Blackfoot Headwaters Planning Area

Water Quality and Habitat Restoration Plan and

TMDL for Sediment

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BLACKFOOT HEADWATERS PLANNING AREA
WATER QUALITY AND HABITAT RESTORATION PLAN
AND TMDL FOR SEDIMENT

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify those waterbodies within its boundaries that do not meet water quality standards, to prioritize the listed waterbodies according to the severity of pollution and their intended beneficial uses, and to develop TMDLs for these waterbodies. Waterbodies are streams, lakes and wetlands, although streams are the only waterbodies determined to be impaired in the Blackfoot Headwaters Planning Area. A total maximum daily load (TMDL) is a pollutant budget establishing the maximum amount of a pollutant that a waterbody can assimilate without exceeding water quality standards. This document is a water quality and habitat restoration plan that incorporates TMDLs for sediment in the Blackfoot Headwaters TMDL planning Area. Water quality restoration planning and TMDL development for metals impairment in the Blackfoot Headwaters Planning Area is addressed in a separate document (Hydrometrics et al., 2003). Together with the metals TMDL and water quality restoration plan, this document identifies an approach to improve water quality and habitat conditions to the level where all beneficial uses are restored and protected. By fulfilling this goal, this document fulfills the requirements of Section 303(d) of the Federal Clean Water Act and Title 75, Chapter 5, Part 7 of the Montana Water Quality Act.

The Blackfoot Challenge, a grass roots watershed group, sponsored development of this plan. The water quality and habitat restoration planning efforts fit well with the mission of the Blackfoot Challenge, namely coordination of efforts to enhance, conserve, and protect the natural resources and rural character of the Blackfoot River Valley. The Blackfoot Challenge's involvement helped ensure that this plan addressed not only all sediment and habitat impairments identified by the 303(d) list, but additional habitat concerns and watershed priorities as well such as noxious weed management, fish passage mitigation, and full consideration of the links between sediment impairments and fish habitat limitations. As a result, this plan functions as both a TMDL for sediments and habitat restoration plan, as well as a general plan to improve and maintain water quality throughout the basin.

Blackfoot Headwaters Planning Area

The Blackfoot Headwaters Planning Area (Planning Area) includes the Blackfoot River watershed from its headwaters to the confluence of the Blackfoot River and Nevada Creek. The Planning Area includes approximately 318,000 acres within portions of Lewis and Clark County and Powell County in west-central Montana. The Blackfoot River has a mapped length of 61.4 miles and an average gradient of 0.98 percent through the Planning Area. Poorman Creek, Landers Fork, and Arrastra Creek are major tributaries with drainage areas ranging from 130 to 24 square miles. Beartrap Creek, Sandbar Creek, and Willow Creek (near Flesher Pass) are all smaller drainages addressed in this document. All surface waters within the Planning Area are classified as B-1 waters (ARM 17.30.607). B-1 classified waters are intended to be 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).

Summary of Impairments

Table E-1 lists all waterbodies, or stream segments, identified on the 1996 and/or 2002 303(d) list as impaired, along with the listed causes of impairment (i.e., sediment, habitat degradation). Stream segments listed as impaired due to siltation in 1996 and/or 2002 include the Blackfoot River between Landers Fork and Nevada Creek, Arrastra Creek, Poorman Creek, Sandbar Creek and Willow Creek. Waterbodies listed as impaired due to habitat alterations include the Blackfoot River from its headwaters to Landers Fork, the Blackfoot River between Landers Fork and Nevada Creek, Arrastra Creek, Poorman Creek, Sandbar Creek and Willow Creek. Other listed causes of impairment include: dewatering, flow alterations, and riparian degradation in Poorman Creek; and bank erosion in Willow Creek. All of these causes of impairment have the potential to contribute to, and compound, sediment-related impairments. Metals-related impairments are addressed in a separate water quality restoration and TMDL document (Hydrometrics et al., 2003).

Based on the 303(d) listing history, and a detailed review of existing information and additional field evaluations, four streams have been identified as being in need of TMDL development for sediment, including the Blackfoot River between Landers Fork and Nevada Creek, Arrastra Creek, Poorman Creek, and Willow Creek (Table E-1). The sediment TMDLs and habitat restoration plans for these streams address all of the siltation and habitat related causes of impairment included in Table E-1. Habitat restoration plans were also developed for Sandbar Creek, Beartrap Creek, Mike Horse Creek, and the Blackfoot River from the headwaters to Landers Fork (upper one mile only) to address habitat related causes of impairment where development of a sediment TMDL was not required. Therefore, this document includes sediment TMDLs and habitat restoration plans for a total of four waterbodies and eight waterbodies, respectively. In addition to the causes of impairment listed in Table E-1 and described above, other non TMDL-related impediments to beneficial use support (and thus potential water quality impairments), such as undersized culverts which impede fish migration, are addressed as part of habitat restoration planning.

Data Collection and Assessment Methods

Development of the Blackfoot headwaters restoration plan and sediment TMDLs followed a phased approach to data collection and assessment. The Phase I assessment included a review and compilation of existing information on the Blackfoot Headwaters watershed (Confluence and DTM, 2000). Water quality and aquatic biological data were compiled and reviewed to evaluate current physical and impairment-related stream conditions. Geographical, physical and land-use information on the watershed was compiled and reviewed for use in TMDL planning. Finally, a GIS-based geomorphic risk assessment (GRA) model was developed in the Phase I assessment for identification of potential sediment loading sources and linkages of impairment to these sources. The GRA model incorporated biological and physical basin characteristics compiled during the Phase I assessment. The Phase I assessment was used for TMDL and restoration planning, with several components of the assessment incorporated into this document.

Table E-1. Summary of Waterbodies in Need of Sediment TMDL and/or Habitat Restoration Plan in the Blackfoot Headwaters Planning Area.

Waterbody	Stream Segment Number	Stream Miles	Causes of Impairment		Water Quality Plans Developed
			1996 303(d) List	2002 303(d) List	
Blackfoot River from Headwaters to Landers Fork	MT76F001-010	16.4	Metals, Other habitat alterations	Metals, Other habitat alterations	Habitat Restoration Plan for upper 1 mile
Blackfoot River from Landers Fork to Nevada Ck	MT76F001-020	48.3	Other habitat alterations, Siltation	Other habitat alterations, Siltation	Sediment TMDL/Habitat Restoration Plan
Arrastra Creek	Mt75f002-070	12.6	Not assessed	Other habitat alterations, Siltation	Sediment TMDL/Habitat Restoration Plan
Beartrap Creek from Mike Horse Creek to mouth	MT76F002-040	0.5	Metals	Metals	Habitat Restoration Plan
Mike Horse Creek	Number Not Yet Assigned	0.6	Not listed	Not listed	Habitat Restoration Plan
Poorman Creek	MT76F002-030	14.0	Dewatering, Flow alterations, Metals, Other habitat alterations, Riparian degradation, Siltation	Dewatering, Flow alterations, Metals, Other habitat alterations, Riparian degradation, Siltation	Sediment TMDL/Habitat Restoration Plan
Sandbar Creek	MT76F002-060	1.6	Not assessed	Copper, Metals, Other habitat alterations, pH, Siltation	Habitat Restoration Plan
Willow Creek	MT76F002-020	2.8	Bank erosion, Other habitat alterations,	Bank erosion, Other habitat alterations, Siltation	Sediment TMDL/Habitat Restoration Plan

The Phase I assessment was followed by an aerial photography evaluation of the Planning Area. Objectives of the assessment included delineation of individual stream reaches with similar geomorphic properties, identification of potentially impaired stream segments, assessment of riparian cover, and evaluation of channel migration rates.

A Phase II field assessment was completed in August 2002 for the purpose of filling data gaps identified in Phase I, documenting sources of sediment loading and habitat alterations, and collecting specific data required for establishing restoration targets and load allocations. The Phase II assessment included three general components:

- Reconnaissance of conditions in 303(d)-listed stream segments;
- A bank erosion inventory and Blackfoot River geomorphic assessment;
- A physical habitat assessment of “typical” or “potentially impaired” reaches as identified through the aerial photography assessment, using a modified Environmental Monitoring and Assessment Program (EMAPS) method. Information on percent of surficial fine sediment in-stream substrate; riparian structure and composition; bank full dimensions; volume of woody debris; and degree of human influence was recorded during the physical habitat assessment.

The Phase II assessment also identified and evaluated potential reference stream reaches for use in establishing restoration targets.

Other site-specific assessments and evaluations completed in support of TMDL and restoration plan development include:

- A road sediment analysis utilizing a sediment yield model developed by the USFS and Plum Creek Timber Company for select forest roads. The previously developed model was applied to roads throughout the headwaters Planning Area to estimate sediment loading from roads to impaired stream segments.
- An analysis of sediment loading to impaired streams due to road traction sanding. This analysis incorporated information on the proximity of sanded roads to streams, sand application rates, and roadbed and road ditch gradients.
- Development of a Sediment Source and Delivery Model (SSDM) for upland areas. The SSDM model was an extension of the GRA model developed in the Phase I assessment and was used to delineate areas within the watershed prone to erosion and accelerated sediment delivery to surface waters. The model incorporated information on slope, soil erodibility, vegetative cover, and precipitation.
- Estimation of sediment loading from eroding stream banks using Phase II field results, with delineation of percent attributable to human sources.
- An assessment of human influences on the geomorphology, sediment yield and water yield in Landers Fork drainage. Although not listed as impaired, Landers Fork received considerable attention due to its strong influence on the geomorphology of, and the significant sediment load (primarily natural in origin) it introduces to the Blackfoot River.

In addition to the current assessments and investigations, results of several previous studies and information sources were incorporated into the Blackfoot Headwaters Planning Area water quality and habitat restoration plan and sediment TMDL including:

- Stream substrate composition data from McNeil Core sediment samples collected by the USFS at numerous locations over a 15 year period;
- A 1996 fish habitat survey conducted by the USFS in Arrastra Creek drainage;
- Investigations of roads in Poorman Creek drainage performed by USFS as part of a vegetation management EIS. The road investigations included, among other things, estimates of sediment contribution rates from roads, and identification of undersized culverts;
- Assessments by Montana DEQ through their sufficient credible data/beneficial use support (SCD/BUD), including evaluations of periphyton and macroinvertebrate community compositions.

Current Conditions and Sediment Loading Sources

Based on the analyses performed, primary sources of sediment loading to streams in the Blackfoot Headwaters Planning Area include sediment from road runoff, road traction sanding, eroding stream banks, and erosion from upland areas. Following is a listing of water quality and habitat conditions documented in the impaired stream segments (Table E-2).

<u>Blackfoot River Upstream of Landers Fork</u>

- Biological data indicates impairment mainly attributable to metals.
- Field assessment indicates good habitat conditions, except in the upper mile where mining activities and a tailings dam breach have impacted the stream channel and riparian habitat.

<u>Blackfoot River from Landers Fork to Nevada Creek</u>

- Biological data indicates both metals and siltation-related impairment. Although indications of metals-related impairment decrease with downstream distance, historic data indicates that sediment-related impairments persist all the way downstream to the confluence with Nevada Creek.
- Physical habitat assessment results show that total sediment loading from Landers Fork, due primarily to natural sources, creates a coarse sediment, braided channel upstream of Lincoln. Streambed sediments become much finer downstream between Lincoln and Nevada Creek, where the river consists of a single channel.
- Sediment loading from eroding stream banks is significant throughout this stream reach, with a total yearly average sediment delivery of 34,400 tons/year. However, only about 5,200 tons/year, or 15%, is attributable to non-natural stream bank sources associated with preventable human-caused loading. Of this human-caused loading rate, 50% is attributable to grazing, 24% to roads, with lesser amounts attributed to logging, buildings, revetments, and other relatively minor causes.

- Traction sanding of Highway 200 contributes approximately 12tons/year of sand to the Blackfoot River and a tributary to the Blackfoot River.
- Hillslope erosion was also identified as a potentially significant source of sediment loading within the Blackfoot River watershed, although these rates could not be accurately quantified.
- Sediment delivery from roads due to erosion was determined through modeling to be about 700 tons per year, of which at least 30% could be controlled via implementation of forest road BMPs.
- Many of the above sources contribute sediment to this segment of the Blackfoot River via tributary drainages.

Arrastra Creek:

- Results of the 2002 Phase II Physical Assessment, as well as previously collected information and data, indicate that physical habitat is impaired due to excess fine sediment (siltation), and excess sediment bed load (aggradation). Siltation is more pronounced in the downstream reach.
- Runoff from roads is estimated to contribute 19 tons/year of sediment to Arrastra Creek and tributaries. Other sediment loading sources include eroding banks and hillslope erosion from harvesting and/or grazing, although these sources could not be accurately quantified.

Poorman Creek:

- Documented habitat impairments within Poorman Creek drainage include streambed sedimentation from various sediment loading sources, undersized and poorly designed culverts, and channel alterations due primarily to historic placer mining operations in the lower stream reaches. Roads are estimated to contribute 22 tons of sediment per year to Poorman Creek. Other sediment loading sources include eroding banks and hillslope erosion associated with harvesting and/or grazing, although these sources could not be accurately quantified. Dewatering also negatively impacts aquatic life in the lower reach of this stream.

Willow Creek:

- Road encroachment and past livestock grazing practices have impacted the physical habitat in Willow Creek, although livestock grazing may no longer be a significant source of habitat impairment at the most impacted sub-reach.
- Sediment loading from road runoff is estimated to be 15 tons/year, with road traction sanding providing an additional 3 tons/year. Other sediment loading sources include eroding banks and hillslope erosion from timber harvesting and/or grazing, although these sources could not be accurately quantified.

Sandbar Creek:

- Habitat alterations within Sandbar Creek drainage are primarily related to historic mining activities. In addition to introducing metals to surface waters and stream sediments, mine waste piles located along the drainage bottom act as a source of habitat degradation. Therefore, water quality restoration goals developed within this plan are linked to remediation efforts within the Blackfoot Headwaters metals TMDL (Hydrometrics et al, 2003). Another source of habitat related impairment is channelization where Sandbar Creek crosses Highway 279.

Beartrap and Mike Horse Creeks:

- As with Sandbar Creek, habitat alterations in Beartrap Creek and Mike Horse Creek are related to historic mining activities. Therefore, water quality restoration goals developed within this plan are linked to remediation efforts within the Blackfoot Headwaters metals TMDL.

Restoration Targets and Allocations

Based on the assessment of current conditions, water quality and habitat restoration goals and targets were established for each stream segment in need of a sediment TMDL. Targets were also established for restoration of habitat-related impairments that are not addressed through the sediment TMDLs, such as non-natural barriers to fish migration. Restoration targets for biological communities and stream substrate composition have been established for all of these stream segments, including the Blackfoot River between Landers Fork and Nevada Creek, Arrastra Creek, Poorman Creek, Willow Creek, Sandbar Creek, Beartrap Creek, Mike Horse Creek, and the upper mile of Blackfoot River (Table E-2). The biological targets include attainment of fully supporting conditions for macroinvertebrate and periphyton communities, and clinger taxa richness greater than or equal to 14. The stream substrate targets include upper limits on the allowable percentage of fine-grained sediments within the stream substrate, with no more than 15% of stream sediments being less than 2.38 mm in size, and no more than 29% less than 6.35 mm. Additional restoration targets were established in most of the streams based on the specific impairment causes and/or sources identified on the 303(d) list through restoration plan and TMDL development. These stream-specific targets range from establishment of minimum percentages of desirable riparian cover and limits on maximum channel width to depth ratios in several stream segments, to development of dynamically stable stream channel configurations in portions of Poorman Creek subject to historic placer mining activities.

Based on the restoration targets and sediment TMDLs, allocations were applied to the individual impairment sources or source categories. In some cases, allocations are quantitative in nature with specific limits placed on source contributions or specific requirements established for source load reductions. For example, the sediment TMDL for Poorman Creek requires 30% and 75% reductions in sediment loading rates from roads and from human-caused bank erosion, respectively. For other sources such as road sanding, performance-based allocations have been applied based on implementation of acceptable management practices to reduce sediment loading. In addition, land use indicators that could lead to establishment of future allocations are applied to address potential future impacts from increased water yield and increased hillslope erosion. The allocations, in conjunction with the implicit margins of safety incorporated into the program, constitute the sediment TMDLs for the sediment-impaired streams.

Implementation Strategy

The water quality and habitat restoration plan includes an implementation plan, or strategy, designed to ensure that restoration targets are ultimately met. The implementation strategy encompasses a wide range of proposed restoration actions as well as land use and management guidelines. The implementation strategy includes basin-wide strategies designed to meet general restoration targets and improve overall watershed health (Table E-2). The implementation strategy also includes stream-specific strategies intended to address observed impairments in each stream segment in need of TMDL and/or restoration plan development. To a large extent, the implementation strategies rely on voluntary participation by landowners and other basin stakeholders.

Due to its considerable length, the listed segment of the Blackfoot River (from Landers Fork to Nevada Creek) was separated into seven individual stream reaches, based on geomorphic form and processes, to facilitate implementation planning in this stream segment.

Basin-wide implementation strategies include:

- Management of land-use activities on erosion-prone hillsides;
- Implementation of basin-wide road improvements and enhanced road BMPs in coordination with ongoing USFS efforts;
- Management of noxious weeds;
- Development and implementation of grazing BMPs;
- Water conservation and maintenance of in-stream flows;
- Conservation of intact landscapes;
- Revegetation of stream banks and riparian zones to promote bank stability, and provide shade and large woody debris to streams;
- Adoption of riparian buffer zones to minimize encroachment and development into riparian zones and allow for natural channel migration processes; and,
- Removal of fish passage barriers, such as undersized culverts.

In addition to the basin-wide strategies, site-specific restoration strategies identified for individual stream segment corridors include:

- Blackfoot River from headwaters to Nevada Creek:
    - Road maintenance and development of grazing BMPs on the Blackfoot River extending from near the town of Lincoln downstream to near the Highway 141 bridge crossing (approximately 24 miles). Based on a prioritization of the Blackfoot River subreaches, this portion of the Blackfoot River exhibits the greatest level of impairment and highest level of eroding banks, with grazing and road encroachment identified as the primary sources of impairment;

  - Integration of channel and habitat restoration activities into currently scheduled reclamation actions proposed for the upper one-mile of the Blackfoot River as described in the Blackfoot Headwaters metals TMDL (Hydrometrics et al., 2003);
  - A combination of measures designed for stream bank stabilization and mitigation of other sediment sources, riparian vegetation enhancement, and stream channel restoration/ fish habitat enhancement in other reaches of the Blackfoot River.
- Arrastra Creek: Noxious weed management, establishment of riparian buffer zones and healthy riparian vegetative cover, and replacement of undersized culverts which affect fish migration and limit the stream's sediment transport potential;
- Poorman Creek: Noxious weed management, removal of fish passage barriers, development and implementation of riparian grazing BMPs, maintenance of in-stream flows, and restoration of placer mined portions of the creek subject to findings of a cost-benefit analysis;
- Willow Creek: Noxious weed management, continued implementation and possible refinement of riparian grazing BMPs, mitigation of road encroachment;
- Sandbar Creek: Mitigate road encroachment at Highway 279 crossing, incorporate channel restoration into proposed mine reclamation activities identified in the metals TMDL;
- Beartrap Creek and Mike Horse Creek: Incorporate channel restoration into proposed mine reclamation activities identified in the metals TMDL.

Implementation strategy coordination will be a cooperative effort, with the Blackfoot Challenge, DEQ, MDNRC, USFS, and other state and federal land management agencies and stakeholders involved. These strategies will be implemented through existing water quality and land management programs, either grass roots or regulatory in nature, such as the Montana Natural Streambed and Land Preservation Act and Floodplain Management Act. Strategies will also be implemented through cooperative agreements with landowners and stakeholders, as spearheaded by the Blackfoot Challenge. Ultimately, the implementation strategy is intended to result in full attainment of the restoration targets and designated beneficial uses, as well as improve the overall health of the watershed. Finally, an adaptive management approach will be adopted for the implementation strategy where results of ongoing monitoring are used to evaluate the success of implementation efforts, and modifications made to restoration goals, load allocations, and implementation strategies as appropriate.

Monitoring Strategy

Based on the existing conditions, restoration targets, and the implementation strategies developed in this plan, a conceptual water quality monitoring plan, or monitoring strategy, was developed. The monitoring program is intended to provide feedback on restoration activities performed under the implementation strategy program, as well as information on general watershed health and trends. The monitoring strategy includes two main categories: "Implementation Monitoring"; and "Additional Assessment and Watershed Characterization Monitoring". The objectives of the Implementation Monitoring program are to: 1) assess progress toward ultimate attainment of the restoration targets; 2) assess overall progress toward meeting load allocations; and 3) assess the effectiveness of specific restoration activities completed under the water quality and habitat restoration plan. Preliminary sampling locations and schedules for Implementation Monitoring are included for each stream in need of TMDL or habitat restoration plan development, with the sampling parameters for each stream segment based on applicable impairments and restoration targets (Table E-2). For instance, the Blackfoot River segment from Landers Fork to Nevada Creek will be monitored for macroinvertebrate and periphyton community health and substrate composition to assess attainment of the associated restoration targets established for this stream segment. Implementation Monitoring results will be used to assess the progress and success of the TMDL implementation and water quality and habitat restoration program, and determine if modifications are required under the adaptive management approach to TMDL implementation.

