Water Yield Guidance in order to minimize effects on channel instability and potential increases in sediment loading.

Fish Passage
Appendix B presents the results of a fish-passage assessment conducted on all culverts in Seventeenmile Creek, Lap Creek and South Fork Yaak River where data was available (about 260 culverts). This evaluation of fish passage criteria provides a 'first-cut' evaluation of the ability of each culvert to allow for the passage of juvenile salmonids and represents a partial evaluation of aquatic life beneficial use determination. As presented in Table 3-4 (Section 3.0),

surface waters in the Yaak TPA are classified as B-1 waters and are "*to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation;* ***growth and propagation of salmonid fishes*** *and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.*" Maintaining fish passage through culverts is one factor that contributes to suitability for the 'growth and propagation of salmonid fishes'.

While fish passage considerations are not specifically a sediment loading issue and not subject to TMDLs, they are considered when making beneficial use determinations for fish and associated aquatic life. Consequently, non-natural barriers to fish passage may be cause for a non-pollutant impairment listing. Restoration of fish passage through culverts is therefore an important component of restoring all beneficial uses in the Yaak TPA, and should be addressed in concert with necessary sediment loading reductions due to culvert failure (a sediment loading allocation). Further information and analysis of culvert fish passage can assist in prioritizing and planning for culvert upgrade and/or removal where appropriate.

Fish passage barrier restoration strategies may include but are not limited to the following.

- Locate and perform fish passage assessments on additional road crossings over stream segments where maintaining fish passage if a priority.
- Develop a priority list of barrier culverts for replacement.
- Conduct culvert replacement in consultation with KNF and FWP biologist to ensure protection of aquatic resources, and maintain proper conditions for the propagation of cold-water fish species.

7.4 Monitoring Recommendations

In addition to the application of BMPs and/or other management actions, monitoring is an equally important part of the implementation and restoration process. Monitoring of water quality is essential for the evaluation of water quality standards attainment and the success of implementation and control efforts. This section provides a framework monitoring strategy to assist in meeting the following goals.

- Evaluate the attainment of water quality targets
- Improve understanding of appropriate reference conditions for the Yaak TPA
- Evaluate effectiveness of implementation and restoration efforts.

The framework monitoring plan presented in this section is meant to provide a starting point for the development of more detailed and specific planning efforts regarding monitoring needs. It does not assign monitoring responsibility. It is expected that monitoring recommendations provided will assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet aforementioned goals.

7.4.1 Water Quality Target Monitoring & Evaluation

Primary water quality targets, supplemental indicators and water quality assessment framework are presented in Section 4.0. Target indicators and values have been developed through evaluation of appropriate reference conditions and their linkage to Montana's surface water quality standards for sediment (see Section 3.0). Evaluation of water quality target attainment consists of two components.

1. Evaluation of the appropriateness of established water quality targets through additional 'reference stream' monitoring
2. Evaluation of target attainment

As primary water quality targets (bioassessment scores, width-to-depth ratios, percent surface fines, percent subsurface fines) are based primarily on reference conditions thought to be appropriate for streams in the Yaak TPA, further monitoring of the target/indicator parameters in reference streams is needed to help increase confidence that the TMDL targets and supplemental indicator values that best represent a translation of the narrative water quality standards for sediment (Section 3.0). The following methods may be used to assist in refining reference conditions in the Yaak TPA.

Primary Approach

- Comparing conditions in a waterbody to baseline data from minimally impaired waterbodies that are in a nearby watershed or in the same region having similar geology, hydrology, morphology, and/or riparian habitat.
- Evaluating historical data relating to condition of the waterbody in the past.
- Comparing conditions in a waterbody to conditions in another portion of the same waterbody, such as an unimpaired segment of the same stream.

Secondary Approach

- Reviewing literature (e.g. a review of studies of fish populations, etc. that were conducted on similar waterbodies that are least impaired).
- Seeking expert opinion (e.g. expert opinion from a regional fisheries biologist who has a good understanding of the waterbody's fisheries health or potential).
- Applying quantitative modeling (e.g. applying sediment transport models to determine how much sediment is entering a stream based on land use information etc.)

DEQ uses the primary approach for determining reference condition if adequate regional reference data are available and uses the secondary approach to estimate reference condition when there are no regional data. DEQ often uses more than one approach to determine reference condition, especially when regional reference condition data are sparse or nonexistent.

Collection of additional reference data and information may assist in investigating specific uncertainties that exist regarding the application of target values in the Yaak TMDL. Percent surface fines and the link between surface fine sediment and threshold effects on macroinvertebrate communities is undetermined. Unpublished, non-peer reviewed reports (Relyea, 2005) suggest that a threshold of 20% surface fines <2mm may demonstrate impairment to aquatic macroinvertebrate populations, yet this supposition has not been verified. Additionally, reference data sets for width-to-depth ratios within the Yaak TPA are limited for some stream types (A, E, C, F). As target values posit a linkage between suggested percent fines and width-to-depth thresholds to impairment conditions, additional reference data on percent fines, macroinvertebrates, and width-to-depth ratios may assist in verifying and refining this relationship.