Additional Assessment and Watershed Characterization Monitoring is presented as a prioritized list of informational and data needs that may be required for assessment of TMDL and restoration program success. These include items such as monitoring of fish populations throughout the watershed, identification of undersized or non-functioning culverts, evaluation of effects of recent forest fires in the headwaters Planning Area, and further assessment of non 303(d)-listed streams which may in fact be impaired due to habitat and sediment-related conditions (i.e., Moose and Sauerkraut creeks). The Additional Assessment and Watershed Characterization Monitoring program will be overseen by the Blackfoot Challenge, and in most cases will incorporate and/or augment ongoing monitoring activities such as the Department of Fish Wildlife and Parks' fish population survey program. Although not specifically required under the TMDL laws, these basin-wide monitoring efforts will provide a greater understanding of the watershed health as a whole, and thus will serve as indirect measures of implementation and restoration program successes in meeting the overall TMDL goals and requirements.

Table E-2. Sediment and Habitat Restoration Plan Summary.

Stream Segment/ Stream Miles	Probable Causes of Impairment (1996 and 2002 Lists)	Existing Probable Sources of Sediment and Habitat Alteration Impairments	Beneficial Uses Not Fully Supported Due to Sediment or Habitat Alterations	Sediment and/or Habitat Related Impairments Confirmed Through Sediment TMDL and Habitat Restoration Planning Efforts	Sediment and Habitat Target Conditions	Allocations or Prescribed Conditions to Meet Water Quality Standards for Sediment and Habitat Alterations	Restoration Activities
Blackfoot River (Headwaters to Landers Fork) 16.4 miles	• Metals • Nutrients • Other Inorganics • Habitat Alteration • Siltation	• Mining	• Cold-water fish • Aquatic life	• Habitat Alterations (in uppermost mile)	• Restoration of channel morphology • Healthy aquatic invertebrate & periphyton communities	• Restoration of physical stream habitat, channel morphology and fully functioning riparian area	• Watershed-wide management activities • River Corridor management activities • Habitat Restoration Plan for upper 1 mile
Blackfoot River (Landers Fork to Nevada Creek) 48.3 miles	• Metals • Siltation • Suspended Solids • Other habitat Alterations	• Agriculture • Timber Harvest • Highway Maintenance • Roads	• Cold-water fish • Aquatic life	• Siltation • Habitat Alterations	• Reduced levels of fine sediment on the streambed • Healthy aquatic insect & periphyton communities	• Reduced contributions of fine sediment from: o Eroding banks o Roads o Road Sanding	• Watershed-wide management activities • River corridor management activities • Sediment TMDL - Mgt of eroding banks
Arrastra Creek 12.6 miles	• Flow alteration • Habitat Alteration • Siltation	• Agriculture • Roads • Bank Modification • Timber Harvest	• Cold-water fish • Aquatic life	• Siltation • Habitat Alterations	• Healthy aquatic invertebrate & periphyton communities • Decreased levels of fine sediment on the streambed • Restoration of channel morphology • Healthy riparian community	• Reduce sediment contributed from: o Roads o In channel sources o Degraded riparian areas	• Watershed-wide management activities • River corridor management activities • Sediment TMDL - Management activities associated with habitat and riparian conditions
Beartrap Creek 0.5 mile	• Metals	• Mining	• Cold-water fish • Aquatic life	• Habitat Alteration	• Restoration of channel morphology • Healthy aquatic invertebrate & periphyton communities	• Restoration of physical stream habitat, channel morphology and fully functioning riparian area	• Watershed-wide management activities • River corridor management activities • Mgt activities associated with habitat and riparian conditions

Table E-2. Sediment and Habitat Restoration Plan Summary.

Stream Segment/ Stream Miles	Probable Causes of Impairment (1996 and 2002 Lists)	Existing Probable Sources of Sediment and Habitat Alteration Impairments	Beneficial Uses Not Fully Supported Due to Sediment or Habitat Alterations	Sediment and/or Habitat Related Impairments Confirmed Through Sediment TMDL and Habitat Restoration Planning Efforts	Sediment and Habitat Target Conditions	Allocations or Prescribed Conditions to Meet Water Quality Standards for Sediment and Habitat Alterations	Restoration Activities
Mike Horse Creek 0.6 mile	• Not Listed	• Mining	• Cold-water fish • Aquatic life	• Habitat Alteration	• Restoration of channel morphology • Healthy aquatic invertebrate & periphyton communities	• Restoration of physical stream habitat, channel morphology and fully functioning riparian area	• Ongoing mine reclamation program associated with Upper Blackfoot Mining Complex • Watershed-wide mgt activities • River corridor management activities • Mgt activities associated with habitat and riparian conditions
Poorman Creek 14.0 miles	• Metals • Habitat Alteration • Riparian Degradation • Siltation • Flow Alteration	• Agriculture • Timber Harvest • Roads	• Cold-water fish • Aquatic life	• Habitat Alterations • Siltation	• Healthy aquatic invertebrate and algae communities • Decreased levels of fine sediment on the streambed • Channel restoration in placer mined reaches • Maintenance of in-stream flows • Removal of barriers to desirable fish migration	• Reduce fine sediment contributed from: o Roads o Eroding banks o Dewatering • Restoration of physical stream habitat, channel morphology and fully functioning riparian area	• Watershed-wide mgt activities • River corridor mgt activities • Sediment TMDL - Mgt activities associated with habitat and riparian conditions
Sandbar Creek 1.6 miles	• Metals • pH • Habitat Alteration • Siltation	• Mining • Channelizatio n • Roads	• Cold-water fish • Aquatic life	• Habitat Alterations	• Restoration of channel morphology • Healthy aquatic invertebrate & periphyton communities	• Restoration of physical stream habitat, channel morphology and fully functioning riparian area	• Ensure completion of metals-related restoration activities • Watershed-wide mgt activities • River corridor mgt activities • Mgt activities associated with habitat and riparian conditions
Willow Creek 2.8 miles	• Metals • Bank Erosion • Habitat Alteration • Siltation	• Agriculture • Roads • Highway Maintenance	• Cold-water fish • Aquatic life	• Habitat Alterations • Siltation	• A restored, functioning channel and riparian area • Healthy aquatic insect & algae communities • Decreased levels of fine sediment on the streambed • Removal of barriers to desirable fish migration	• Restoration of physical stream habitat, channel morphology and fully functioning riparian area. • Reduced contributions of fine sediment from: o Eroding banks o Roads o Road Sanding	• Watershed-wide mgt activities • River corridor mgt activities • Sediment TMDL - Mgt activities associated with eroding banks

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SECTION 1.0
INTRODUCTION

This document is a water quality and habitat restoration plan (WQHRP) and total maximum daily load (TMDL) submittal for sediment related impairments in the Blackfoot Headwaters Planning Area (Figure 1). The primary objective is to develop an approach to restore and maintain the physical, chemical, and biological integrity of streams in the sub-basin. Restoration and maintenance of these aspects of the integrity of the nation's waters is the objective of the Clean Water Act, which requires the development of TMDLs. Furthermore, attaining this level of watershed function will ensure full support of beneficial uses consistent with Montana Water Quality Act. The focus of this document is on habitat alterations and sediment related impacts; a separate effort addressed impairment associated with metals (Hydrometrics et al., 2003).

The Blackfoot Headwaters Planning Area contains six stream segments listed on Montana's 2002 list of impaired waters with probable causes of impairment that are associated with sediment-related pollutant conditions, including various habitat alterations. An additional two stream segments, Mike Horse Creek and Beartrap Creek, have since been identified as impaired due to habitat alterations. Montana State law defines an impaired water as a water or stream segment for which sufficient, credible data indicate that the water or stream is failing to achieve compliance with applicable water quality standards (Montana Water Quality Act, Section 75-5-103). Compilation of this list by states is a requirement of section 303(d) of the Federal Clean Water Act. Both state law and the Clean Water Act require development of TMDLs for waters on this list where sediment pollution results in impairment. This plan also includes restoration strategies where habitat or other conditions impair a beneficial use but a clear link to sediment or any other pollutant is lacking.

TMDL development and water quality restoration planning is essentially a problem-solving process. The first steps include assessment of the health of 303(d) listed streams and identification of causal mechanisms responsible for impairment. Numerical targets provide the basis of determining the degree to which stream conditions depart from desired conditions. Numerical allocations are developed to apportion the pollutant reduction needed across the watershed. Based on these analyses, watershed planners, in collaboration with stakeholders, develop a strategy or set of solutions to remedy the identified problems. The result is a plan to restore the bodies of water to a condition that meets Montana's water quality standards and support of designated beneficial uses. This document exceeds both state and federal requirements for TMDL development by dovetailing these activities into a more comprehensive water quality and habitat restoration plan for the Blackfoot Headwaters Planning Area.

According to Montana State Law, development of TMDLs is ultimately the responsibility of the Montana Department of Environmental Quality (DEQ); however, local involvement in the process ensures protection of stakeholder interests and increases the overall quality, acceptance, and ongoing implementation of the plan. In 2001, DEQ requested the Blackfoot Challenge help in developing TMDL plans for the Blackfoot Headwaters Planning Area. The Blackfoot Challenge, a local, grass roots group consisting of private landowners, federal and state agency representatives, local government officials and corporate landowners, in cooperation with other partners in the watershed, agreed to take the lead.

The Blackfoot Challenge decided to create a Blackfoot Headwaters Habitat and Water Quality Restoration Plan. The purpose of the plan was to provide a framework within which a wide array of habitat protection and restoration activities will be coordinated within the private-public partnership. A key component of this plan is the development of sediment TMDLs that address water quality issues associated with state listed impaired streams. The Blackfoot Challenge hired Confluence Consulting, Inc. and their TMDL planning partners (DTM Consulting and Applied Geomorphology, Inc.) to assist in the development of the plan. Substantial in-kind contributions from agencies, private sources, and a DEQ 319 grant funded this effort. From December 2001 through November 2003, the Blackfoot Challenge Habitat and Water Quality Restoration Committee (Appendix A) collaborated with DEQ and the contractors. The goal of employing this multiparty, interdisciplinary approach was to produce a plan that provides a better understanding of the Blackfoot headwaters, the issues, and opportunities for protection and restoration of the natural resources important to the health and vitality of the Blackfoot watershed.

While TMDL development is currently a driving force behind water quality planning efforts in the Blackfoot Headwaters Planning Area, the Blackfoot Challenge seeks to address other natural resource concerns in the basin. The goal of this plan is to provide a framework for the protection and restoration of the natural resources and the rural lifestyles that these resources support. The Blackfoot Challenge seeks to meet these objectives through education, land and water stewardship, and habitat restoration. Specific actions to achieve this objective include:

- Promote understanding of stream dynamics and impacts from human activities;
- Promote healthy riparian habitat through stream setbacks, floodplain management, riparian buffers, and riparian vegetation management;
- Promote alternatives to riprap and other bank armoring;
- Foster grazing, timber harvest, and road best management practices (BMPs);
- Control noxious weeds;
- Work with individual landowners on land stewardship; and
- Implement a long-term habitat restoration program.

An important consideration in this TMDL planning effort is the operational definition of the term restoration. Restoration, as it is used in this document, refers to any activity that promotes attainment of water and habitat quality objectives. A range of strategies fall within the concept of restoration including best management practices (BMPs), revegetation, riparian setbacks, addition of large woody debris, and mechanical channel alterations. Restoration activities will vary by stream and will reflect a number of factors such as severity of impairment aquatic species likely to benefit, and expected level of benefit.

Addressing issues of seasonality is an important consideration in sediment TMDL planning efforts. Some sediment and related habitat impairments vary in their severity with season. For example, flow is a considerable influence on siltation with scouring of fines occurring during spring runoff and accumulations occurring during low flows. Despite seasonal variations, in-stream conditions need to ensure beneficial use support throughout the year.

This plan incorporates seasonality through several ways. First, the US Forest Service monitors substrate composition based on timing of spawning for the species of concern to ensure that core samples represent recent spawning locations. Bull trout spawning areas are monitored during the fall and westslope cutthroat trout streams are monitored during early summer. Furthermore, the index period for developed for macroinvertebrate and periphyton also has a built in mechanism for addressing seasonality. The index period begins following spring runoff and extends through September. This captures the period when conditions are likely to be most stressful to aquatic life. For example, low flows during this time will result in accumulation of fine sediment. Furthermore, other stressful conditions associated with riparian and habitat degradation such as warm water temperatures is more pronounced in this period. Note that this has significant influence on aquatic macroinvertebrates as insects with an aquatic life stage evolved in cold headwater streams (Ward and Stanford, 1982). Therefore, warmer temperatures may be constraint to those species that have not adapted to these conditions.

Seasonality and high flow/runoff conditions are incorporated into the sediment loading model developed to address hillslope erosion processes, models that address erosion from forest roads, evaluation of road sand loading to streams, and sediment loading estimates derived for the Landers Fork. Models that predict sediment loads from eroding banks inherently incorporate runoff flows when bank erosion is greatest. Impacts from human related flow alterations are considered from a seasonal basis. During runoff conditions, increased bank erosion or increased hillslope erosion from increases to peak flows is assessed as a potential source of increased sediment loading throughout the watershed. During low flow conditions, flow diversions that reduce baseflow conditions are assessed as a contributing factor to sediment accumulation in the lower portion of Poorman Creek.

Consideration of margin of safety is another 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 in several ways:

- Consideration of seasonality as described above;
- The adaptive management approach evaluates target attainment and allows for refinement of load allocations, targets, and restoration strategies to ensure restoration of beneficial uses;
- The sediment delivery from roads allocation is set at 30% for the Blackfoot River TMDL whereas the assessment suggests a lower reduction would satisfy the TMDL;
- An allocation is set for highway road sanding even though sediment contributions are relatively minor;
- The target setting approach for percent fines developed in Appendix G was based on a conservative assumptions regarding the set of least impaired streams to represent reference conditions;
- Multiple targets addressing biota measures and physical channel conditions are developed to address excess fines and other impairments;

- Land use indicators are added to the allocations section to help address sediment loading from future activities;
- Impairment determinations were based on conservative assumptions that favored the resource when impairments were not obvious; and
- The monitoring plan calls for evaluations of tributaries not on the 303(d) list that may contribute sediment to the Blackfoot Headwaters Planning Area.

1.1 Watershed Characterization

1.1.1 Location and Description of Watershed

The Blackfoot Headwaters Planning Area lies approximately 40 air miles northwest of Helena, Montana in west-central Montana just west of the continental divide (Figure 1). The watershed consists of the contributing area of the headwaters of the Blackfoot River watershed down to its confluence with Nevada Creek and encompasses approximately 500 square miles (318,294 acres) in Lewis and Clark and Powell counties. The Continental Divide bounds the watershed to the east and south and the Swan Range limits the northwestern extent. Elevations range from over 8000 feet in the headwaters of the Landers Fork to 4260 feet at its confluence with Nevada Creek.

Listed streams in the Blackfoot Headwaters Planning Area vary in drainage area, stream length, and gradient (Table 1-1). The main stem of the Blackfoot River in the planning area has a mapped length of 61.4 miles and an average gradient of 0.98 percent. Poorman Creek, Landers Fork, and Arrastra Creek are major tributaries with drainage areas ranging from 130 to 24 square miles. Beartrap, Sandbar, and Willow creeks are relatively small streams with a combined watershed area of about 33 square miles.

Table 1-1. Drainage Statistics for 303(d) Listed Streams in the Blackfoot Headwaters Planning Area.

Drainage Name	Area (sq mi)	Main stem Length (mi)
Arrastra Creek	23.8	12.61
Beartrap Creek	3.27	0.52
Blackfoot River MT76F001_010	115.3	14.94
Blackfoot River MT76F001_020	497.3	46.46
Landers Fork	130.8	11.63
Poorman Creek	48.0	14.02
Sandbar Creek	10.1	1.64
Willow Creek	19.34	2.80

1.1.2 Geological Setting

The Blackfoot Headwaters Planning Area consists dominantly of Proterozoic aged sedimentary rocks of the Belt Supergroup thrust eastward during the Late Tertiary Laramide orogeny (Figure 2). The majority of area consists of Proterozoic sedimentary rocks (Greyson shale, Spokane shale, Empire shale, Helena limestone; Roberts, 1986). Small amounts of Cambrian and Mississippian sedimentary rocks outcrop in the northern portion of the watershed. Cretaceous and Tertiary diorites and gabbros intrude the east central and southeast portions of the watershed and are host for many of the mineral occurrences in the area. Minor amounts of Tertiary volcanic and sedimentary rocks occur in the southern part of the watershed. Finally, Quaternary alluvium and glacial deposits cover much of the Blackfoot River and Landers Fork valley bottoms as well as much of the Beaver Creek, Stonewall Creek, and Willow Creek sub-watersheds. The headwaters of the Landers Fork deeply down cuts through this Quaternary glacial till, providing a significant natural source of fine sediment and coarse cobbles to the Landers Fork and ultimately, the Blackfoot River.

Late Cretaceous and early Tertiary intrusive activity led to the formation of numerous metallic mineral occurrences in the watershed (Figure 2). This includes occurrences of gold, silver, lead, zinc, and copper. Three major mining districts contain most of the area's historic mining activity: the Upper Blackfoot Mining Complex (UBMC) otherwise known as the Heddleston District or Mike Horse Mine, the Seven-Up Pete area, and the Swansea Mine.

1.1.3 Climate

Long, cold winters and short, moderately hot summers typify the climate of the upper Blackfoot watershed. Monthly minimum and maximum temperatures average 10.0 and 80.6 °F in January and July respectively (Table 1-2). Average annual precipitation ranges from 12.73 inches just west of the outlet of the watershed to 18.71 inches at the Lincoln Ranger Station. Higher elevations receive considerably more precipitation with the headwaters of Copper Creek averaging almost 53 inches per year (Figure 3).

Table 1-2. Climate Summary from Lincoln Ranger Station (Period of Record is from July 1948 through December 2000).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temp (°F)	29.7	36.3	43.3	53.6	63.6	71.3	80.8	80.6	69.5	55.9	38.9	31.1	54.6
Average Min. Temp (°F)	10.0	14.9	19.2	26.3	33.1	39.3	41.9	40.1	32.9	27.4	19.5	12.9	26.5
Average Total Precip (in.)	2.0	1.4	1.2	1.3	2.3	2.2	1.2	1.3	1.2	1.2	1.5	1.9	18.7

Table 1-2. Climate Summary from Lincoln Ranger Station (Period of Record is from July 1948 through December 2000).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Total Snow Fall (in.)	21.9	14.5	12.1	6.7	2.0	0.0	0.0	0.0	0.4	2.3	10.3	19.4	89.6
Average Snow Depth (in.)	14.0	16.0	12.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	8.0	4.0

1.1.4 Vegetation

Plant community types within the upper Blackfoot watershed are typical of higher elevation areas of the Rocky Mountains ecoregion. Vegetation classes most abundant include lodgepole pine, mixed subalpine forest, low/moderate cover grasslands, and Douglas fir (Table 1-3). Forested vegetation types occur mainly in higher elevations with grasslands dominating in valley portions in the watershed (Figure 4).

Table 1-3. Percent Area of Vegetation Types Occurring in the Blackfoot Headwaters Planning Area.

Vegetation Cover Type	Percent Area
Lodgepole Pine	18.47
Mixed Subalpine Forest	15.72
Low/ Moderate Cover Grasslands	12.06
Douglas-Fir/ Lodgepole Pine	11.58
Douglas-Fir	11.36
Mixed Mesic Shrubs	5.94
Mixed Xeric Forest	5.11
Standing Burnt Forest	3.44
Mixed Whitebark Pine Forest	2.66
Mixed Mesic Forest	2.44
Montane Parklands & Subalpine Meadows	1.94
Conifer Riparian	1.57
Mixed Broadleaf Forest	1.41
Shrub Riparian	1.26
Rock	1.10
Mixed Riparian	0.60
Ponderosa Pine	0.43
Moderate/ High Cover Grasslands	0.43
Western Larch	0.40
Agricultural Lands – Irrigated	0.38
Mixed Barren Sites	0.35
Alpine Meadows	0.30

Table 1-3. Percent Area of Vegetation Types Occurring in the Blackfoot Headwaters Planning Area.

Vegetation Cover Type	Percent Area
Mixed Broadleaf & Conifer Forest	0.21
Broadleaf Riparian	0.12
Water	0.09
Mines, Quarries, Gravel Pits	0.05
Sagebrush	0.04
Graminoid & Forb Riparian	0.04
Agricultural Lands – Dry	0.03
Urban Or Developed Lands	0.02
Mixed Broadleaf & Conifer Riparian	0.01

1.1.5 Land Ownership and Use

A mixture of public and private ownership comprises land holdings in the Blackfoot Headwaters Planning Area (Figure 5). Public lands account for the majority of the watershed with most of these lands under USFS ownership (64%), which includes “wilderness” identified in Figure 5. Plum Creek Timber Company is the next largest single landowner with approximately 6.5% of lands, while the combined holdings of other private landowners encompass 23.5% of the watershed. The State of Montana is a minor player with less than 4% ownership. USFS lands occupy higher elevations with state and Plum Creek holdings interspersed throughout. Other private holdings concentrate in lower elevation, valley portions of the watershed.

Land uses in the Blackfoot Headwaters Planning Area are typical of rural, forested watersheds in Montana (Figure 6). The dominant land uses in the watershed are livestock grazing, timber harvest, recreation, and minor dry land and irrigated agriculture. Irrigated agriculture occurs primarily in a small portion of the watershed, near Poorman Creek. Residential development is relatively minor with concentrations around Lincoln, Montana, the only town in the planning area. According to the 2000 census, Lincoln has a population of about 1,100 people. Of that number, about 600 are permanent residents and 500 reside in Lincoln seasonally (Lincoln Chamber of Commerce, personal communication).

1.1.6 Baseline Hydrology

Stream flow data from four USGS stream gage stations provide the basis for descriptions of hydrological conditions in the Blackfoot Headwaters Planning Area (Figure 3). The period of record varies considerably among these stations. USGS gauge station number 12335000 (Blackfoot River near Helmville) has the longest period of record (1940-1953) of the four stations and is closest to the outlet of the watershed at the confluence of the Blackfoot River and Nevada Creek. Stream flow measurements at the other stations covered a shorter period of record, between 2 and 4 years. Note that a more complete hydrologic record would enhance abilities to assess flow conditions and trends in the watershed.

Average monthly discharge hydrographs generated for gaging stations in the Blackfoot Headwaters Planning Area indicate that stream flows follow the pattern typical of snowmelt driven systems (Figure 7). Peak flows occur in May and June followed by a slow decrease in flow through July and August. The relatively gradual decline of the falling limb of the hydrograph suggests that dewatering is not significant, at least not for this reach of the main stem of the Blackfoot River. These data do not provide a basis to assess dewatering on individual tributaries.

The median daily hydrograph generated for the Helmville gaging station (1233500) further characterizes stream flow characteristics in the basin (Figure 8). The data show rapidly increasing discharges in March and April with peak discharges in late May indicative of snowmelt runoff. In contrast, the average monthly discharge data show peak flows for the 1940-1953 period of record occurring in June. A review of the daily discharge data for USGS Station 12335000 revealed that several large runoff events up to 6000 cfs during June raised the average discharge but not the median above that of May. This suggests that rain-on-snow event or other large event occurred during the period of record at this gage. Note that none of the data from other hydrographs shows this trend. These large but relatively rare events may have significant influence on channel morphology in the main stem Blackfoot River.

1.1.7 Fisheries

The Blackfoot Headwaters Planning Area supports a largely native assemblage of fish comprised of eight species within four families (Table 1-4). Salmonids include the native bull trout, westslope cutthroat trout, mountain whitefish, and the introduced brook trout and brown trout. Two species of catostomid, longnose sucker and largescale sucker, occur in the upper Blackfoot watershed. The longnose dace is the sole member of the minnow family and the slimy sculpin is presumably the only member of the sculpin family occurring in the upper Blackfoot River watershed.

The Blackfoot Headwaters Planning Area has tremendous importance in the conservation and recovery of bull trout, a federally listed threatened species. The Montana Bull Trout Scientific Group (1995) identified Copper Creek and Landers Fork as core areas for bull trout due to the importance of these streams for spawning and rearing or migration to nursery areas. As a result, these areas are the focus of restoration and monitoring activities in the management of this sensitive species. Factors contributing to the decline of bull trout throughout their range include siltation and habitat degradation, increased water temperatures, introduced fish species, and barriers that restrict the movements of this highly migratory species.

Table 1-4. Fish Species Occurring in the Blackfoot Headwaters Planning Area.

Family/Common Name	Scientific Name	Introduced/ Native	Status
Salmonidae (trout, char and whitefish)			
Bull trout	*Salvelinus confluentus*	Native	Threatened
Westslope cutthroat trout	*Oncorhynchus clarki lewisii*	Native	Species of special concern
Mountain whitefish	*Prosopium williamsoni*	Native	

Table 1-4. Fish Species Occurring in the Blackfoot Headwaters Planning Area.

Family/Common Name	Scientific Name	Introduced/ Native	Status
Brook trout	*Salvelinus fontinalis*	Introduced	
Brown trout	*Salmo trutta*	Introduced	
Catostomidae (suckers)			
Largescale sucker	*Catostomus macrocheilus*	Native	
Longnose sucker	*Catostomus catostomus*	Native	
Cyprinidae (minnows)			
Longnose dace	*Rhinichthys cataractae*	Native	
Cottidae (sculpin)			
Slimy sculpin	*Cottus cognatus*	Native	

The Blackfoot Headwaters Planning Area is a stronghold for westslope cutthroat trout; another species experiencing marked declines. A major concern in the conservation of westslope cutthroat trout is the cumulative effects of siltation and introduced species on its persistence in the headwater streams, which comprise most of the remaining habitat for this species. In the presence of both brook trout and relatively high levels of fine sediment, westslope cutthroat trout face a higher risk of extirpation (Shepard et al., 1998). This underscores the need to address siltation in the conservation of westslope cutthroat trout.

Considerable efforts are underway to promote the conservation of native fish throughout the entire Blackfoot watershed. In the early 1990s, Montana Fish, Wildlife & Parks (MFWP), and the Big Blackfoot Chapter of Trout Unlimited (BBCTU) formed a partnership aimed at recovery of native fish in the Blackfoot River watershed. Initially, these efforts concentrated in the middle area of the watershed. Beginning in 1999, MFWP and BBCTU expanded their focus to include the upper Blackfoot drainage. Activities included baseline fish and habitat assessments for upper Blackfoot tributaries, identification of constraints on native fish, and monitoring in five study reaches previously sampled in 1988. These investigations resulted in identification of restoration priorities on Poorman Creek, including livestock management, conversion to sprinkler irrigation and reduction of fish loss to ditches. Implementation of these activities began in 2001. Meanwhile, evaluation of habitat and water temperatures continues in the upper Blackfoot to identify potential restoration projects benefiting recovery of native species.

In addition to sensitive, native species, the Blackfoot Headwaters Planning Area also supports high quality, recreational fishing opportunities. Montana Fish, Wildlife & Parks rates this fishery as an outstanding fisheries resource due in part to the abundance of game species and the relatively high numbers of large fish (MFISH database, http://nris.state.mt.us/wis/data/fisheries.html). Based on fishing pressure data, the uppermost 30 miles of the Blackfoot River regularly rates within the top ten streams in the upper Clark Fork sub-major basin, which includes the Bitterroot, Flint-Rock, and upper Clark Fork hydrologic units (MFISH database). Consequently, recreational fishing in the Blackfoot Headwaters

Planning Area contributes to the local economy through purchases by anglers of food, gas, and lodging.

1.1.8 Fluvial Geomorphology and Associated Conditions

Fluvial geomorphology refers to the study of the physical, morphological processes that operate within river systems and the landforms they create or have created. A number of factors influence fluvial geomorphology including basin geology, climate, vegetation, and hydrology. Because alterations in river geomorphology appear to be an issue with many 303(d) listed streams in the Blackfoot Headwaters Planning Area, characterization of fluvial processes in the basin, as described below, provides an important element supporting watershed restoration planning efforts. This section also includes description of associated features such as riparian condition and land use that may influence the geomorphic character of each stream.

As the upper Blackfoot River and its tributaries occupy headwater and main stem environments, the geomorphic character of the river system is highly variable. The uppermost reaches of the Blackfoot are typically small, moderately confined, single thread channels. At the Landers Fork confluence, the geomorphic character and size of the Blackfoot River changes markedly due to contributions of flow and coarse sediment from the Landers Fork. For the first mile downstream of the confluence, the channel is moderately confined, and thereby capable of transporting the sediment load. However, downstream of Lincoln, the channel widens significantly into a transitional meandering/braided system characterized by extensive sediment storage, lateral channel shift, and avulsion.

Downstream of Lincoln, the braided channel corridor narrows and the channel transitions back to a single thread, meandering stream. The channel gradient drops from 0.3% to approximately 0.09% as the channel enters the canyon section below Dalton Bridge. The low gradient and fine-grained perimeter sediments within and downstream of the canyon suggest historical impoundment of the river through the canyon, perhaps by an extensive series of beaver dams. Support for this supposition includes descriptions of the Blackfoot River provided in Merriweather Lewis's journals that confirm the presence of extensive beaver activity prior to the influx of European settlers. The channel has cut into those fine-grained deposits, forming a defined channel course surrounded by low terraces. The relatively narrow channel corridor results in frequent impingement of the main channel thread against the terrace margin. This results in cycling of sediment via storage of coarse sediment in bar environments and entrainment of fines from the banks. This fine material moves downstream, where it is especially deleterious to channel function and habitat value downstream of the Highway 141 Bridge.

Willow Creek is a tributary of the uppermost reach of the Blackfoot River. The channel is relatively confined, and black cottonwood, alder, willow, spruce, and lodgepole pine dominate the narrow riparian corridor. Willows exhibit indications of substantial browse pressure from wildlife in at least one location, and there are significant historical impacts, likely from livestock grazing, in the section that represents the primary reason for the impairment determination (DEQ, 2004). Heavy infestations of spotted knapweed and lesser amounts of musk thistle and Canada thistle occur on terrace environments. At the mouth of Sandbar Creek, Willow Creek consists of a wetland complex characterized by pools, multiple channels, and dense riparian vegetation. Downstream, to the Blackfoot River confluence, woody debris accumulations are common, and debris jams occur locally.

Mining activities are a significant impact on Sandbar Creek, a tributary of Willow Creek. Mine tailings border the banks in the upper reaches and iron hydroxide covers much of the stream substrate. Near its mouth, the Highway 279 embankment channelizes approximately 200 ft of Sandbar creek. Conditions occurring in this segment include bank failure, flow impoundment, and loss of cross sectional definition.

Poorman Creek is a major tributary of the Blackfoot River, joining the Blackfoot just downstream of Lincoln. Headwater channels within the Poorman Creek watershed are confined, relatively steep, and stable. Black cottonwood occurs in the riparian zone, along with conifer, willow, dogwood, and alder. In middle reaches, historic placer mining was extensive, and the channel flows through placer spoil piles, as well as locally confined canyon sections. In some segments influenced by placer mining, the channel has short aggradational reaches, and high width-to-depth ratios. In other sections, the channel has down cut into spoils, although these incised channel segments tend to be well vegetated and relatively stable. Encroachment of residences, livestock grazing, and dewatering all have an adverse effect on the lower reaches of Poorman Creek. Heavy infestations of spotted knapweed, Canada thistle, and musk thistle occupy mined areas. The lowermost portion of Poorman Creek is a relatively coarse grained, moderately entrenched single thread channel.

Arrastra Creek is the western most tributary of the Blackfoot River within the Blackfoot Headwaters Planning Area. Riparian communities typically consist of black cottonwood, alder, snowberry, dogwood, and occasional spruce and willow. High width-to-depth ratios, coarse substrate, intermittent flow conditions, and local aggradations collectively suggest that the channel is overly wide due to high sediment loads. Infrequent woody debris jams create local pool and cover habitat. Livestock grazing and logging may be contributing to channel widening and increased sediment loads.

1.2 Water Quality Impairments and 303(d) List Status

The Montana 303(d) list includes several streams in the Blackfoot Headwaters Planning Area (Table 1-5). Inclusion of a stream on this list indicates that it is not supporting one or more of its beneficial uses. According to the Administrative Rules of Montana, waters in this basin are B1 streams, which designate the following beneficial uses:

- Support and propagation of cold-water fisheries,
- Associated aquatic life,
- Contact recreation,
- Agriculture,
- Industry, and
- Drinking water.

The Montana 2002 303(d) List (DEQ, 2002a) is the most current EPA-approved list. Some listings identified on the 1996 list were omitted from the 2002 303(d) list for one of two reasons.

In some cases, sufficient, credible data (SCD) were not available to assess reliably the status of a body of water with respect to certain pollutants. Alternatively, review of SCD occasionally indicated that the stream is not impaired or threatened as previously described. When SCD are lacking, the body of water becomes a priority for reassessment. In cases where the reassessment data indicate impairment, development of TMDLs will follow. In order to explain discrepancies between the 1996 and 2002 lists, this document includes information on the 1996 list and rationale for alterations to these listings.

This document addresses several causes of impairment for streams in the Blackfoot Headwaters Planning Area. These include siltation, suspended solids, habitat alterations, bank erosion, and riparian degradation. Sediment is the pollutant that effectively encompasses most or all of these causes of impairment (EPA, 1999). The objective of sediment TMDL development is to define acceptable sediment loading, transport and/or depositional characteristics associated with human sources so that water quality and stream habitat provide full support for cold-water fish and aquatic life.

Because riparian or stream habitat alterations relate to undesirable levels of sediment within a stream, TMDL development for sediment needs to be closely linked to most impairments associated with habitat alterations. These alterations can result in greater sediment loading to streams and/or alter transport and storage of sediment. Consequently, TMDL plans that restore impaired habitat also serve to decrease excess sediment deposition and overall sediment loading within the basin.

While not included as a probable cause of impairment for streams in the Blackfoot Headwaters Planning Area, barriers to fish movement throughout the basin present another identifiable constraint to cold-water fisheries. Improperly designed or maintained culverts at road crossings are the most common features that block fish migrations in forested watersheds. These fish passage barriers constitute an alteration to habitat that potentially prevents a stream from supporting propagation of cold-water fish, a designated beneficial use. This is an important consideration in the upper Blackfoot River watershed, which supports bull trout and westslope cutthroat trout. These species have migratory life history strategies and rely on headwaters for spawning and rearing. Therefore, this habitat restoration plan includes elimination of undesirable fish passage barriers as supplement to TMDL development requirements.

Dewatering is another type of habitat alteration that negatively influences fish and associated aquatic life. Most obviously, dewatering reduces the amount and quality of available habitat for fish. Dewatering may be a factor in siltation when reduced flows are not capable of transporting fine sediment resulting in accumulations on streambed surfaces. Dewatering can also negatively impact riparian health, thereby contributing to bank instability, increased sediment loading, and overall reduced habitat complexity. Furthermore, low flow volume associated with dewatering has less thermal inertia and is more susceptible to heating compared to non-altered flows. This is an important consideration in the watershed, which supports bull trout, a species very sensitive to thermal loading. The lower portion of Poorman Creek provides an example of a dewatered reach in the Blackfoot Headwaters Planning Area.

In addition to sediment, metals contamination is a cause of impairment for several streams in the Blackfoot Headwaters Planning Area. TMDL planning to reduce metals pollution occurred separately from this effort (Hydrometrics et al., 2003). However, it is important to note that restoration efforts designed to decrease loading of metals will also decrease sediment loading from mining impacted reaches. Conversely, efforts defined by this plan to reduce erosion can also reduce metals loading to streams in situations where native soils are naturally high in some metals concentrations.

1.3 Modifications and Updates to the 303(d) List

Comprehensive review of available data during the course of TMDL planning efforts indicated that several modifications to the 303(d) list were in order. Modifications include delisting of streams (as in the case of Marcum Creek), changes in impaired sub-reaches, and elimination or addition of some probable causes of impairment. This section provides a description and justification for existing or pending modifications to the 303(d) list.

1.3.1 Marcum Creek

Several lines of evidence support the removal of Marcum Creek from the 303(d) list. During two separate field investigations, both Pipp and Roberts (DEQ, 2004) were unable to locate a stream channel, observing only a jeep trail. Furthermore, sample station locations for data used in listing Marcum Creek do not correspond to an existing channel. Based on this information, DEQ determined Marcum Creek does not exist in the Blackfoot Headwaters Planning Area and removed it from the 303(d) list in 2002.

1.3.2 Willow Creek

The modification to the Willow Creek listing involved listing the entire length of this stream as impaired. This is consistent with the DEQ SCD/BUD files, which treat Willow Creek all as one stream segment. The 2002 303(d) list identifies the section of Willow Creek from Sandbar Creek to the mouth as impaired due to bank erosion. However, this is not consistent with bank erosion data and the DEQ files (DEQ, 2004), which confirm that there are impairments above Sandbar Creek.

1.3.3 Blackfoot River from the Headwaters to Landers Fork

An important concern in this TMDL planning effort was the discrepancy between the 1996 and 2002 lists for two probable causes of impairment: nutrients and other organics. Detailed analysis of existing information supports the removal or clarification of these pollutants as probable causes of impairment. The following subsections detail the rationale and justification developed by DEQ for eliminating some pollutants of concern on the 303(d) list.

Nutrients

DEQ reviewed analyses of nutrient concentrations and sources of nutrient enrichment in evaluating the potential for eutrophication in the main stem Blackfoot River. Biologically available forms of nitrogen (nitrate + nitrite, ammonia, and ammonium) were consistently low and usually below detection limits. In contrast, total Kjeldahl nitrogen measured in 1994 was higher than average concentrations reported for the ecoregion (Richards and Miller, 2000) and occasionally higher than the value set as a standard on the Clark Fork River (0.3 mg/L). Concentrations of different forms of phosphorus were variable. Orthophosphorus, a soluble form of phosphorus was usually below the detection limit (0.01 mg/L). Concentrations of total phosphorus, a measure of all the phosphorus in the sample, were frequently higher than the ecoregion average and standards developed for the Clark Fork River. However, because total phosphorus showed a strong, positive correlation with flow, it is likely that loading of inorganic, phosphorus-bearing sediments was responsible (Confluence and DTM, 2002). Note that phosphorus adsorbed to soil particles is typically not biologically available and does not present a significant risk for eutrophication.

Potential human sources of nutrient enrichment in this portion of the Blackfoot River are limited. However, wetland marshes in the upper reaches of the Blackfoot River provide a natural source of potential nutrient loading. This possible natural source of nutrients, along with an apparent lack of negative influences to beneficial uses justify removal of nutrients as a cause of impairment on the 303(d) list. Nevertheless, nutrient sampling will continue as part of monitoring activities in the Blackfoot Headwaters Planning Area. In the event that monitoring results suggest eutrophication in this portion of the Blackfoot River, development of a TMDL to address nutrient enrichment will follow.

Other Inorganics

Inorganic constituents evaluated for this portion of the Blackfoot River include a number of common ions (sulfate, chloride, and potassium). Among the major inorganic solutes, elevated sulfate concentrations were the major concern. Sulfate concentrations have been consistently high in this reach, a condition observed since the early 1970s. Elevated sulfate is probably related to old mining activities in the headwaters and is often used as an indicator of acid mine drainage. Chloride concentrations were typically below laboratory detection limits, however, occasionally chloride exceeded mean concentrations for streams in the ecoregion (Richards and Miller, 2000). Potassium concentrations were consistently low and usually around 1.0 mg/L, a pattern holding since the 1960s. Because of the links between sulfate and metals contamination, efforts to reduce loading of sulfate are effectively included in TMDL planning for metals pollution (Hydrometrics et al., 2003).

Table 1-5. List of Impaired Waters for the Blackfoot Headwaters Planning Area (1996 and 2002).

Listed Stream and Number	List	Probable Cause(s)	Probable Source(s)	Uses Not Fully Supported Due To Sediment Or Habitat Alterations
Blackfoot River (Headwaters to Landers Fork) MT76F001-010	1996	Metals, Nutrients, Other Inorganics, Siltation	Agriculture, Harvesting, Restoration, Residue Management, Mine Tailings, Resource Extraction, Subsurface Mining	Cold-Water Fishery, Aquatic Life
	2002	Metals, Habitat Alterations	Silviculture, Resource Extraction, Acid Mine Drainage, Abandoned Mining, Habitat Modification (other than hydromodification), Bank Modification/Destabilization	Cold-Water Fishery, Aquatic Life
Blackfoot River (Landers Fork to Nevada Cr) MT76F001-020	1996	Metals, Siltation, Suspended Solids	Agriculture, Natural Sources, Resource Extraction, Silviculture	Cold-Water Fishery, Aquatic Life
	2002	Other Habitat Alterations, Siltation	Agriculture, Silviculture	Cold-Water Fishery, Aquatic Life
Willow Cr MT76F002-020	1996	Metals	Resource Extraction, Subsurface Mining	NA
	2002	Bank Erosion, Habitat alteration, Siltation	Agriculture, Grazing, Habitat Modification, Bank Modification, Highway Maintenance and Runoff	Cold-Water Fishery, Aquatic Life
Poorman Cr (headwaters to mouth) MT76F002-030	1996	Metals, Habitat Alteration, Siltation	Agriculture, Canalization, Dredge Mining, Irrigated Crop Production, Logging Road Construction/ Maintenance, Natural Sources, Resource Extraction, Stream bank Modifications/ Destabilization	Cold-Water Fishery, Aquatic Life
	2002	Dewatering, Flow Alteration, Metals, Habitat Alterations, Riparian degradation, Siltation	Silviculture, Logging roads, Construction, Resource Extraction, Abandoned Mining	Cold-Water Fishery, Aquatic Life
Beartrap Cr (Mike Horse Cr to mouth) MT76F002-040	1996	Metals	Mill Tailings, Resource Extraction, Subsurface Mining	NA
	2002	Metals	Resource Extraction, Mill Tailings	NA

Table 1-5. List of Impaired Waters for the Blackfoot Headwaters Planning Area (1996 and 2002).

Listed Stream and Number	List	Probable Cause(s)	Probable Source(s)	Uses Not Fully Supported Due To Sediment Or Habitat Alterations
Sandbar Cr (from forks to mouth) MT76F002-060	1996	Metals	Resource Extraction Subsurface Mining	NA
	2002	pH, Copper, Metals, Habitat Alterations, Siltation	Resource Extraction, Acid Mine Drainage, Abandoned Mining, Highway Maintenance and Runoff	Cold-Water Fishery, Aquatic Life
Arrastra Cr (headwaters to mouth) MT76F002-070	1996	Flow Alteration, Habitat Alterations, Siltation	Agriculture, Highway/ Road/ Bridge Construction, Natural Sources, Range Land	Cold-Water Fishery, Aquatic Life
	2002	Habitat Alterations, Siltation	Agriculture, Habitat Modifications, Shoreline Modification, Highway Maintenance and Runoff	Cold-Water Fishery, Aquatic Life

1.3.4 Beartrap Creek and Mike Horse Creek Impairments

Changes to Beartrap and Mike Horse creeks include the addition of habitat alterations as probable causes of impairment. Historic mining activities and failure of the Mike Horse Mine Dam in 1975 resulted in the listing of these streams for metals contamination on the 1996 and 2002 lists. Through the course of this TMDL planning effort, sufficient evidence of habitat alterations surfaced as another probable cause of impairment. These habitat alterations relate to mining disturbances.