In addition to further reference data collection for validation of established water quality targets, collection of water quality target parameter data will assist in evaluation of target attainment. Sediment impairment determinations are based on a limited data set. Collection of primary target parameters (percent surface fines data, percent subsurface fines data, macroinvertebrates, and width-to-depth ratio) at various locations throughout the three impaired watersheds will allow a larger data set to be developed and may assist in the refinement of causal relationship affecting impairment conditions. DEQ recommends that primary target parameters be collected annually at several established monitoring sites in order to evaluate attainment of water quality targets over time.

7.4.2 Implementation and Restoration Monitoring & Evaluation

As defined by Montana State Law (MCA 75-5-703(9)), DEQ is required to evaluate progress toward meeting TMDL goals and satisfying water quality standards associated beneficial use support. If this evaluation demonstrates that water quality standards and beneficial use support have not been achieved, then DEQ is required to conduct a formal evaluation of progress in restoring water quality and the status of reasonable land, soil, and water conservations practice implementation to determine if any of the following is the case.

- The implementation of a new or improved phase of voluntary reasonable land, soil, and water conservation practices is necessary.
- Water quality is improving, but more time is needed for compliance with water quality standards.
- Revisions to the TMDL are necessary to achieve applicable water quality standards and full support of beneficial uses.

Implementation and restoration monitoring may include summaries of such items as the length of road upgraded to BMP standards, length of decommissioned roads, fish passage barriers corrected, or the estimated impact of these actions in terms of decreased pollutant loading or improved habitat. Specific details of the implementation and restoration monitoring should be coordinated with local stakeholders and DEQ before future restoration activities occur. To ensure that TMDL implementation is effective in achieving full support of beneficial uses, this monitoring should be closely integrated with target and reference monitoring discussed previously in this section.

SECTION 8.0
PUBLIC INVOLVEMENT

Public and stakeholder involvement is a component of TMDL planning efforts. Stakeholders, including the US Environmental Protection Agency, KNF, Kootenai River Network, Yaak Headwaters Partnership Group, Lincoln County Conservation District, and the US Fish & Wildlife Service were kept abreast of the TMDL process and were provided opportunities to review and comment on technical documents. Stakeholder review drafts were provided to several agency representatives, conservation district and government representatives, and representatives from conservation and watershed groups.

An additional opportunity for public involvement is the 30-day public comment period. This public review period was initiated on November 19th, 2007 and extended to December 19th, 2007. A public meeting was conducted on Tuesday, December 4th, 2007 at the USFS Ranger Station in Troy, MT. In response to public comment requests, DEQ extended the public comment period to January 14th, 2008 and conducted a second public meeting in Troy, MT on Jan 7th.

Responses to written comments received during the public comment period are given in Appendix E.

SECTION 9.0
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Acronyms

%ECA .... Percent Equivalent Clear Cut Area
ARM .... Administrative Rules of Montana
ASQs .... Allowable Sale Quantities
BER .... Board of Environmental Review
BMPs .... Best Management Practices
CER .... Comprehensive Evaluation Report
CFR .... Code of Federal Regulations
cfs .... cubic feet per second
CWA .... Clean Water Act
DEQ .... Montana Department of Environmental Quality
ECA .... Equivalent Clear Cut Area
EIS .... Environmental Impact Statement
EPA .... United States Environmental Protection Agency
EPT .... Ephemeroptera, Plecoptera, and Trichoptera
FPWYG .... Forest Plan Water Yield Guidance
FSI .... Fine Sediment Index
GCMA .... Grizzly Bear Core Management Area
GIS .... Geographic Information Systems
HIBI .... Hilsenhoff Index of Biological Integrity
HUC .... Hydrologic Unit Code
IGBC .... Interagency Grizzly Bear Community
IR .... Integrated Report
KNF .... Kootenai National Forest
LA .... Load Allocation
MAP .... Mean Annual Precipitation
MCA .... Montana Code Annotated
MFISH .... Montana Fisheries Information System
MFWP .... Montana Fish, Wildlife and Parks
mi^2 .... Square Miles
mmbf .... Million Board Feet
MMI .... Multi-Metric Index
MNHP .... Montana Natural Heritage Program
MPDES .... Montana Permitting Discharge Elimination System
MSU .... Montana State University
MTNHP .... Montana Natural Heritage Program
NRCS .... Natural Resources Conservation Service
O/E .... Observed / Expected
PFI .... Peak Flow Increase
RSI .... Riffle Stability Index
SCD/BUD .... Sufficient Credible Data/Beneficial Use Determination
SD .... Standard Deviation
SNOTEL .... Snowpack Telemetry
TMDL .... Total Maximum Daily Loads
TPA .... TMDL Planning Area

USFS .... United States Forest Service
USFWS .... United States Fish and Wildlife Service
USGS .... United States Geological Survey
W/D Ratio .... Width to Depth Ratio
WLA .... Waste Load Allocation
WQA .... Water Quality Act
YHRP .... Yaak Headwaters Restoration Partnership