1.3.5 Changes to Probable Causes on 303(d) List

There were a number of minor changes made to probable causes of impairment related to sediment pollution between the 1996 and 2002 303(d) list. These changes reflect the improved understanding of conditions in these streams following review of the available data during compilation of the 2002 list. For example, the Blackfoot River had suspended sediment as a probable cause on the 1996 but not on the 2002 list. This is because the data did not indicate a clear link between concentrations of suspended sediment and impairment. In contrast, indications that siltation impaired beneficial uses were unambiguous. Overall, this alteration in probable causes is not significant as a TMDL for sediment is still required.

1.4 Applicable Water Quality Standards

All streams in Montana are assigned a stream classification that designates appropriate standards and beneficial uses (Montana Surface Water Quality Standards and Procedures: Title 17, Chapter 30, Sub-Chapter 6). Streams in the Blackfoot Headwaters Planning Area are B-1 waters (17.30.607). As stated previously, the B-1 classification standards (17.30.623[1] ARM), include the beneficial uses “drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonids, fishes, and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.”

There are two categories of standards applicable to water quality conditions in the Blackfoot Headwaters Planning Area, numeric and narrative standards. Numeric standards apply to pollutants such as metals, organic chemicals, or other toxic constituents. These standards address concentrations known to have adverse effects on aquatic life or human health. Aquatic life standards include chronic and acutely toxic levels, which relate to partial or non-support of that beneficial use respectively. Narrative standards differ from numeric standards in that they describe either the allowable condition or an allowable increase of a pollutant over “naturally occurring” rather than a specific number. In addition to the beneficial uses as discussed above and defined within 17.30.623[1], there are several additional rules within the Water Quality Standards that apply to B-1 waters such as the Blackfoot Headwaters Planning Area and its pollutant and habitat conditions of concern. These rules (Water Quality Standards: Title 17, Chapter 30, Sub-Chapter 6 of the Administrative Rules of Montana) are summarized in Table 1-6.

DEQ typically uses a reference condition to determine if narrative water quality standards are being achieved (DEQ, 2002a), and to help set TMDL targets. The term “reference condition” is defined as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. Waterbodies that are used to determine reference condition are not necessarily pristine. Reference condition does not reflect an effort to turn the clock back to conditions that may have existed before human settlement, but is intended to accommodate natural variations in biological communities, water chemistry, etc. due to climate, bedrock, soils, hydrology and other natural physiochemical differences. In other words, reference condition reflects a waterbody's greatest potential for water quality given existing and historic land use activities, and should reflect minimum impacts from human activities.

Comparison of conditions in a waterbody to conditions in a reference waterbody must be made during similar season and/or hydrologic conditions for both waterbodies. The primary or secondary approach may be used to determine reference conditions. The primary approach involves:

- 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.

The secondary approach involves reviewing literature, seeking expert opinion, or applying quantitative modeling such as 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 regional reference data are lacking. DEQ often uses more than one approach to determine reference condition depending on the type of data availability.

Data are often collected from "least impaired" waterbodies to determine reference condition for interpreting Montana's water quality standards and for setting TMDL targets. The term "least impaired" is applied to waterbodies that have reasonable land, soil and water conservation practices and are supporting their beneficial uses. Often these waters have human activities occurring within their watersheds. However, the water quality impacts that are caused by the human activities are controlled by conservation practices and the stream's water quality corresponds to its potential.

In this document the term "least impaired" is applied to waters that are either at reference condition, as described above, or likely very close to reference condition. These waterbodies may be supporting their beneficial uses relative to a given pollutant of concern, but there may be some uncertainty if the waterbody is at its greatest potential. Often, the waterbody may be recovering from past impacts, and further recovery may be possible. Nevertheless, the existing data and information from these least-impaired waterbodies are used to interpret Montana's water quality standards and develop TMDLs targets. For this reason, adaptive management is often proposed for the collection of additional data and information in the future to refine our interpretations of the standards and adjust TMDL targets when appropriate.

Reasonable land, soil, and water conservation practices are not always accomplished by using best management practices (BMPs) (DEQ, 2002a). BMPs are land management practices that provide a degree of protection for water quality, but they may not be sufficient to achieve compliance with water quality standards and protect beneficial uses. Therefore, reasonable land, soil, and water conservation practices generally include BMPs, but additional conservation practices may be required to achieve compliance with water quality standards and restore beneficial uses.

Table 1-6. Applicable Rules for Sediment Related Pollutant and Habitat Conditions of Concern for Waters Classified as B1.

Rule(s)	Standard
17.30.623(1)	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.
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.
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 2.0 SUMMARY OF DATA COLLECTION AND ASSESSMENT METHODOLOGIES

This section briefly describes the information used to develop the *Blackfoot Headwaters Planning Area Water Quality and Habitat Restoration Plan and TMDL for Sediment*. Types of information included review of existing information, GIS modeling, and field assessments designed to fill data gaps and provide a basis for numeric targets. See the appendices referenced below for details regarding methods and results.

2.1 Phase I Assessment

The initial step in this watershed planning endeavor was a Phase I assessment (Confluence and DTM, 2002). A significant portion of this effort involved compilation and review of existing information. Other components of the Phase I assessment included identifying links between impairments and pollutants of concern, identification of potential sources of pollution, identification of data gaps and development of a watershed characterization. Previous work by DEQ through sufficient credible data/beneficial use support (SCD/BUD) review provided a thorough list of available sources of information on the Blackfoot Headwaters Planning Area and was an invaluable resource for Phase I planning. Resources compiled through the SCD/BUD process included data sources and reports addressing physical, biological, and physicochemical assessments in the watershed.

A major product of the Phase I assessment was development of a GIS based geomorphic risk assessment (GRA) model (Confluence and DTM, 2002). This model integrated spatial data on the physical and biological characteristics of the basin to predict potential for sediment production throughout the watershed. The model allowed for identification of potential sources of sediment in the basin and provided a means to link these sources to impairment wherever possible.

Compilation and review of biological data was another significant component of the Phase I assessment. This included fisheries information and analyses of macroinvertebrate and periphyton assemblages. The macroinvertebrate and periphyton association information was particularly useful in developing TMDL endpoints. See Appendix B for a description of analyses and interpretations.

2.2 Aerial Photography Assessment

The next step in TMDL development was an assessment of aerial photos of the Blackfoot Headwaters Planning Area. The aerial photo assessment effort had several objectives. The initial objectives included to delineation of reaches based on Rosgen Level I classification (Rosgen, 1996) and identification of potentially impaired areas. This delineation provided the basis for field sampling efforts during the summer of 2002. The other objectives included assessment of riparian cover and the amount of channel migration over the period of record. See Appendix C for detailed methods of the aerial photo assessment and assessment results.

2.3 Phase II Field Assessment

The Phase I efforts and aerial photo assessments provided the framework for Phase II field assessment in August 2002. Scientists from several state and federal agencies contributed to this watershed-scale effort. The objectives of the field assessment were to fill data gaps, identify sources of sediment loading and habitat alterations, and collect data used in the development of numeric targets for TMDLs and other restoration goals. Appendix D provides more detail on the field assessment methods.

Three principal components comprised the 2002 field assessment activities. The first component was a reconnaissance inventory of conditions on 303(d) listed tributaries of the Blackfoot River. The purpose of this reconnaissance was to evaluate geomorphic and riparian conditions and other indicators of impairment in these streams. The second component of the field assessment consisted of a bank erosion inventory and geomorphic assessment of the Blackfoot River. The bank erosion inventory provided information on the proportion of banks that are eroding, severity of bank erosion, and the grain size contributed from those banks. A proximity-weighted index of human influence applied to each eroding bank provided a means to evaluate the relative roles of human activities and natural disturbance on increasing erosion.

The final component of the field assessment was an evaluation of physical habitat using a combination of two common habitat assessment methodologies: Environmental Monitoring and Assessment Program (EMAP) habitat methods developed by the EPA (Lazorchak et al., 1999) and the R1/R4 fish habitat inventory developed by the US Forest Service (Overton et al., 1997). Because EMAP methods comprised the majority of this assessment approach, “modified EMAP” is an appropriate description of this methodology. Reaches were located in areas identified in the aerial photo assessment as representing either typical or potentially impaired reaches of the Blackfoot River and listed tributaries. In addition, evaluation of a number of least impaired or reference reaches provided a means to develop numeric endpoints. The modified EMAP allowed for assessment of a number of parameters including percent surface fines, riparian structure and composition, bank full dimensions, volume of woody debris, and a proximity-weighted index of human influence.

Synthesis of reconnaissance, erosion inventory, EMAP habitat assessments, and aerial photo analysis provided the basis to describe the fluvial geomorphic processes for sub-reaches of the Blackfoot River and its listed tributaries. This assessment includes other identified impairments and conditions that merit attention such as barriers to fish migration and noxious weed infestation. See Appendix E for detailed geomorphic descriptions of the Blackfoot River and listed tributaries.

2.4 Sediment Load Estimations from Eroding Banks

The erosion inventory conducted as part of field assessments in 2002 provided the basis for estimating the amount of sediment contributed from bank erosion in the main stem of the Blackfoot River (Appendix F). A number of analyses supported this method of estimating loads. The first step involved determination of an average rate of bank retreat for the Blackfoot River.

Comparison of rates of bank retreat from aerial photos of the Blackfoot River with rates observed in similar streams provided an annual average retreat for banks on the Blackfoot River. The next step was to calculate volumes of sediment from the surveyed banks on the Blackfoot River. Field data collected on length, height, and severity of erosion for each eroding bank and soil data addressing bulk density of the soils were used in this calculation. These analyses culminated in an estimate of the average, annual load of sediment from eroding banks for each sub-reach of the Blackfoot River. Finally, incorporation of a proximity-weighted human influence index measured for each eroding bank allowed for inference on the load contributed due to human activities along the stream margin as well as the relative contributions from the different types of human activities.

2.5 McNeil Core Analyses

A wealth of McNeil Core data provided by the US Forest Service presented an opportunity to develop TMDL targets based on potential for spawning success. Over the course of 15 years, the USFS collected McNeil cores at numerous sampling stations throughout the basin. Note that McNeil core sampling is the most accurate method of sampling substrate composition in comparison to other commonly used methods (Young et al., 1991). Sources used in development of criteria for suitability of spawning gravels included scientific literature (primarily Kondolf, 2000), the potential for the stream to meet the criteria, and input from TMDL specialists from DEQ. Appendix G provides detailed methods and results for these analyses.

2.6 Arrastra Creek Fish Habitat Survey

Existing assessments of physical habitat conditions in Arrastra Creek (USFS, unpublished data) provided a quantitative basis for assessing stream conditions and establishing targets. USFS field crews conducted a fish habitat assessment (Hankin and Reeves, 1988) in Arrastra Creek in 1996. These data provide a surrogate for the modified EMAP assessments conducted during Phase II field assessments in 2002. Appendix H provides a summary of the results from this analysis.

2.7 Landers Fork Investigations

The Landers Fork, a major tributary of the Blackfoot River, has a strong influence on the geomorphology and character of the Blackfoot River below its confluence. The Landers Fork produces a substantial sediment load from glacial deposits from much of its length. Still, the role of land use practices in exacerbating sediment delivery and transport was not well documented. Therefore, TMDL planning efforts included an effort to characterize conditions in the Landers Fork in order to assess the relative impacts of human activities on channel morphology, sediment production, and water yield. These activities included a field reconnaissance investigation and analysis of the Landers Fork sediment transport potential (Appendix I).

2.8 Road Sediment Analyses

The US Forest Service (Helena National Forest) and Plum Creek Timber Company conducted an analysis of sediment derived from forest roads in select areas of the watershed. From this, they developed sediment delivery rates for unit length of roads. Within the project GIS, it was possible to extrapolate these rates to all roads within the Blackfoot Headwaters Planning Area. The result was an estimate of sediment contributed from roads in sub-watersheds throughout the Blackfoot Headwaters Planning Area. Appendix J provides details on road sediment data, analysis, and results.

2.9 Poorman Creek Road Investigations

During the mid-1990s, the USFS conducted investigations on roads in the Poorman Creek watershed as part of an environmental impact statement (EIS) investigation for watershed-wide vegetation management. Several of these investigations had similar objectives to these TMDL planning efforts. These include estimation of volume of sediment contributed from roads, identification of barriers to fish movement, identification of undersized culverts, and remedies to reduce sediment loading to streams. Appendix K provides a summary of these investigations in Poorman Creek.

2.10 Road Traction Sanding

Sanding roads to increase traction during winter months provides a potential source of increased sediment loading to streams in the Blackfoot Headwaters Planning Area, specifically the main stem of the Blackfoot River and Willow Creek. An analysis provided the basis to estimate loading of sand to these streams (Appendix L). This analysis was based on the length of highway within a certain distance from each stream, sand application rates, and estimated delivery of road sand to the stream.

2.11 Assessment of Upland Sources of Sediment to Streams

Production and delivery of sediment from upland sources is a natural occurrence in watersheds. Still, many human activities can intensify these processes resulting in increased siltation over background levels. Enhancement of the GIS-based Sediment Source and Delivery Model (SSDM) developed in Phase I allowed estimation of potential sediment production and delivery potential from upland sources. The model was used to delineate areas within the watershed that are more prone to both produce sediment and deliver sediment to tributary and main stem streams. The sediment production component of the model integrates spatial information on slope, soil erodibility, vegetative cover, and precipitation. Sediment delivery is a function of the connectivity of high sediment production areas via steep, low vegetation cover areas to streams. In order to summarize the resultant data by a meaningful management unit, the watershed was subdivided into 16 sub-watersheds, each representing the contributing area of a significant stream in the basin. Figure 9 shows the location of the sub-watersheds and identified areas of elevated sediment production and delivery potential. Table 3-1 in the next section summarizes the results by sub-watershed. Appendix M provides an explanation of the SSDM Model and results.

This model has several applications with regard to water quality planning in the Blackfoot Headwaters Planning Area. First, it provides a tool to quantify relative loading of upland sediment from human activities among sub-watershed in the larger basin. Second, it provides a tool to help develop restoration goals and to help with implementation planning. The identification of high-risk areas with steep slopes, low vegetation cover, higher precipitation, erodible soils, and connectivity to streams provides the Blackfoot Challenge and Blackfoot River communities with a tool to manage land use activities to avoid excess sediment loading following land disturbances.

SECTION 3.0
EXISTING STREAM CONDITIONS RELATED TO SEDIMENT AND HABITAT IMPAIRMENT

This section addresses existing stream conditions, sources of sediment and related habitat impairment in the Blackfoot Headwaters Planning Area. The focus is on nonpoint sources of pollution and the links with riparian condition and stream morphology, as there are no known point sources of sediment pollution in the Blackfoot Headwaters Planning Area. Data assessment methods summarized in Section 2.0 and detailed in appendices provide the basis for these descriptions.

Sediment production and transport is a natural occurrence within watersheds. A significant challenge in this TMDL development was to partition the natural, background loads from human-induced loads and to then determine to what extent the loads associated with human activities can be controlled via BMPs and reasonable land, soil and water conservation practices. This is an important distinction in light of Montana's water quality standards and the use of reference conditions. To explain, some of the narrative standards are based on increases above "naturally occurring" concentrations of sediment that can negatively impact beneficial uses. The multiple lines of evidence to assess sources and potential for delivery of sediment (summarized in Section 2.0 and detailed in the appendices) provide the basis for discriminating among natural and human-related sources.

There are several potential natural sources of sediment in the upper Blackfoot River watershed. Erosion and ultimate delivery of sediment from hillslopes is a potentially significant natural source, especially in areas with erodible soils and low vegetation cover. Mass wasting is an extreme form of hillslope erosion that can contribute large amounts of sediment to streams. Note that review of aerial photos and satellite images did not locate any significant examples of mass wasting in this portion of the Blackfoot River watershed. Finally, some erosion of stream banks is a natural occurrence within streams that contributes to the system's sediment load.

Human activities can accelerate natural erosional processes resulting in contributions of sediment in excess of natural, background levels. Examples of human activities that increase sediment production and delivery include removal of riparian vegetation, such as may be caused by land clearing or grazing. Land use practices that reduce riparian vegetation can increase the rate and change the pattern of bank erosion. Channel changes, such as historic channel straightening or activities that prevent natural channel movements, also cause accelerated erosion. Removal or alterations in vegetative cover on uplands have the potential to increase hillslope erosion above natural. Similarly, increased water yield from vegetation removal can accelerate bank erosion downstream through increases in peak flows. Erosion from the surface of roads is another potential source of sediment from streams. This also includes sediment contributed from cut and fill slopes along roads, sanding, and impacts associated with culverts and bridges. Finally, significant reductions in flow during lower flow periods may influence sediment by reducing transport resulting in increased amounts of fine sediment settling on the streambed.

An additional goal of assessment efforts is to evaluate overall human influences on stream stability. A "stable" stream is one that has the ability, over time (in the present climate), to transport the flows and sediment produced by its watershed in such a manner that the dimension, pattern and profile are maintained without either aggrading, or degrading (Rosgen, 1996). Accelerated erosion can cause changes in stream channel stability and associated stream type changes. The instability and consequential shifts in stream type can further increase sediment supply, cause reduced land productivity, land loss, fish habitat degradation, and degrade the physical and biological function of rivers.

3.1 Blackfoot River Conditions (Above Landers Fork)

The field assessment in 2002 combined with existing sources of information provided a robust means to describe existing riparian and channel conditions in the Blackfoot River. In addition, this assessment allowed for identification of sources of sediment and calculation of loads from various sources. Based on these analyses, it was possible to verify or negate impairment status and differentiate among natural and human-induced sources of sediment or channel instability.

3.1.1 Biological Indicators

Periphyton and aquatic macroinvertebrate assemblages are commonly assessed indicators of biological integrity and represent a direct measure of the level of support of aquatic life, a designated beneficial use. For the Blackfoot River above the confluence with the Landers Fork, metals contamination appears to be an overwhelming influence on biotic communities (Appendix B). This includes high proportions of abnormal diatoms (Bahls, 2001), an indication of toxics, and severely depressed mayfly, stonefly, and caddis fly richness and abundance (Bollman, 2001). Because metals contamination may mask or overwhelm community response to siltation, the ability to draw inferences regarding siltation from these data is limited.

3.1.2 Physical Habitat

Field assessments of 2002 combined with analyses of aerial imagery provided the primary means of evaluating the physical habitat in the Blackfoot River above the confluence with Landers Fork. In general, sediment and habitat conditions in this reach appear to be "least impaired" and provide a suitable reference for developing TMDL targets. The exception to this is a reach in the uppermost portions of the stream affected by mining activities. Otherwise, the channel is predominately stable with erosion balanced by storage. Siltation was minimal as described by several indicators including surface fines measured with the 49-point grid (Appendix E) and McNeil cores (Appendix G).

3.1.3 Sediment Source Loading Determinations

A number of sources of sediment have the potential to increase loading of fine sediment to this portion of Blackfoot River and its tributaries. These include eroding banks, roads, road traction sanding, and hillslope erosion. The following subsections summarize the estimated contributions of sediment from these sources.

Estimate of Sediment Load from Stream Bank Erosion

The erosion inventory conducted in 2002 provided the basis to characterize bank erosion in this reach and estimate a yearly load of sediment from eroding banks (Appendix F). Overall, bank erosion was not a significant feature in this portion of the Blackfoot River. Geomorphic analyses indicate a mostly stable stream channel with erosion balanced by local storage of sediment (see Appendix E). Most eroding banks rated as slightly eroding with relatively few banks in the moderate or severe categories. In addition, the human influence indexes calculated for eroding bank indicate minimal human disturbance. Human activities leading to accelerated erosion include roads, revetments, and limited grazing. Overall, the results suggest that most bank erosion was the result of natural patterns of erosion and aggradation and not significantly intensified by human activities. In terms of sediment load, bank erosion in this portion of the Blackfoot River produces the lowest estimated volume of sediment per mile of any reach in the Blackfoot River examined in this planning effort (Figure F-2). Therefore, bank erosion is not a significant contributor of sediment to the Blackfoot River above the Landers Fork.

Sediment from Road Surface Erosion

Increased sediment delivery to streams from roads is a probable source of impairment in the Blackfoot Headwaters Planning Area. The results of two separate analyses by the USFS and Plum Creek Timber Company provided information to quantify these increased sediment loads. The USFS approach involved developing a road sediment delivery coefficient for a unit length of road surface based on field measurements. In contrast, the Plum Creek approach involved detailed measurements at road/stream crossings of road surface, cut slope, and fill slope areas as well as observations on soil type, traffic level and other factors affecting sediment routing from the roads. Both methodologies yielded similar results for sediment yield per unit length of road. Since the Plum Creek Timber Co. method sediment yield per unit length (0.26 tons/mile) was slightly higher than the USFS estimate, this coefficient was then applied to all roads in the planning area to develop total sediment yield from roads. Although these analyses were conducted on forest roads, the sediment production coefficient was applied to all roads in the planning area regardless of surface. The rationale used is that even though roads with gravel or paved surfaces will yield less sediment than forest roads per unit area, these roads have a larger footprint and therefore a larger cut slope and fill slope. This will lead to a similar sediment yield per unit length of road. The results from this analysis for all of the Blackfoot Headwaters are presented in Appendix J. These results do not indicate high levels of loading to the Blackfoot River, with a total of about 7 tons of sediment loading to this reach via results for the upper Blackfoot and the 303(d) listed Willow Creek combined (Table J-1).

Sediment from Highway Traction Sanding

Road sanding in winter months is a potential source of sediment to this portion of the Blackfoot River. Efforts to evaluate sediment loading from road traction sanding are described in Appendix L. Essentially, this analysis suggests that the road sand load in the upper portion of the watershed is similar to the above load from forest roads.

Hillslope Erosion and Increased Water Yield

The sediment source and delivery model (SSDM) described in Appendix M provides a means to evaluate the relative potential of sub-watersheds to produce and deliver sediment from hillslope erosion. Sediment loads for the Blackfoot River above the confluence with the Landers Fork are sourced from two of the sub-watersheds in Table 3-1; upper Blackfoot and Willow Creek listed. Approximately 11 to 12% of the area in these two sub-watersheds has a relatively high potential to both produce and deliver sediment to streams based on model results (Columns F and G). None of this higher sediment production and delivery potential area is known to have had recent (1992-1999) timber harvests (Column G). The modeled increase in water yield due to vegetation reduction over this same time was also negligible in the Willow Creek listed and very low in the Upper Blackfoot (Column H). Based on this analysis, hillslope erosion is not believed to be a significant source of sediment to the watershed. Also, the analysis indicates that increased sediment production associated with increased water yield and peak flows is not a significant concern.

Table 3-1. Results of SSDM Model. Area of Recent Vegetation Changes, Predicted Elevated Sediment Source and Delivery Potential, and Predicted Water Yield Increase from Recent Vegetation Changes are Listed.

Column A	Column B	Column C	Column D	Column E	Column F	Column G	Column H
Sub-watershed Name	Area (acres)	Percent High Cover (1999)	Percent High Cover Change, 1992 to 1999	Percent of Area with Elevated Potential Sediment Yield and High Cover (1999)	Percent of Area with Elevated Potential Sediment Yield and Low Cover (1999)	Percent of Area with Elevated Potential Sediment Yield and Recent Harvest	Calculated % Change in Water Yield, 1992 to 1999
Arrastra Creek	15218	66.8	-1.9	16.9	3.9	0.5	1.2
Beaver Creek	11509	75.6	-1.3	6.9	2.7	0.0	0.8
Copper Creek	26663	83.2	-0.6	9.0	4.2	0.0	NA
Humbug Creek Area	16720	76.2	-3.3	2.9	0.4	0.0	1.0
Keep Cool Creek	9103	77.4	-5.5	1.5	0.1	0.0	1.6
Landers Fork	83722	73.4	-1.4	4.9	1.5	0.0	1.3
Lincoln Gulch	7628	79.9	-3.5	9.3	0.8	0.2	1.0
Mineral Hill	1464	28.6	0.0	0.4	2.5	0.0	0.3
Moose Creek Area	7497	84.1	-9.0	3.6	0.9	0.4	3.0
Patterson Prairie	6524	54.6	-5.0	7.2	4.5	1.2	1.4
Poorman Creek	26294	90.7	-1.4	15.5	0.8	0.0	0.6
Sauerkraut Creek	9150	74.6	-18.5	0.6	0.1	0.0	5.9
Stonewall Creek	17349	73.4	-1.3	12.8	1.8	0.0	0.4

Table 3-1. Results of SSDM Model. Area of Recent Vegetation Changes, Predicted Elevated Sediment Source and Delivery Potential, and Predicted Water Yield Increase from Recent Vegetation Changes are Listed.

Column A	Column B	Column C	Column D	Column E	Column F	Column G	Column H
Sub-watershed Name	Area (acres)	Percent High Cover (1999)	Percent High Cover Change, 1992 to 1999	Percent of Area with Elevated Potential Sediment Yield and High Cover (1999)	Percent of Area with Elevated Potential Sediment Yield and Low Cover (1999)	Percent of Area with Elevated Potential Sediment Yield and Recent Harvest	Calculated % Change in Water Yield, 1992 to 1999
Upper Blackfoot	73786	79.8	-1.1	9.8	1.5	0.0	0.5
Willow Creek	11854	77.5	-5.3	0.3	0.0	0.0	1.7
Willow Creek listed	12381	88.2	0.0	11.6	1.5	0.0	0.1

3.2 Blackfoot River (Landers Fork to Nevada Creek)

A significant amount of information was available to evaluate the existing conditions in this reach of the Blackfoot River. A substantial portion included monitoring data collected by state and federal agencies. In addition, the field assessment of 2002 focused considerable effort on this portion of the Blackfoot River. Finally, evaluations in the Landers Fork (Appendix I) were an important component of evaluating the relative roles of human activities and natural disturbance on the geomorphic character and water quality conditions in the Blackfoot River below the confluence with the Landers Fork.

3.2.1 Biological Indicators

Macroinvertebrate and periphyton samples collected in this reach of the Blackfoot River suggest conditions ranging from minor (not impaired per the 303 (d) list) to moderate (impaired per the 303[d] list) impairment of aquatic life beneficial uses (Appendix B). Indications from diatom associations suggest the continued impact of metals contamination at sampling sites in the reach of the Blackfoot River, although these indicators diminished with distance from the source of metals in the headwaters.

Macroinvertebrate communities collected on the Blackfoot River demonstrated indications of both siltation and drought conditions. Samples collected in 2001 suggested moderate impairment at the sampling station near Helmville Bridge with depressed richness of clinger taxa. In contrast, macroinvertebrate community composition at the station just above Nevada Creek did not demonstrate indications of impairment. Still, macroinvertebrate monitoring at this location in the late 1980s and the early 1970s suggest siltation impaired beneficial uses (McGuire, 1991).

3.2.2 Physical Habitat

Fluvial geomorphology, bank and riparian condition, and substrate composition change dramatically along this portion of the Blackfoot River. In the section of river between the Landers Fork and Lincoln, conditions are mostly the result of substantial deposition of coarse bedload from the Landers Fork. This results in a wide, braided channel characterized by bedload storage. While residential development poses isolated alterations in habitat conditions, these are minimal compared to the overwhelming influence of sediment inputs from the Landers Fork.

While this portion of the Blackfoot River does not provide quality habitat for fish, the question regarding causality was important from a restoration and TMDL perspective. In other words, were the observed habitat conditions the result of natural disturbance or were human activities negatively influencing conditions in the Landers Fork and ultimately the Blackfoot River. Investigations in the Landers Fork associated with this planning effort suggested that while human activities had a minor impact on the Landers Fork, natural factors were the overwhelming influence (Appendix I).

Conditions change dramatically below Lincoln, Montana. The channel returns to a single thread channel, bank erosion becomes more prevalent, and substrate composition becomes progressively finer. Furthermore, sediment core data collected in this reach indicate accumulations of fine sediment on the streambed are at levels that are harmful to cold-water fisheries (Appendix G). These fines are at levels shown to limit survival of salmonid embryos and provide evidence of sediment impairment in the Blackfoot River.

Additional evidence of impairment in this reach of the Blackfoot River includes the relatively large percentage of eroding banks linked to human influences (Appendix F; Table F-3) and the corresponding relationship between bank erosion and human influence (Figure F-3). This suggests that streamside management activities are decreasing the health and function of banks and increasing rates of bank erosion.

3.2.3 Sediment Source Loading Determinations

Estimate of Sediment Load from Stream Bank Erosion

Bank erosion is a significant feature in this portion of the Blackfoot River. In the assessment of 2002, observers inventoried eroding banks in 32% of this reach and documented about 10 miles of eroding bank (Appendix F). When extrapolated along the total length of the Blackfoot River from Nevada Creek to the headwaters, this yielded an estimated loading of 34,492 tons of sediment per year that comes from eroding banks along this stream.

To evaluate compliance with water quality standards, it is important to distinguish between natural and human sources of sediment. Human influence index information suggested a strong correlation between bank erosion severity and human disturbance. Still, a considerable proportion of eroding banks lacked obvious indications of human activities influencing bank stability. Furthermore, not all sediment contributed from banks associated with human disturbance can be attributed to human activities. Using best professional judgment, an estimate of 75% of the erosion from banks associated with human disturbance was linked to the human disturbance. This yields an estimate of 5,250 tons per year from human activities. Livestock grazing was the most significant influence (about 50% of the total human influence index), followed by encroachment by roads and railroads (25% of total). Buildings, logging, and revetments all had relative contributions between 5 and 10% of the total impacts from human activities (Appendix F, Table F-3).

Sediment Contributed from Roads

Increased sediment delivery to streams from roads was evaluated as a source of loading. The total road sediment load throughout the drainage was estimated at about 302 tons per year (Appendix J). Most or all of this load has the potential to reach the lower segments of the Blackfoot River above Nevada Creek.

Sediment from Highway Traction Sanding

Evaluation of potential delivery of sand from traction sanding (Appendix L) suggests this mechanism could deliver a total of about 12 tons per year of sediment to the Blackfoot River. This sand comes from Highway 200, which is located within 200 feet of the Blackfoot River for over three miles of its length in the Blackfoot Headwaters Planning Areas, and located within 200 feet of Willow Creek for about 0.6 mile.

Hillslope Erosion and Increased Water Yield

Hillslope erosion and a related increase in water yield is a probable source of sediment loading to the Blackfoot River. Table 3-1 above lists the results of the SSDM model used to predict which areas have elevated potential to both produce and deliver sediment to streams. All 16 of the tabled sub-watersheds are tributaries to the Blackfoot River and/or include main stem portions of the Blackfoot River drainage from the headwaters to Nevada Creek. Therefore, all of the tabled areas can be considered sources of sediment to this reach. Note the total percent area with an elevated potential to produce and deliver sediment (Columns E + F) varies from a high of 20.8% in Arrastra Creek to a low of 0.3 % in Willow Creek (unlisted). Other drainages with high sediment potential include Copper Creek (13.2%), Patterson Prairie (11.7%), Poorman Creek (16.3%), Stonewall Creek (14.6%), Willow Creek listed (13.1%).

The total amount of apparent timber harvest in these drainages between 1992 and 1999 provides an indication of the potential for increased hillslope erosion (Column D). Harvest during this period has been as high as 18.5% of Sauerkraut Creek drainage to 0% in Willow Creek listed. Many of the drainages have harvest levels during this period of less than 2%. Other drainages with significant recent harvest during this period include Keep Cool Creek (5.5%), Moose Creek (9.0%), Patterson Prairie (5.0%), and Willow Creek (5.3%). Equally important is how much of the total drainage includes harvest within the areas of elevated potential sediment production and delivery. This varies from 1.2 % in Patterson Prairie to 0% for the majority of the watershed. This analysis suggests that hillslope erosion is not a significant source of sediment to the watershed if timber harvest involved a high rate of BMP compliance, particularly in the areas of elevated potential sediment production.

The total harvest within the drainage was also used to calculate water yield (Column H) as an indicator of potential increased impacts to channel bank erosion (see Appendix M for discussion on methodology). The calculated increases for the 1992 to 1999 period ranged from as high as 5.9% in Sauerkraut Creek to nearly 0% in Willow Creek listed. All other drainages had values less than 2%, with the exception of Moose Creek Area with a 3% calculated water yield increase. This indicates a potential for increased bank erosion in a few tributaries due to increased flow conditions, with any increased sediment production likely reaching the lower reaches of the Blackfoot River. Most tributaries appear to have had only minor increases and increased erosion from water yield in these tributaries is considered insignificant. The exception may be the Landers Fork, where minor increases in water yield can lead to significant increases in bank erosion as identified in Appendix M. This analysis indicates that increased sediment production associated with increased water yield and peak flows is probably not a significant concern.

3.3 Arrastra Creek Assessment Results

3.3.1 Biological Indicators

Macroinvertebrate and periphyton associations gave mixed results with regard to siltation in Arrastra Creek (Appendix B). The siltation index calculated from diatom associations at the two sampling stations in Arrastra Creek was consistent with full support and excellent biological integrity. Based on metric results, macroinvertebrate communities indicated an impairment at the upper site and full support at the lower site. Additionally, richness of clinger taxa was relatively low at both sampling sites, which provides evidence that siltation may be negatively affecting aquatic life beneficial uses on Arrastra Creek, although there was a low sample size (total organisms collected) at the upper site thus reducing the reliability of the data (Bollman 2001).

3.3.2 Physical Habitat

Investigations used in assessing the physical habitat in Arrastra Creek include reconnaissance investigations conducted in August 2002 (Appendix E) McNeil core samples collected by USFS personnel (Appendix G) and a fish habitat survey conducted by USFS personnel in 1996 (Appendix H). Habitat conditions observed in Arrastra Creek consistent with sediment impairment include an overly wide, aggradational channel with a large supply of cobble-sized particles (see Appendix H for geomorphic descriptions). Undersized culverts may be contributing to braided, depositional areas from obstructed flows upstream of culverts thereby further limiting habitat suitability for fish locally.

Analyses of substrate composition suggest relatively low levels of fine sediment in the upper reaches on the stream and increasing siltation in the lowest reach. Pebble counts conducted as part of the 1996 fish habitat survey indicate particles less than 2.38 mm in diameter account for nearly 35% of the substrate. Although based on a different methodology, these levels are still significantly greater than levels measured in the Blackfoot River above the Landers Fork, a reach that appears to be an acceptable reference or least-impaired condition for tributary streams in the Blackfoot Headwaters Planning Area. Furthermore, McNeil core data provide evidence of excess siltation with proportions of fine sediment at levels that impair propagation of salmonids.

3.3.3 Sediment Source Loading Determinations

Estimate of Sediment Load from Stream Bank Erosion

Data to support estimation of sediment loads contributed from eroding banks as described in Appendix F were not collected on Arrastra Creek. Still, there are indications that human activities are accelerating bank erosion above natural on Arrastra Creek. Specifically, fish habitat assessments collected by USFS personnel indicates about 40% of stream banks in the lowest reach of Arrastra Creek are vegetated but unstable, a condition that may increase sediment loading from bank erosion to Arrastra Creek (Appendix H).

Estimate of Sediment Loads from Roads

Roads in the Arrastra Creek watershed are a potential source of sediment loading. There are over 73 miles of road in the Arrastra Creek drainage that yield an estimated 19 tons per year of sediment to surface waters (Appendix J). Note that Arrastra Creek has one of the higher road densities in the planning area, leading to a relatively high proportion of sediment loading from roads.

Hillslope Erosion and Increased Water Yield

Results of the model developed to assess the potential for hillslope erosion (Appendix M) suggests that the Arrastra Creek sub-basin contains the largest proportion of area falling into the category of elevated sediment production and delivery potential (Table 3-1, Columns E and F). While it is not possible to provide a defensible estimate of a numeric load from hillslope erosion, these results suggest that Arrastra Creek has a higher potential to produce and deliver relatively high levels of sediment from both natural and human induced hillslope erosion compared to other sub-watersheds in the Blackfoot Headwaters Planning Area. Although the Arrastra Creek watershed has undergone only a moderate level of recent timber harvest at 1.9% of the total drainage (Column C), a fair amount of harvest has been in the areas of elevated sediment risk (0.5% per Column G). Also of concern would be potential impacts from excessive grazing pressure in the areas of elevated sediment potential, although this activity was not evaluated outside of riparian zones. Based on this analysis, hillslope erosion could be a significant source of sediment to the watershed if timber harvest and other activities in areas of elevated potential sediment production have not involved a high rate of BMP compliance. The relatively low water yield increase (1.2%) due to timber harvest indicates that increased sediment production associated with increased water yield and peak flows is probably not a significant concern in this watershed.

3.4 Poorman Creek Assessment Results

3.4.1 Biological Indicators

Biological indicators on Poorman Creek suggest moderate to no impairment from siltation at the three sampling stations (Appendix B). The siltation index developed for diatom associations was slightly elevated at the middle sampling station, a level consistent with minor impairment but full support of beneficial uses. The full range of macroinvertebrate community metrics calculated in Table B-3 indicates full support at all three sites. In contrast, the clinger taxa results at the upper and lower sampling stations on Poorman Creek indicate a potential impairment based on richness of clinger taxa at these stations.

3.4.2 Physical Habitat

A combination of long term monitoring and more recent field evaluations conducted in August 2002 provide evidence of several types of impairment of physical habitat in Poorman Creek. These relate to sediment pollution in that they are direct measures of sediment in the system or relate to the links between stream morphology and riparian function and sediment pollution. Another observed limitation to support of cold-water fisheries was the presence of several potential barriers to fish migration in the basin.

Assessments of substrate composition provide evidence for siltation impairing beneficial uses in Poorman Creek. Long term monitoring of substrate composition using McNeil cores indicates relatively high levels of particles less than 6.35 mm in spawning areas (Appendix G). These levels were considerably higher than levels occurring in the main stem of the Blackfoot River above Landers Fork, an internal reference for tributaries in the Blackfoot Headwaters Planning Area. Similarly, fines measured with the 49-point grid during field assessments in August 2002 were markedly higher than the upper Blackfoot River reference conditions (see Appendix E).

Placer mining in the lower reaches in Poorman Creek has resulted in alterations to stream morphology that changed sediment transport processes and limited habitat for fish (see Appendix E). These reaches are overly wide, aggraded reaches that lack pool development. In some areas, the stream has cut through spoil piles. Although these areas are currently stable, fish habitat limitations support an impairment determination.

Of considerable concern in Poorman Creek is the occurrence of several undersized or perched culverts (see Appendix E and K). These present several potential problems in Poorman Creek. For example, undersized culverts are at risk of washing out during high flows, thereby increasing channel instability and contributing sediment to the stream. In addition, some culverts present possible barriers to fish movement in the basin, which are a constraint to a stream's ability to support cold-water fisheries, a key beneficial use. On the other hand, fish barriers in streams with westslope cutthroat trout, are sometimes desirable to prevent encroachment of brook trout. This emphasizes the importance of incorporating fisheries management plans into TMDL and water quality planning efforts to ensure implementation plans are consistent with native fish conservation objectives.

3.4.3 Sediment Source Loading Determinations

Estimate of Sediment Loads from Roads

Roads in the Poorman Creek basin have the potential to increase sediment loading to surface waters. Poorman Creek has over 85 miles of road and a road density of 2.08 miles of road per square mile. Two analyses provided estimates of sediment contributed from roads in the Poorman Creek basin. First, a watershed wide evaluation based on road/sediment relations by USFS and Plum Creek modeled an estimate of loading from all roads in the Poorman Creek basin (Appendix J). In addition, the USFS conducted an intensive survey of several roads in the basin that identified sources of sediment loading, poorly designed road crossings, and barriers to fish (Appendix K).

USFS and Plum Creek based calculations of sediment contributed from roads throughout the Poorman Creek basin indicate these roads supply about 22 tons of sediment per year to surface waters. The road density in the Poorman Creek watershed is considerably lower than Arrastra and Willow creeks as well as many other drainages in the Blackfoot Headwaters Planning Area. As a result, Poorman Creek has less potential to contribute sediment per watershed area than these streams, based on the analysis used in Appendix J. Nevertheless, the existence of a major, unpaved road along substantial portions of the main stem of Poorman Creek presents an additional risk for sediment loading.

Estimates of sediment contributed by roads conducted by the USFS indicate that the surveyed roads contribute over seven tons per year of sediment to Poorman Creek and its tributaries. Note that this survey focused primarily on roads on USFS property and used a different methodology than the road erosion survey discussed above. The USFS investigations included numerous recommendations to decrease risks of sediment loading. Moreover, the USFS has completed a significant portion of these improvements.

Hillslope Erosion and Increased Water Yield

The Poorman Creek sub-watershed contains a relatively high percent total area (16.3%) with elevated potential to produce and deliver sediment (Table 3-1, Columns E and F). While it is not possible to provide a defensible estimate of a numeric load from hillslope erosion, these results suggest that Poorman Creek has a high potential to produce and deliver sediment from both natural and human induced hillslope erosion compared to other sub-watersheds in the Blackfoot Headwaters Planning Area. Human related activities of concern include timber harvest and grazing. Poorman Creek watershed has undergone only a moderate level of recent timber harvest at 1.4% of the total drainage (Column C), and no harvest was in areas of elevated sediment potential (Column G), indicating a relatively low overall increased risk of significant sediment production from hillslope erosion. Also, the total recent harvest only had a minor calculated increase (0.6%) in water yield (Column H), also indicating a low risk of increased sediment production.

3.5 Willow Creek Assessment Results

3.5.1 Biological Indicators

Biological indicators of siltation are equivocal from the sampling stations on Willow Creek. The siltation index calculated from diatom associations at the upper site shows some negative impact but is consistent with minor impairment and full support. The lower site scored higher within the range of full support. In contrast, richness of clinger taxa calculated from macroinvertebrate community composition scored with the range of full support.

3.5.2 Physical Habitat

Assessments of physical habitat suggest that highway encroachment is a cause of limited habitat alterations on Willow Creek. This includes localized gully erosion and channelization. In addition, both McNeil core data and percent fines measured with the 49-point grid suggest that siltation is elevated above natural levels. Furthermore, DEQ field assessment notes from 2001 indicate that bank erosion constitutes a probable indicator of impairment in the reach above the Sandbar Creek confluence. This reach has experienced severe down cutting in addition to the bank erosion, and land use indicators suggest historic grazing as a probable source that led to these conditions. Current grazing practices no longer appear to be a significant limiting factor for recovery of this reach, whereas upstream floodplain constriction from a Forest Service bridge is possibly limiting stream recovery in this impaired reach.

3.5.3 Sediment Source Loading Determinations

Estimate of Sediment Load from Stream Bank Erosion

Data to support estimation of sediment load from bank erosion were not available. Still, a field assessment conducted by DEQ indicates that bank erosion and related habitat alterations associated with a down cutting impair beneficial uses. The alterations increase sediment loading to the stream and, more importantly, severely reduce habitat suitability for fish and likely contribute to intermittent flow conditions.

Estimate of Sediment Loads from Roads

Roads in the Willow Creek basin have the potential to increase sediment loading to surface waters. There are nearly 60 miles of road in this watershed yielding a relatively high road density of 3.06 miles of road per square mile of area. Modeling results (Appendix J indicate roads in the Willow Creek drainage contribute an estimated 15 tons of sediment to surface waters per year.

Hillslope Erosion and Increased Water Yield

The Willow Creek (listed) sub-watershed contains a relatively high percent total area (13.1%) with elevated potential to produce and deliver sediment (Table 3-1, Columns E and F). No recent harvest activity has occurred in these sensitive areas (Column G). While it is not possible to provide a defensible estimate of a numeric load from hillslope erosion, these results suggest that Willow Creek has a high potential to produce and deliver sediment from both natural and human related hillslope erosion compared to other sub-watersheds in the Blackfoot Headwaters Planning Area. Human related activities of concern include timber harvest and grazing, although water quality impacts from timber harvest in the form of hillslope erosion or increased water yield appear to be negligible for the 1992 through 1999 period evaluated.

Road Traction Sanding

Road traction sanding by MDOT is another potential source of sediment loading to Willow Creek. Highway 279, which parallels Willow Creek for nearly its entire length before it crosses the Blackfoot River, encroaches within 100 feet of streams for 0.15 miles and within 200 feet for 0.60 miles. Using methods to estimate delivery of sand described in Appendix L, an estimated 3.3 tons per year of road sand is potentially delivered to Willow Creek on an annual basis.

3.6 Sandbar Creek Assessment Results

3.6.1 Biological Indicators

Metals contamination in Sandbar Creek presents a confounding factor in evaluating siltation based on the periphyton and macroinvertebrate communities. Metals contamination in this stream contributed to ratings of severe impairment of beneficial uses. However, biological indications of siltation were not readily apparent. Still, because of the overwhelming influence of metals on these communities, it is difficult to assess reliably the impacts of siltation based on these analyses.

3.6.2 Physical Habitat

Reconnaissance investigations documented several types of alterations to physical habitat in Sandbar Creek (see Appendix E) Mining activities had substantial negative influences on physical habitat in the upper reaches of this stream. Mine tailings border the banks in the upper reaches and iron hydroxide covers much of the stream substrate. Presence of these metals contaminated sediments constitute a metals-related impairment, linked to siltation of metals precipitates, that differs from the typical, uncontaminated sediment listing for most other streams in the Blackfoot Headwaters Planning Area. Remediation, related to TMDL development for metals, should also require mechanical restoration of the stream channel in upper impacted reaches. Near its mouth, the Highway 279 embankment channelizes approximately 200 ft of Sandbar Creek providing another negative impact on in-stream habitat. Bank failure, flow impoundment, and loss of cross section definition characterize this channel segment.

3.7 Beartrap Creek & Mike Horse Creek

Failure of the Mike Horse Tailings Dam in the 1976 and other historic mining activities have contributed to major alterations in physical habitat in Mike Horse Creek and Beartrap Creek. The restoration goal is to incorporate habitat restoration as a required element of remediation efforts associated with metals remediation (Hydrometrics et al., 2003). This plan addresses the development of targets and restoration objectives to supplement the remediation goals associated with mining impacts to these streams.

SECTION 4.0
IMPAIRMENT STATUS OF STREAMS IN THE BLACKFOOT HEADWATERS PLANNING AREA

This section summarizes sediment and habitat related impairment status for 303(d) listed streams in the Blackfoot Headwaters Planning Area. Information utilized in these descriptions includes assessments and analyses summarized in Section 3.0. See the appendices for detailed descriptions of these methods and results.

An important consideration in determining impairment status is the water quality standards that apply to the pollutants of concern. This planning effort focused on sediment and associated habitat alterations, which are addressed with narrative standards as opposed to numeric standards. The challenge in applying narrative standards is determining the extent to which the observed conditions deviate from naturally occurring conditions and determining if this deviation is harmful to aquatic life or other beneficial uses.

A number of criteria and evaluations provided the basis to evaluate the extent to which conditions depart from naturally occurring or a least-impaired condition in the Blackfoot Headwaters Planning Area. These are described in more detail in the appendices. For measures of substrate composition, an internal reference and regional comparison provided the means to evaluate departure from desirable or least-impaired conditions. Analyses of McNeil core data collected from tributary streams located in or near the Blackfoot Headwaters Planning Area formed the basis of evaluating which sampling sites where impairment from excess fine sediment (siltation) was likely (Appendix G). Likewise, comparison of percent fines measured with a 49-point grid to an internal reference was a way to evaluate the extent to which siltation differed from a least-impaired condition.

Biological indicators also afforded an approach to evaluate impairment status and support of beneficial uses. Montana Department of Environmental Quality has developed biological indicators for benthic macroinvertebrates and periphyton (Bahls, 1993; Bollman, 1998) that evaluate biological integrity, a measure of beneficial use support. These integrate a number of community level responses to various environmental stressors into an overall score or rating. To evaluate sediment pollution in the Blackfoot Headwaters Planning Area, metrics that measure the response to siltation received more emphasis. These include the siltation index developed for diatom associations and richness of clinger taxa, a metric under development for application in Montana streams (Wease Bollman, personal communication).

Measures of physical habitat conditions such as riparian vegetation structural composition, bank condition, and channel morphology are other concerns in evaluating impairment status with regard to sediment. Departure from reference was evaluated using a combination of different reference approaches combined with evaluations of associated human disturbance. This allowed evaluation of whether observed conditions were natural or related to land use activities.

4.1 Blackfoot River: Headwaters to Landers Fork

Detailed review of the various investigations on the Blackfoot River above Landers Fork to the upper marsh area indicates this reach is not impaired for sediment or habitat-related conditions. As a result, a TMDL for sediment or restoration targets to address sediment or habitat impairment is not necessary for this section of the Blackfoot River. Although a TMDL is not required for this segment of the Blackfoot River, there are a number of opportunities for conservation. Restoration in this portion of the watershed is still necessary to maintain existing habitat conditions and to support water quality goals for downstream reaches of the Blackfoot River. Therefore, Section 6.0 details a management strategy aimed at conserving or improving existing full support conditions.

Several lines of evidence were available to evaluate the impact of sediment and related habitat conditions on beneficial uses in this reach of the Blackfoot River. These include macroinvertebrate and periphyton associations, pebble counts, McNeil cores, bank erosion inventory, and a habitat assessment. Biological indicators were consistent with impairment from metals, but not for sediment or habitat alterations. Indications that sediment or habitat alterations do not impair beneficial uses include relatively low surface fines as measured by several methods, limited eroding banks, and low human influence index associated with eroding banks. Geomorphic indicators suggest that this reach is in balance in terms of sediment production and storage. Evaluations of riparian condition provide evidence that human activities have minimal negative influences on riparian health and function. Large woody debris numbers, which can be an important contribution to fish habitat and indicator of beneficial use support, tend to be low over much of this reach. This appears to be due dominance of large marsh complexes and steep hillsides in this reach. These are features with limited potential for contributing woody debris.

While habitat conditions in most of this portion of the Blackfoot River are consistent with full support of beneficial uses, it is important to note an isolated area of habitat alteration in this stream. Failure of the Mike Horse Tailings Dam in 1976 contributed nearly 100,000 tons of tailings to two tributary streams and ultimately the Blackfoot River. This failure, along with other mining related impacts, resulted in severe impairment of habitat in about one mile the Blackfoot River. This reach extends from the upstream extent of the Blackfoot River, the confluence of Beartrap and Anaconda Creeks, to the upstream end of the upper marsh area. For water quality planning purposes, this reach is impaired due to habitat alterations. This impairment results in partial support of two beneficial uses, cold-water fish, and aquatic life.

In summary, this reach of the Blackfoot River will remain listed as impaired due to habitat alterations as identified on the 2002 303(d) list. However, it is important to note that this impairment covers a relatively short portion of the reach. Accordingly, this plan includes restoration goals to address the habitat alteration impairments. Although the habitat alterations could be linked to sediment storage and/or transport problems, such relationships are difficult to define and provide limited advantage to the development of appropriate restoration goals in this situation. These restoration goals include targets and a defined methodology on how to achieve the targets, thereby effectively addressing the major components of a sediment TMDL.

4.2 Blackfoot River: Landers Fork to Nevada Creek

Both natural factors and human activities influence conditions in this reach of the Blackfoot River. For example, natural disturbance and large volumes of bedload result in a braided, overly wide channel in the Blackfoot River between Landers Fork and Lincoln. While changes in management may result in small gains in habitat and water quality conditions, overwhelming natural conditions are the limiting factors in this section.

In contrast, human activities do result in significant impairment of water quality and habitat in the reach below Lincoln to Nevada Creek. The resulting degradation of physical habitat and water quality constitute impairment, thus requiring development of a TMDL to reduce fine sediment pollution and associated impacts to physical habitat. The beneficial uses affected by sediment pollution and associated habitat alterations are cold-water fish and associated aquatic life.

Examinations of available biological and physical data confirm this determination. The primary indication of impairment associated with fine sediment are McNeil core samples collected by Helena National Forest personnel from several locations in this reach from the late 1980s to the present. Substrate composition shows a marked increase in fine sediment compared to samples collected upstream of this reach. Furthermore, this increase in fine sediment, when compared to reference conditions, was at levels that would be harmful to incubating eggs and would contribute to increased entombment of fry. Bank erosion data demonstrate that contributions of fine sediment from banks are at least partly associated with human disturbance, therefore indicating that the elevated percent fines are preventable via best management practices and reasonable land, soil, and water conservation practices. Furthermore, eroding bank lines do not provide high quality habitat for fish. These reaches are typically devoid of undercut banks and overhead cover, important components of fish habitat.

In-channel sources of sediment such as bank erosion are not the only contributor to this portion of the Blackfoot River. Sediment contributed from roads and upland sources exceed background levels. Surveys of roads and culverts identified numerous cases where sediment delivery occurred from poorly designed roads and/or improperly applied BMPs in the basin. Recent timber harvest and associated road building activities in tributary watersheds have increased the risk of production and delivery of fine sediment to the Blackfoot River. In many parts of the watershed, the increased sediment loading associated with timber harvest may be within naturally occurring levels if BMPs are being applied appropriately. In a few small drainages, timber harvest has been substantial, thereby increasing the risk of sediment production above naturally occurring levels. Observations by local biologists of highly turbid flows from recently logged drainages corroborate modeled predictions of increased hillslope erosion and delivery.

In summary, this reach of the Blackfoot River will remain listed as impaired due to siltation and habitat alterations as identified on the 2002 303(d) list. Biological and physical data support the determination that human activities increase sediment loading to streams and result in degraded physical habitat in this reach. The sediment TMDL presented in this plan will address both of these impairments to help return the river to conditions that fully support its beneficial uses.

4.3 Arrastra Creek

Assessment results indicate that sediment and related habitat impacts are causes of impairment in Arrastra Creek. Sediment loading has created impairments through two mechanisms: aggradation and excess fine sediment. Aggrading conditions, as described in Appendix H, limit desirable habitat for aquatic life due to undesirable channel characteristics. Accumulations of fine sediment on streambed surfaces negatively affect both cold-water fisheries and aquatic life beneficial uses. McNeil sediment cores collected in the lower reaches of Arrastra Creek downstream of the Forest Service boundary, exceeded target criteria for particles < 6.35 mm and < 2.38 mm in some of the recent sample events. Macroinvertebrate communities indicated impairment at the lower site. In addition, clinger taxa richness, a metric sensitive to siltation, was less than 14 at the lower site where an adequate numbers of invertebrates were present in the sample allowing this analysis. Richness of clinger taxa of less than 14 is a numeric target developed for evaluating the effects of siltation on aquatic life (Appendix B). This evidence suggests that Arrastra Creek is partially supporting cold-water fisheries and aquatic life beneficial uses, at least in the lower assessed portions.

There are several probable sources of sediment loading and habitat alterations in the Arrastra Creek watershed. These include activities related to timber harvest that increase hillslope erosion, erosion from forest roads, and livestock grazing. Increased water yield from timber harvest and disruption of riparian areas from grazing can lead to channel widening and a resultant decrease in sediment transport capability. It is important to note that Arrastra Creek has a naturally high potential to produce and deliver sediment due to the presence of erodible areas with low vegetative cover in proximity of streams, and is therefore more susceptible to human induced increases in sediment loading.

In summary, Arrastra Creek will remain listed as impaired due to siltation and habitat alterations as identified on the 2002 303(d) list. Both physical and biological evidence support this listing. The sediment TMDL presented in this plan will address both of these conditions to help return the river to conditions that fully support its beneficial uses.

4.4 Poorman Creek

Assessment results show that Poorman Creek is impaired due to sediment and related habitat alterations. The majority of the evidence pointing to impairment was physical in nature. These included high proportions of fine sediment in cores (Appendix G), habitat alterations due to placer mining, riparian degradation, and eroding banks. This results in proportions of fine sediment that limit survival-to-emergence of salmonids. Similarly, these conditions present a limitation to aquatic life by limiting habitat suitability. In addition, clinger taxa richness, a metric sensitive to siltation, was less than 14 at one of three sites, thus indicating impairment due to fine sediment.

A number of land use activities negatively influence water and habitat quality in Poorman Creek. Livestock grazing, placer mining and residential development were identifiable sources of impairment in the lower reaches of Poorman Creek. Roads were another probable source of sediment loading and channel alterations. Poorly designed culverts, road crossings, and other erosive features associated with roadways were present at numerous locations in the basin.

Several culverts present another probable limitation to fisheries potential in the Poorman Creek watershed. Perched or otherwise improperly designed culverts at road crossing are common habitat alterations that have the potential to restrict fish movements through the Poorman Creek watershed. In some cases, these can present a condition that prevents a stream from supporting propagation of salmonids. For example, westslope cutthroat trout and bull trout spawn in headwater streams, which they may not be able to access due to impassable culverts.

Dewatering in the lower stretches of Poorman Creek is another potential contributor to an increase in-streambed siltation. Low flow volumes due to irrigation withdrawals may decrease stream energy to the point that fine sediment accumulates on the streambed. These low flows also negatively impact the riparian health, which then has negative impacts on bank and channel stability. In addition, the flow diversions and resulting lack of flow during portions of the year create a separate impairment. Although TMDL development is not a requirement to address this impairment associated with low flows, increasing flows to help flush fine sediments and improve riparian health can be part of the solution to excess fines. Water users in the Poorman Creek sub-basin have been working cooperatively with the Department of Natural Resources Conservation to maintain in-stream flows.

In summary, this reach of Poorman Creek will remain listed as impaired due to siltation and habitat alterations consistent with the 2002 303(d) list. The riparian degradation impairment cause may be removed due to redundancy with the other two causes. The development of a TMDL for sediment and the development of additional habitat restoration goals will address these impairments from a beneficial use support perspective. Dewatering and flow alteration, both of which address the same issue on the lower stretch of Poorman Creek, will also remain on the 303(d) list as a cause of impairment. This plan includes restoration goals to address the flow related impairment.

4.5 Willow Creek

Assessment results indicate that Willow Creek is impaired due to sediment and related habitat conditions. Evidence supporting this determination includes both biological and physical indicators. Biological indicators include elevated periphyton siltation index and partial support rating for macroinvertebrates at the upper sample location. Physical indicators include elevated fines measured with a 49-point surface fine grid. Channel alterations probably associated with historic grazing practices are also contributing to eroding banks and associated habitat degradation.

Links between human activities and observed conditions strengthen impairment determinations on Willow Creek. Roads and probable historic grazing practices were recognizable disturbances that influenced physical habitat and water quality. This relationship between human activities and water quality and habitat conditions substantiates the impairment determination for this stream.

In summary, this reach of Willow Creek will remain listed as impaired due to siltation and habitat alterations consistent with the 2002 303(d) list. The bank erosion cause of impairment may be removed due to redundancy with the other two causes. The development of a TMDL for sediment and the development of additional habitat restoration goals will address these impairments from a beneficial use support perspective.

4.6 Sandbar Creek

Review of existing information indicates impairment of habitat in Sandbar Creek resulting in partial support of salmonid fishes and associated aquatic life. Significant habitat alterations occur in two reaches. Highway 279 channelizes about 200 feet of channel upstream of where it crosses Sandbar Creek. Further upstream, historic mining and related road building has disrupted the geomorphology of this reach. These habitat alterations constitute an impairment of cold-water fisheries and aquatic life beneficial uses due to the resulting lack of pools, woody debris, and riparian vegetation. Metals contamination presents another significant impairment of beneficial uses in Sandbar Creek. Precipitates of metals blanketing much of the streambed in Sandbar Creek provide an obvious indication of metals pollution. This impairment is addressed in TMDL development for metals contamination, which is part of a separate planning effort for the Blackfoot Headwaters Planning Area (Hydrometrics et al., 2003).

In summary, Sandbar Creek will remain listed as impaired due to siltation and habitat alterations. The siltation listing is addressed in the metals TMDL due to the links with metals pollutant (Hydrometrics et al., 2003). This plan includes restoration goals to address the habitat alterations impairment. Although the habitat alterations could be linked to sediment storage and/or transport problems, such relationships are difficult to define and provide limited advantage to the development of appropriate restoration goals in this situation. These restoration goals include targets and a defined methodology on how to achieve the targets, thereby effectively addressing the major components of a sediment TMDL.

4.7 Beartrap and Mike Horse Creeks

Assessment results show that Beartrap Creek & Mike Horse Creek are both impaired due to habitat alterations. Past mining activities, including failure of the Mike Horse Tailings Dam, have significantly altered physical habitat conditions in these streams. Impairment indicators include limited pools, woody debris, and riparian vegetation. These alterations result in impairment of cold-water fish and aquatic life beneficial uses. Habitat alteration listings will be added as impairment causes for both streams, with Mike Horse Creek being an addition to the 303(d) list. This plan includes restoration goals to address these impairments. Similar to Sandbar Creek and the upper section of the Blackfoot River, these goals effectively address all the major components of a sediment TMDL.

SECTION 5.0
WATER QUALITY GOALS

This section presents water quality goals to address causes of sediment and habitat impairment for each waterbody that will remain on the 303(d) list due to causes other than metals. The goals include water quality targets, total maximum daily loads (TMDLs) and allocations. The water quality targets are numeric or measurable values that represent desired conditions and achievement of water quality standards, both numeric and narrative, for each stream. TMDLs are developed where sediment impairment exists. The TMDL identifies the maximum sediment loading, sediment reductions, and/or other conditions necessary to achieve target values. The TMDL is allocated among the various sources. These allocations apply to existing sources that contribute to sediment and related habitat impairments. Allocations can also be developed for future activities that have the potential to significantly contribute to impairment if not properly managed (EPA, 1999). Together, the water quality goals provide a basis for prioritizing efforts and measuring success of improvement activities in the Blackfoot Headwaters Planning Area. Section 6.0 provides a practical implementation strategy to achieve the goals defined in this section.

Adaptive management is applied toward the water quality goals defined within this section. Adaptive management addresses important considerations such as feasibility and uncertainty in establishment of targets, TMDLs and allocations. For example, despite implementation of all restoration activities, the attainment of targets may not be feasible due to any number of reasons. Natural disturbance such as forest fires, flood events, or landslides may negate the effects of restoration activities for a period of time, therefore extending the period before target conditions can be satisfied. 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 fine sediment at levels that prevent the attainment of numeric targets associated with fine sediment. Conversely, some targets or allocations may be underestimates of the potential of a given stream and more stringent targets may be more appropriate. In light of these issues, it is important to recognize that the adaptive management approach provides the flexibility to refine allocations, targets, and restoration activities to ensure compliance with Montana's water quality standards. Section 7.0 provides further discussion on adaptive management.

5.1 Blackfoot River (Landers Fork to Nevada Creek)

5.1.1 Targets

Water quality targets for this reach of the Blackfoot River include both biological targets and substrate composition targets (Table 5-1). These targets are all applicable to the sediment impairment and any sediment-related habitat impairment. All targets must be met to satisfy applicable water quality standards and ensure full support relative to the sediment impairment. The target for periphyton associations requires that samples meet biological indicators for full support developed for Montana mountain and foothill valleys streams (Bahls, 1993). Targets for macroinvertebrates require that communities meet criteria for full support of beneficial uses based on criteria developed by Bollman (1998). Both the periphyton and macroinvertebrate targets only apply to conditions that can be linked to sediment and/or habitat alterations. For example, it is possible to have an impairment associated with periphyton communities that is linked to metals, but the sediment and habitat indicators imply full support and thus satisfy the sediment TMDL target. Furthermore, the target for clinger taxa richness is a value greater than or equal to 14 based on DEQ's standard protocol for data collection and analysis (DEQ, 2002b). Most recent performance on these assessments indicates that both macroinvertebrates (based on clinger taxa richness) and periphyton assemblages suggest a variety of conditions. These range from sediment impairment to full support of beneficial uses in the Blackfoot River between Landers Fork and Nevada Creek (Appendix B). Table 5-1 summarizes these results. Note that deviations from target conditions due to sediment impacts are relatively minor.

Future research efforts may result in refinement or changes to biological indicators and metrics. Therefore, DEQ may update the biological indicators and metrics used for beneficial support determinations as TMDL and related target development continues throughout the state. These updated biological indicators, under the direction of DEQ, may replace one or more of the biological targets within Table 5-1.

Substrate composition targets developed for the Blackfoot River include fine sediment in two gradations (< 2.38 mm, and < 6.35 mm). These target conditions are to be applied to all three sub-reaches (Dalton, Helmville, Nevada/Odgen). Table 5-1 provides a summary of these targets based on least-impaired reference conditions developed in Appendix G. Table 5-1 also provides existing percent fines results for the Blackfoot River (from Appendix G) and the departure from the target conditions. Note that the existing conditions are further from meeting the finer 2.38 size gradation target than the coarser 6.35 mm gradation target. The data indicate that reductions as high as 38% from existing levels of fines < 2.38 mm may be necessary to meet the target based on 1997 results for the Nevada-Ogden Reach. The other two sites are closer to meeting target conditions, and the 2000 results for the Dalton Reach show that target conditions are met for both percent fines targets.

Section 8.0 summarizes and addresses sampling requirements for assessing target compliance. Macroinvertebrate and periphyton sampling is to be done at three representative locations similar to the McNeil Core sampling target requirements. This sampling should be coordinated with similar biota sampling required to assess metals targets (Hydrometrics et al., 2003). Percent fines sampling in the three sub-reaches will continue to be at the same areas previously sampled with specific locations representing documented spawning sites. To meet the target conditions, the 2.38 mm and 6.35 mm median values for a set of five or more core samples per location need to satisfy the target value. Average values may be an acceptable alternative to median values in the event that available assessment data is limited, assuming that such an approach can be properly justified.

When evaluating target compliance, comparisons should be made to reference condition data from the same representative period, meaning that reference stream monitoring will need to continue and target values could change due to climate or other conditions. As discussed in Section 1.4 and Appendix G, the least impaired streams used to determine reference condition may under-represent the stream's potential. For example, the Blackfoot River between the Landers Fork and the upper marsh is the only reference or least impaired stream where full support of beneficial uses relative to sediment impacts has been documented through adequate assessments. Therefore, these percent fines targets may be updated using a subset of the five least impaired streams or by incorporating information from new reference or least impaired streams.

The targets all apply under normal conditions of natural background loading and natural disturbance. It is recognized that under some natural conditions such as a large fire or flood events, it may be impossible to satisfy some of the targets, such as percent fines, until the stream recovers. The goal, under these conditions, will be to ensure that management activities within the watershed or individual tributaries are undertaken in such a way that the achievement of targets is not significantly delayed compared to natural recovery. Another goal will be that human activities do not significantly increase the extent of negative water quality or habitat impacts from natural events during the recovery period.

Another important factor is target achievability. The reference condition approach implies that 25% of streams may naturally vary above the target value since it is set at the 75^{th} percentile of the reference range. Also, the lower portion of the Blackfoot River is unique in comparison to most of the tributaries, and has high natural fines loading from eroding banks and from the Landers Fork. This natural loading could preclude meeting one or more target conditions even after successful implementation of management practices. The adaptive management approach discussed in Section 7.0 accounts for these uncertainties.

Table 5-1. Water Quality Targets for the Blackfoot River (Landers Fork to Nevada Creek), Existing Conditions, and Departure from Target.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Macroinvertebrate and periphyton assemblages will score as full support of beneficial uses for sediment and habitat related indicators	Periphyton data indicate full support Macroinvertebrate data indicate impairment at one of two recently sampled locations	Target currently satisfied. Target not satisfied; metals impacts may mask ability to interpret relative sediment impacts.
Clinger taxa richness will be ≥ 14	Clinger taxa richness at two locations range from 13 to 15	One location satisfies target, another location needs a small increase in taxa richness from 13 to 14 to meet target.
The median of percent fines < 2.38 mm in McNeil core samples will be ≤ 15%	Medians values range from 13 to 24%	Conditions range from satisfying the target to requiring a significant reduction (24% value needs to decrease to 15% or less); reduction needed to meet the target may be less based on recent sample results.

Table 5-1. Water Quality Targets for the Blackfoot River (Landers Fork to Nevada Creek), Existing Conditions, and Departure from Target.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
The median of percent fines < 6.35 mm in McNeil core samples will be ≤ 29%	Median values range from 20% to 34%	Ranges from satisfying the target to requiring a reduction from 34% to 29% fines; reductions needed to meet the target may be less based on recent sample results.

5.1.2 Total Daily Maximum Load (TMDL)

The technical definition of TMDL is "the sum of load allocations plus waste load allocations plus a factor of safety." Alternatively, the TMDL can be expressed through appropriate measures other than mass loads per time (40 CFR 130.2). The use of an alternative approach for sediment TMDL analysis is justified in guidance developed by EPA (EPA, 1999). EPA guidance recognizes that it can be difficult or impossible to relate sediment mass loading levels to use impacts or source contributions. The analytical connections can be difficult to draw for several reasons including the following:

- sediment yields vary radically at different spatial and temperal scales within a watershed making it difficult to draw meaningful "average" sediment conditions;
- sediments are a natural part of all waterbody environments making it difficult to determine whether too much or too little mass loading is expected to occur in the future and how sediment loads compare to natural or background conditions; and
- a significant level of uncertainty is associated with sediment delivery, storage, and transport estimates.

A commonly used alternative approach is to express the sediment TMDL as a percent reduction in loading. This reduction can be based on departure from target conditions or estimates of human loading conditions above natural background loading. Table 5-1 suggests that a reduction in the < 2.38 mm fine sediment load as high as 38% could be required to meet all target conditions, although recent 2000 core sample results suggest a lower sediment loading reduction to meet targets, perhaps in the 10 to 15% range.

Appendix F Blackfoot River bank erosion study results attribute 5,200 tons of the total 34,500 tons to controllable human activities, or about 15% of the total (5,200 divided by 34,500). In comparison to other human related loads in the watershed, this bank erosion loading appears to be the most significant load that can be addressed via management practices. The proximity of this loading to the impairment conditions contributes to the significance of this load. Sediment delivery from roads and highway sanding were also identified as quantified loads that can be reduced via management practices. Based on the estimated bank loading reduction that can be achieved via management practices and the likely reduction necessary to meet target conditions, the sediment TMDL for the Blackfoot River between Landers Fork and Nevada Creek is expressed as a 15% reduction in sediment delivery. This reduction will come from decreasing bank erosion along the Blackfoot River from Nevada Creek to the headwaters and from roads and highways throughout the watershed.

5.1.3 Allocations and Land Use Indicators

Allocations are developed for significant sources or source categories as necessary to achieve the targets identified in Section 5.1.1. Per EPA guidance (EPA, 1999), sediment TMDLs should clearly provide for allocations by source based on maximum allowable loads, needed load reductions, or, in some cases, source control actions. This section provides allocations for the identified sources of sediment impairment.

Also included are land use indicators that address sources not covered by the allocations. These sources are currently not considered significant to the point where reductions are necessary to meet TMDL and target conditions. Nevertheless, these additional sources or source categories should be tracked to ensure that they do not become significant problems and to ensure protection of water quality in the watershed.

5.1.3.1 Allocations

The allocations for the Blackfoot River sediment TMDL are presented in Table 5-2. Because the differing methodologies used in the source assessment analysis (Section 2.0) can lead to varied sediment loading results, the allocations approach used here applies load reductions or control actions to several of the key source categories as an added margin of safety to ensure protection of the resource. The allocations all apply to three categories of nonpoint sources that include accelerated stream bank erosion from human impacts along the Blackfoot River, sediment delivery from roads, and road sanding. There is also a waste load allocation to address point sources covered by storm water permitting. The allocations are consistent with the TMDL in Section 5.1.2 and should result in conditions where sediment targets in Section 5.1.1 are satisfied.

Table 5-2. Allocations for Identified Sources of Sediment to the Blackfoot River (Landers Fork to Nevada Creek).

Sediment Source Category	Load or Waste Load Allocations
Accelerated stream bank erosion from human impacts along the Blackfoot River (Nevada Creek to headwaters)	15% reduction in total yearly sediment load from eroding banks along the Blackfoot River.
Sediment Delivery from Roads	30% reduction of sediment loading from all roads in the watershed.
Road Traction Sanding	Based on development and implementation of road sanding BMPs (performance-based allocation).
Storm Water Permits	Based on proper implementation and maintenance of erosion BMPs consistent with standard storm water permit conditions (performance-based allocation).

The "accelerated stream bank erosion" allocation will apply to the human activities that can be addressed via BMPs. In Appendix F, it was estimated that about 75% (5,200 tons) of the maximum bank erosion due to human activities was controllable via management practices. The 5200 tons represents 15% of the total 34,500 tons of yearly load from eroding banks. Thus justifying the 15% allocated load reduction. About 50% of the total maximum human related bank erosion is attributed to cattle grazing, which may represent the most controllable portion of the sediment loading from accelerated bank erosion. Roads, revetments, lawns, and logging are other human activities associated with eroding banks. Some of these activities are linked to permanent infrastructure such as roads or buildings. Under these circumstances, some of the bank erosion impacts may be irreversible, which is why the allocation only applies to a percentage of the total loading associated with human activities. Nevertheless, all significant sources should be evaluated to promote implementation of management practices that will eliminate or minimize erosion where possible. The use of riprap or other stream hardening techniques will not be considered acceptable erosion reducing approaches for meeting sediment reduction allocations, and can be considered a contribution toward increased bank erosion. In addition, future growth along the Blackfoot River would need to be managed in a way that is consistent with this allocation to ensure full support of beneficial uses.

The "sediment delivery from roads" allocation applies to timber harvest activities as well as county and other private roads. The 30% reduction is based on Forest Service and Plum Creek analyses on roads under their control after full BMP implementation. Other landowners can be expected to have similar capabilities for sediment loading reductions via BMP applications. This equates to a 90 ton per year modeled reduction in potential loading to the tributaries and the Blackfoot River based on the results presented in Appendix J. This is double the load reduction that would be achieved if set at the 15% TMDL load reduction value. The 30% reduction is used in recognition of achievable reductions from this source category and as a component of the margin of safety. The use of a 30% reduction is also important for the protection of tributary streams to avoid impairments in these streams. This road sediment allocation can be applied to individual landowners. For example, the Forest Service will have satisfied this allocation, as it relates to them, if they have reduced sediment inputs by 30% for roads under their management.

The performance-based road sanding allocation is based on ongoing efforts by the Montana Department of Transportation to incorporate BMPs. This includes ongoing research to identify the best designs and procedures for minimizing road sand impacts to adjacent waterbodies. These BMPs must also be compatible with the safety of the traveling public and road maintenance crews. Road sand BMPs may include a reduction in plowing speeds, improved maintenance and road sand recovery, and the increased use of chemical deicers as long as doing so does not create a safety hazard or cause undue degradation to plant and water quality. Implementation of BMPs should be focused on those stretches of highway within 200 feet, with significant focus on those stretches within 100 feet of the river or tributary stream. It is anticipated that the BMPs, once implemented, will ultimately lead to a percent reduction of road sand loading consistent with the sediment TMDL.

The waste load allocation for storm water permits is based on proper implementation and maintenance of erosion BMPs consistent with standard storm water permit conditions. These permits typically require erosion controls versus setting discharge loads. At this time there is at least one point source of sediment permitted under the National Pollutant Discharge Elimination System. This point source is addressed via a storm water permit for the Upper Blackfoot Mining Complex. The erosion controls include application and maintenance of BMPs. Similar storm water permits are possible to address mining or other future developments within the watershed. This performance-based allocation will apply to all such permits.

TMDL development to address causes of impairment in listed waters downstream from the confluence of the Blackfoot River and Nevada Creek could require sediment and other pollutant loading reductions in the Blackfoot Headwaters. It is expected that the sediment allocations described above will be consistent with future sediment and nutrient TMDL development in downstream waters. This integration of planning across the larger basin is part of a watershed approach to planning and restoration.

5.1.3.2 Land Use Indicators

As discussed above there are additional sources or source categories that should also be tracked to ensure protection of water quality in the watershed. These sources are currently not considered significant sources of loading and therefore do not require load reductions to meet TMDL and target conditions, but could become significant sources if BMPs and/or reasonable land, soil, and water conservation practices are not applied. These sources include timber harvest impacts associated with hillslope erosion, timber harvest impacts associated with flow alterations that can contribute to in-stream bank erosion or stream scour, and impacts from road crossings with undersized or poorly maintained culverts. For each of these source categories, indicators are developed to help determine conditions where significant sediment loading may be possible. These indicators do not represent allocations, but do represent conditions where future allocations could be required or where additional study may be necessary to ensure that water quality is adequately protected.

5.1.3.2.1 Timber Harvest Impacts on Hillslope Erosion

In timber harvest areas, hillslope erosion and sediment delivery to streams is typically not observed when forestry BMPs are applied to logging skid trails and Streamside Management Zones (SMZs) are retained as required by State Law (Ethridge and Heffernan, 2001). However, harvest and other alterations in riparian vegetation near streams not covered under the SMZ law can present a higher risk of sediment delivery. A land use indicator is therefore developed to address this sediment delivery concern.

The assessment of potential sediment contributions from upland sources (Appendix M) identified areas of elevated potential sediment yield for each tributary watershed. The results of this analysis revealed that most watersheds only had minor amounts of recent timber harvest within these areas (Column G of Table M-1). A few small watersheds had harvest levels approaching or exceeding 10% of the total of this higher risk sediment yield area (Column G divided by Column E). The analyses generally identified an area as going from high to low cover when harvest occurred, and then returning back to high cover after vegetation had been established, which would typically occur within 7 years. This amount of recent harvest in areas of high sediment potential should therefore be used as an indicator to help ensure that hillslope erosion from timber harvest is not a significant source of sediment loading to the Blackfoot River and individual tributary streams. Whenever the amount of recent harvest exceeds or is expected to exceed 10% of the total potential high sediment production area there should be a review of BMP planning and implementation success in these high-risk areas to ensure that hillslope erosion and delivery is minimized.

5.1.3.2.2 Timber Harvest Impacts on Peak Flows

As discussed in Appendix M, timber harvest activities can affect water yield such that peak flows can be increased and lead to increased bank erosion and bed scour. In fact, the analyses for the Landers Fork in Appendix M suggests that such increases within this drainage can be significant, probably much more than other drainages due to the significant existing loading potential from this stream (Appendix I). The analysis for water yield detailed in Appendix M suggested that forestry activities resulted in generally low water yield increases between the 1992 to 1999 time frame for all tributary drainages (Column H, Table M-1). Another approach to evaluate water yield is based on equivalent clear-cut area (ECA) protocols developed by the Forest Service, where forest harvest impacts on ECA and resultant modeled water yield are sometimes kept within 10%, adjusting for channel stability and/or soil characteristics following ECA protocols (King, 1989). Therefore, the modeled water yield indicator within any impaired tributary drainage (Arrastra, Poorman, and Willow Creeks) and the Blackfoot River drainage as a whole is set at 8%. The indicator level in all other tributary drainages is set at 10% with the exception of the Landers Fork, which is set at 6% due to the significant potential loading conditions. Any time a proposed harvest will exceed any of these values, the cumulative impacts associated with potential peak flow increases should be evaluated to ensure consistency with the allocations, TMDL, and target goals developed within this document.

In evaluating potential impacts and/or determining whether this indicator level has been reached, the historic structure of conifer stands can be a consideration. In other words, some types of thinning efforts may actually end up increasing water yield, but the increase may be more representative of naturally occurring conditions. Also, areas of permanent settlement and permanent land clearing, such as the town of Lincoln, can be considered a naturally occurring ECA reduction within the watershed. Alternatively, forest roads are to be added to the ECA. For watersheds where fire has significantly increased water yield, then increases in water yield due to timber harvest are to be evaluated to ensure that management activities within the watershed or individual tributaries are undertaken in such a way that the recovery time to conditions where the targets can be met is not significantly delayed. Another goal will be that water yield increases due to human related clearing do not significantly increase the extent of negative water quality or habitat impacts from natural events during the recovery period.

The use of water yield and potential impacts on a stream is consistent with EPA guidance for sediment TMDLs (EPA, 1999), which states: “In some settings, land management changes cause changes in runoff even if they do not result in increased upslope erosion. Where this occurs, channel erosion or sediment deposition may increase. It might be appropriate to develop sediment TMDLs to address this type of situation.” Montana State Water Quality Standards also support limits on water yield and related increased flow where activities increasing mean monthly flows above a certain value can require an authorization to degrade (ARM 17.30.715).

5.1.3.2.3 Impacts from Undersized or Improperly Maintained Culverts

This planning effort did not include an analysis of the potential loading associated with undersized culverts. Analyses performed in other watersheds, such as for St Regis TMDL development (Lolo National Forest, unpublished data) indicate that the sediment loading risk associated with undersized or poorly maintained culverts could be significant within individual tributaries of the Blackfoot Headwaters Planning Area. An indicator of the potential risk is overall road density, since a higher road density indicates more stream crossings. The Forest Service classified road density in examining the characteristics of aquatic/riparian ecosystems in the Columbia River Basin. Road density was considered “high” if it exceeded 1.7 miles per square mile (USDA Forest Service, 1996). Therefore, whenever new road building is pursued and the road density exceeds or will exceed 1.7 miles/mile^2 in a third order or greater drainage, then the risks associated with culvert failure should be evaluated. Where there are a large number of undersized culverts, such as those that cannot at least pass a 25-year storm even, then timber harvest activities should account for this risk in determining overall potential cumulative impacts. It may be necessary to reduce the sediment loading risk from culvert failure to offset additional sediment loading risk associated with new culverts on a case-by-case basis to ensure consistency with the water quality goals of this section. Similar to the road sediment allocation, a given landowner can only be expected to address undersized culverts on roads under their ownership, although the total road density indicator value must consider roads under all ownership including abandoned roads where culverts may still be in place.

5.2 Arrastra Creek

5.2.1 Targets

5.2.1.1 Biota and Percent Fines Targets

Arrastra Creek water quality targets presented in Table 5-3 address biological integrity as measured by macroinvertebrates and periphyton. The targets also address substrate composition as measured by McNeil Core sampling. These targets and their applicability are the same as the targets for the Blackfoot River (Section 5.1.1). All considerations discussed for the Blackfoot River targets also apply to the Arrastra Creek targets presented in Table 5-3 except the specific monitoring sites further defined in Section 8.0. Note that existing conditions either satisfy or come very close to satisfying the Table 5-3 targets.

Table 5-3. Water Quality Targets for Arrastra Creek, Existing Conditions, and Departure from Target.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Macroinvertebrate and periphyton assemblages will score within full support of beneficial uses for sediment and habitat related indicators	Periphyton data indicate full support Macroinvertebrate data indicate impairment at one of two sampling locations	Target currently satisfied. Target not satisfied; but close to being satisfied (78% vs. 83% reference criteria per Appendix B).
Clinger taxa richness will be ≥ 14	Clinger taxa richness indicates impairment at the downstream location with a value of 13	Downstream location needs a small increase in taxa richness from 13 to 14 to meet the target.
The median of percent fines < 2.38 mm in McNeil core samples will be ≤ 15%	Medians values from 1999 to 2001 range from 13 to 14%; median values from 1993 to 1996 range from 9 to just above 15%	Recent data indicates that target is satisfied.
The median of percent fines < 6.35 mm in McNeil core samples will be ≤ 29%	Median values range from 1999 to 22% to 30%	Ranges from satisfying the target in the upper reach to exceeding the target by a small amount (30% vs. 29%) in the lower reach.

5.2.1.2 Additional Targets Based on Habitat and Aggrading Conditions

Table 5-4 presents additional target conditions to ensure overall full support of beneficial uses in Arrastra Creek. These targets address riparian health and in-stream habitat indicators associated with channel conditions and potential aggradation impacts as well as potential contributions to excess fines loading. Arrastra Creek was not assessed in 2002 using the modified EMAP or bank erosion methods as other impaired waterbodies were. Instead, results from a 1996 Forest Service assessment were used to evaluate similar parameters (Appendix H). The 1996 data indicates riparian health impacts and aggrading conditions that are causing additional sediment and/or habitat impairments. McNeil Core sampling and associated fines targets may not sufficiently characterize this condition. This is because the sediment size gradation associated with aggrading conditions may be larger than 6.35 mm on average, and aggraded areas may no longer support spawning and thus would not be sampled using McNeil Cores.

Two water quality specialists performed a field reconnaissance along the lower five miles of this stream during 2002 to supplement the 1996 assessment data (Appendix E). The 2002 results indicate high width to depth ratios, a lack of pools, and other indicators consistent with the aggradational characteristics noted in the 1996 Forest Service assessment. The observers also noted aggradational areas apparently caused by undersized culverts. A 2001 DEQ stream reassessment of Arrastra Creek (DEQ, 2003) identified lateral bank erosion and mid-channel bars. Some of the impairment indicators were associated with a road crossing and improperly sized culverts leading to aggrading conditions above the culverts. The three assessments described above justify development of the additional Table 5-4 targets to address riparian health and channel indicators. The overall goal is to provide bank erosion protection via healthy riparian vegetation. This will reduce sediment loading from banks and subsequent channel aggradation, and will help ensure that the stream reaches its potential regarding sediment transport capabilities.

Appendix E provides information to justify target development using width to depth ratios, and Appendix H provides information to justify target development using riparian health and other channel indicators. Appendix E results suggest desirable bank full width to mean depth ratios are less than 25. This is based on an internal reference approach using information from a portion of Sub-reach AC1. Therefore, a bank full width to depth maximum ratio of 25 is applied as a target condition for Sub-reaches AC1 and AC2 as defined in Appendix E. Because of the depositional nature of Sub-reach AC3, and associated beaver dam impacts, this particular width to depth target is not applied in this lower area that extends from the mouth 0.75 miles upstream.

Appendix H suggests a potential for improved riparian conditions. Desirable riparian species comprised of sedge/rush, riparian shrub, or riparian trees comprise approximately 76% of Reach 4 based on the 1996 assessment results (Table H-1). Similar desirable riparian species values range from 50% along Reach 2 to 63% along Reach 1. The riparian target is set at 75% for the combination of desirable riparian species, based on Reach 4 results. This target is further supported by the fact that Reach 4 has about 95% stable, vegetated banks whereas Reaches 2 and 1 have about 73% and 52% stable, vegetated banks, respectively (Figure H-2). If a different assessment approach is developed to measure target compliance, then this value may be adjusted based on new internal or other reference values through the adaptive management approach (Section 7.0).

For beneficial use support, the width to depth and riparian targets must be met. A more direct measure of aquatic habitat, such as percent pools, may provide a more desirable measure of beneficial use support than width to depth measures. The assessment results described above did not provide adequate data to develop such a target. As part of implementation monitoring, (Section 8.0), an additional target based on in-stream channel conditions such as percent pools, can be developed for the lower five miles of Arrastra Creek. This target may be used in place of, or in combination with, the width to depth target.

An additional performance based target applies to the aggraded channel conditions above undersized culverts. These culverts need to be evaluated to determine potential culvert-related impediments to flow and sediment transport, and overall contributions to upstream sediment accumulations. The culverts should at a minimum be capable of passing a 25-year flood event based on forest road BMPs. This is not a strictly applied target. The target can be satisfied if the culvert can pass an event approaching a 25-year event, upstream habitat impacts are not significant when compared to conditions within the lower five miles of stream, and all Table 5-3 and 5-4 target conditions are otherwise satisfied.

The Table 5-4 targets apply to the lower 5 miles of Arrastra Creek consistent with the length of stream assessed in 1996 and 2002. Meeting the targets will be based on an assessment of representative reaches along the lower 5 miles of Arrastra Creek, either using methodologies similar to the above referenced assessments or an equivalent methodology acceptable to DEQ and stakeholders. Representative reaches can be selected based on aerial analyses and/or physical observations so that the overall conditions can be adequately summarized in the lower sections of the drainage. The assessment methodology must quantify riparian health and quantify target conditions relative to a reference or least impaired condition as defined in Section 1.4.

As with other targets, attainability is always a factor. The lower reach is influenced by beaver activity and represents a depositional area that may have naturally high width to depth ratios and other depositional indicators. Care must be taken in applying targets in this reach, which is why the width to depth target is not applied. The setting of pool or other habitat related in-stream targets must consider naturally achievable sediment transport capabilities. This will need to include an evaluation of historic riparian structure regarding the potential for a higher percentage of large trees and their contribution to stream bank stability and large woody debris. Conversely, the potential for large natural sediment loads in the drainage and location of natural depositional areas must also be considered.

Table 5-4. Additional Water Quality Target for Arrastra Creek to Address Additional Habitat and/or Sediment Impairments.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Width to Depth ≤ 25 for upper stream segments (0.75 mi above mouth)	Ranges from 20 to 40 in reaches from about 1 mile above the mouth to about 5 miles above the mouth	Target not met in upper assessed reaches; target not applied to lowest reach
Desirable riparian species comprise > 75% based on FS 1996 assessment method	Values from three reaches are 50%, 63% and 76%	Target not met in lower two reaches
Restore sediment transport capabilities at undersized culverts; ensure 25 year storm passage capability	Up to 200 feet of aggraded channel is associated with potentially undersized culverts; existing flood passage unknown	Unknown

5.2.2 Total Maximum Daily Load

The Arrastra Creek sediment TMDL is based on a percent load reduction, similar to the sediment TMDL developed for the Blackfoot River between Landers Fork and Nevada Creek. The McNeil Core samples imply that only a small percent reduction in loading is necessary to meet the percent fines target, whereas the clinger taxa richness, riparian health, and width to depth targets suggest a more significant improvement in water quality is necessary. The Appendix H results indicate that a potentially greater overall reduction of in-stream sediment load is needed to provide full beneficial use support. Table 5-2 has already identified a 30% load reduction for sediment delivery from roads in support of the Blackfoot River sediment TMDL. This is used as the basis for the Arrastra Creek sediment TMDL, which is defined as a 30% decrease in total sediment load from eroding banks and roads, as well as a 30% decrease in sediment load accumulation within the stream channel due to undersized culverts and reduced stream transport capabilities. This TMDL addresses attainment of the targets established for fine-grained sediment fractions as well as potential larger size fractions of sediment associated with aggrading conditions.

5.2.3 Allocations and Land Use Indicators

5.2.3.1 Allocations

The allocations for the Arrastra Creek sediment TMDL are presented in Table 5-5. The allocation for sediment delivery from roads is the 30% reduction applied to other roads in the watershed to meet the Blackfoot River TMDL (Section 5.1.2). A second, similar sediment load reduction is applied to eroding banks and the loss of sediment transport capabilities due to existing and historical human impacts on riparian health and channel dimension, pattern and profile. Undersized culverts are included as part of this allocation since they reduce sediment transport capabilities. The allocation is a 30% reduction in sediment loading to the stream and sediment deposition within the channel. The primary approach to satisfying this allocation is via improved riparian health based on the assumption that improved riparian health will result in reduced bank erosion. This assumption is supported by information provided in Figures H-1 and H-2, where increases in desirable vegetation cover in Reach 4 is associated with a high percentage of stable, vegetated banks. Furthermore, the increase in desirable vegetation and improved bank stability is expected to reduce width to depth ratios and increase sediment transport capabilities. This will contribute to decreased sediment accumulation within the stream and will improve fisheries habitat. Additionally, the percentage of large trees should also be increased if historical or other information suggests that the stream should have a higher percentage of large trees. In addition to potential sediment transport improvements, the larger trees will contribute to an increase in large woody debris over time, further improving aquatic life and fishery habitat. A third and final performance-based allocation applies to any future storm water permits. This allocation will be similar to the storm water permit allocation defined in Section 5.1.3.1 and Table 5.2.

One of the uncertainties associated with the Arrastra Creek targets, TMDL and allocations is a source assessment linking reduced riparian vegetation and associated bank erosion to existing or historical human activities. This will likely require further evaluation as part of the effort to evaluate progress toward achieving targets (Section 8.0) and evaluate target achievability. This will be an important adaptive management component for Arrastra Creek.

Another uncertainty is the origin of excess sediment loads within aggraded portions of the channel. A high percentage of Arrastra Creek has elevated potential for sediment yield (Appendix M), indicating a high potential for natural background loading. It also represents a higher potential for accelerated loading from timber harvest or grazing impacts. It is recognized that recent management activities are more likely to apply BMPs and that most loading may be within the range of naturally occurring. Nevertheless, it is possible that a significant percent of the sediment load associated with aggradational conditions is associated with historical harvest or grazing activities.

Table 5-5. Allocations for Arrastra Creek.

Sediment Source Category	Allocations
Sediment Delivery from Roads.	30% reduction of sediment loading from all roads in the watershed (about a 5.7 ton modeled reduction.)
Eroding banks and loss of sediment transport capabilities due to existing and historical human impacts on riparian health and channel dimension, pattern and profile. This includes undersized culverts.	30% reduction in sediment loading to the stream and sediment deposition within the channel.

5.2.3.2 Land Use Indicators

All the same land use indicators applied to the Blackfoot River also apply to Arrastra Creek drainage. Given the large percent of area with elevated potential for sediment loading, and potentially sensitive main stem conditions, it would be worthwhile to calculate the existing water yield using the ECA method, and to perform some field evaluations of BMP success in high sediment risk areas with recent harvest. Also, the road density indicator has been exceeded. Landowners should evaluate their existing culvert capacities and overall risks of failure and subsequent sediment loading potential.

5.3 Poorman Creek

5.3.1 Targets

5.3.1.1 Biota and Percent Fines Targets

Poorman Creek water quality targets presented in Table 5-6 address biological integrity as measured by macroinvertebrates and periphyton. The targets also address substrate composition as measured by McNeil Core sampling and by the 49-point grid. The biological and McNeil Core targets and their applicability are the same as the targets for the Blackfoot River (Section 5.1.1). All considerations discussed for the Blackfoot River targets also apply to the Poorman Creek targets presented in Table 5-6 with the exception of the specific monitoring sites defined in Section 8.0.

The median percent surface fines target using the 49-point grid in pool tails provides a measure of potential impacts to spawning fish as well as aquatic life. To satisfy the target, the median value of 49-point grid results must be $\leq$ 6% based on the 75th percentile for the reference data for Reaches 1 and 2 of the Blackfoot River (Figure E-5 in Appendix E). The approximate 10% median value measured in Poorman Creek is higher than this 6% value based on the results presented in Figure E-5. Monitoring to satisfy this target needs to focus on two or three representative reaches of Poorman Creek. This target must be met to satisfy the Poorman Creek siltation listing similar to the other targets presented in Table 5-6.

Note that existing conditions either satisfy or come very close to satisfying the Table 5-6 targets, with the exception of the targets for percent fines < 6.35 mm. Recent McNeil Core sampling resulted in median values near 37% for both 2000 and 2001. These values are well above the 29% target value. Also, the existing 15% condition for the 49-point grid target is well above the target value of 5%.

Table 5-6. Water Quality Targets for Poorman Creek, Existing Conditions, and Departure from Target.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Macroinvertebrate and periphyton assemblages will score within full support of beneficial uses for sediment and habitat related indicators	Periphyton assemblage data indicate full support Macroinvertebrate assemblage data indicate full support	Target currently satisfied Target currently satisfied
Clinger taxa richness will be ≥ 14	Clinger taxa richness indicates impairment at one of three locations with values ranging from 13 to 18	Slight increase in taxa richness (from 13 to 14) required at one of three sites to fully meet the target
The median of percent fines < 2.38 mm in McNeil core samples will be ≤ 15%	Medians values from 1996 to 2001 range from 7% to 17%	Data suggests conditions close to satisfying target, only one year in five since 1996 exceeded 15% (17% vs. 15% for 2000)
The median of percent fines < 6.35 mm in McNeil core samples will be ≤ 29%	Median values range from 1996 to 2001 range from 28% to 37%	Recent three years of data all exceed target, with two most recent medians values for 2000 and 2001 both near 37% vs. the 29% target
The median percent fines < 6.35 mm in pool tails measured with a 49-point grid will be ≤ 6%	Median values approximately 10%	Median surface fines values in pool tails need to be reduced from 10% to 6% or less

5.3.1.2 Additional Targets Applied to the Lower Reach of Poorman Creek

The lower reach of Poorman Creek (PC5) was not assessed using the modified EMAP, although field reconnaissance identified channel and riparian concerns as well as dewatering impacts above the confluence with Grantier Spring Creek. To ensure full support conditions for aquatic life, additional sediment target requirements are applied to this reach above Grantier Spring

Creek as presented in Table 5-7. A modified EMAP (or equivalent assessment) will be required on this reach to ensure that channel and riparian conditions in Reach PC5 are comparable to internal or other applicable reference conditions.

For width to depth target development, Figure E-3 in Appendix E indicates a potential value, based on the modified EMAP protocol, of less than 22 using the 75th percentile of upstream reaches. For riparian health, the EMAP riparian evaluation, or other suitable method to measure riparian health, can be applied. In addition to the Table 5-7 target requirements, this lower reach will also be monitored to ensure compliance with the Table 5-6 biota and fines targets. Meeting these targets will ensure full support conditions as they related to any potential sediment impairment.

Table 5-7. Additional Sediment Targets Applied to Lower Reach (PC5) of Poorman Creek.

Width to depth and riparian health values in Reach PC5 comparable to internal or other applicable reference reaches	Not quantified, currently not satisfying targets based on professional observations	Not quantified

5.3.1.3 Targets and Goals to Address Specific Habitat Impairments and Reduced Flows

Table 5-8 presents additional targets to address very specific habitat impairments. A performance-based target applies to the placer-mined areas along Poorman Creek. Much of Poorman Creek has been placer mined, some segments to a greater extent than others. Many of the placer-mined areas have relatively healthy vegetation and stable channel conditions. Although these placer-mined segments have revegetated, the channel can lack the hydraulic complexity that makes for good habitat. The level of aquatic life impact due to habitat loss varies significantly, with more significant impacts noted in Reach PC4 (Appendix E). The target applied to the placer mine areas includes the following conditions:

- Establishment of a functioning, native riparian community;
- Development of a dynamically stable channel configuration, with appropriate range of substrate type, pool/riffle ratio, width to depth ratio, entrenchment ratio, and sinuosity with respect to site potential.

Prior to any restoration efforts, feasibility studies will be performed to evaluate the aquatic life gains, the risks involved with physical stream restoration, and overall costs and benefits for each impacted sub-reach. The target only applies to those areas where restoration efforts are considered feasible. Input from fisheries biologists and water quality specialists, as well as key stakeholders, will be a critical component of any such decisions.

Another performance-based habitat target applies to potential fish passage barriers within Poorman Creek and its tributaries, which are identified and discussed in Appendix E and Appendix K. This target requires evaluation of fish passage potential at desirable migration points as identified by fisheries biologists. Where a culvert is negatively impacting fish passage, and such passage is considered to be significant for overall aquatic life and cold-water fish beneficial use support, then the culvert must be upgraded to allow passage in order to satisfy this target.

A final water quality goal not presented as a target in Table 5-8 addresses the lack of flow during summer in the lower part of Poorman Creek. The goal is to increase flow to Poorman Creek to provide improved habitat for aquatic life. This can be particularly important in this stream since Poorman Creek serves as a migration corridor for spawning bull trout. Although increased flows would improve aquatic life and cold-water fish use support in Poorman Creek, any attempts to satisfy this goal must be in recognition of Montana Law regarding TMDL development and water quality planning. This law states "Nothing in this part may be construed to divest, impair, or diminish any water right recognized pursuant to Title 85" (Montana Water Quality Act §§75-5-705). Another important consideration regarding flow expectations is the apparent natural intermittent condition of the lower portion of Poorman Creek. Recent BMPs and water leasing agreements may be adequate to satisfy this goal.

Table 5-8. Targets to Address Specific Habitat Impairments in Poorman Creek and Tributaries to Poorman Creek.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Channel restoration in reaches altered by placer mining	Habitat in many placer-mined reaches does not provide suitable habitat for fish	Limited quantitative data
Culverts upgraded to allow fish passage where such passage is considered of significant importance	Assessments indicate fish passage limitations at several culverts	Not quantified

5.3.2 Total Maximum Daily Load

The McNeil Core and 49-point grid sampling suggest that sediment loading needs to be significantly reduced in Poorman Creek in order to meet targets and support beneficial uses. The Poorman Creek sediment TMDL will be consistent with the Arrastra Creek and Blackfoot River sediment TMDLs since roads and eroding banks are probably the two most significant sources of excess fine sediment loading from human activities. Therefore, the Poorman Creek sediment TMDL is expressed as a 30% decrease in sediment delivery from roads and a 75% reduction in bank erosion associated with human impacts. Note that this reduction is not based on the total bank erosion load since the assessment results did not provide this type of information. It is instead consistent with the percentage of human related bank erosion considered controllable along the Blackfoot River main stem (Appendix F).

5.3.3 Allocations and Land Use Indicators

5.3.3.1 Allocations

The allocations for the Poorman Creek sediment TMDL are presented in Table 5-9. The allocation for sediment delivery from roads is the 30% reduction applied to roads in other portions of the watershed to meet the Blackfoot River TMDL (Section 5.1.2). The allocation applied to accelerated bank erosion from human activities is a 75% reduction. As discussed above, this reduction is not based on the total bank erosion load since the assessment results did not provide this type of value. It is instead consistent with the percentage of human related bank erosion considered controllable along the Blackfoot River main stem (Appendix F). The assessment results indicated grazing impacts from horses and cattle, and noted the potential for improved riparian conditions in grazed areas as well as in areas where private homes and yards encroach upon streams. Also, some bank erosion in placer-mined areas was identified. The intent is to address bank erosion in the main stem as well as tributary drainages since bank erosion within tributaries has the potential to contribute to excess fines in the Poorman Creek main stem (and ultimately the Blackfoot River). Efforts to implement BMPs along Poorman Creek and tributaries to Poorman Creek, as discussed in Section 6.0, can reduce this bank erosion and satisfy the intent of this allocation.

The intent of the flow allocation is to help ensure a healthy riparian community in the lower section of Poorman Creek to help protect stream banks from erosion. The flow can also help avoid excess fine sediment accumulation due to a lack of transport capabilities. As stated above (Section 5.3.1.3), any efforts to address this allocation must be done in recognition of valid water rights. Also discussed in Section 5.3.1.3 is the fact that recent BMPs and water lease agreements may be adequate to address this allocation.

Allocations are not developed for the habitat impairment targets identified in Table 5-8. The placer mining and road building activities responsible for the habitat impairment conditions are inherently linked to the corrective actions as described in Section 5.3.1.3.

Table 5-9. Allocations for Poorman Creek.

Sediment Source Category	Allocations
Sediment Delivery from Roads	30% reduction of sediment loading from all roads in the watershed
Accelerated Stream Bank Erosion from Human Impacts in the Poorman Creek Drainage	75% reduction in eroding banks load associated with human impacts
Lack of flow during July through September	Increased stream flow conditions while not compromising valid water rights.

5.3.3.2 Land Use Indicators

All the same land use indicators applied to the Blackfoot River also apply to Poorman Creek drainage. Given the large percent of area with elevated potential for sediment loading, and bank erosion concerns along the main stem, the existing water yield using the ECA method should be calculated, and field evaluations of BMP success in high sediment risk areas with recent harvest should be performed. Also, the road density indicator has been exceeded. Landowners should evaluate their existing culvert capacities and overall risks of failure and subsequent sediment loading potential.

5.4 Willow Creek

5.4.1 Targets

5.4.1.1 Biota and Percent Fines Targets

Willow Creek water quality targets presented in Table 5-10 address biological integrity as measured by macroinvertebrates and periphyton. The targets also address substrate composition as measured by the 49-point grid. The biological targets and their applicability are the same as the targets for the Blackfoot River (Section 5.1.1). All considerations discussed for the Blackfoot River biota targets also apply to the Willow Creek targets presented in Table 5-10 with the exception of the specific monitoring sites defined in Section 8.0. Note that existing conditions either satisfy or come close to satisfying the Table 5-10 biota targets.

The median percent surface fines target using the 49-point grid in pool tails provides a measure of potential impacts to spawning fish as well as aquatic life. To satisfy the target, the median value of 49-point grid results must be $\leq$ 6% based on the 75th percentile for the reference data for Reaches 1 and 2 of the Blackfoot River (Figure E-5 in Appendix E). The approximate 8% median value measured in Willow Creek is higher than this 6% value based on the results presented in Figure E-5. Monitoring to satisfy this target needs to focus on two or three representative reaches of Willow Creek. McNeil Core sampling targets can be applied instead of, or in addition to the grid toss target if suitable native salmonid spawning areas can be located for sampling purposes. The target values would be the same 15% and 29% percent fines limits applied to fines < 2.38 mm and < 6.35 mm respectively. The grid toss and/or the McNeil core target(s) must be met to satisfy the Willow Creek siltation listing similar to the other targets presented in Table 5-10. In evaluating target compliance and overall achievability of the fines target, consideration must be given to potential impacts that a system with significant beaver activity may have, particularly on the lower sections of Willow Creek.

Table 5-10. Water Quality Targets for Willow Creek, Existing Conditions, and Departure from Target.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Macroinvertebrate and periphyton assemblages will score within full support of beneficial uses for sediment and habitat related indicators	Periphyton data indicate full support Macroinvertebrate data indicate impairment at one of two sampling locations	Target currently satisfied Target not satisfied; but close to being satisfied (72% vs. 75% of reference per Appendix B)
Clinger taxa richness will be ≥ 14	Clinger taxa richness data indicate full support	Target currently satisfied
The median percent fines < 6.35 mm in pool tails measured with a 49-point grid will be ≤ 6%	Median values are approximately 8%	Median surface fines values in pool tails need to be reduced from 8% to 6% or less

5.4.1.2 Additional Habitat and Sediment Targets

Table 5-11 presents additional targets to address the habitat impairment reach below the West Flesher Road. The target applied to this reach includes the following conditions:

- Establishment of a functioning, native riparian community;
- Development of a dynamically stable channel configuration, with appropriate range of substrate type, pool/riffle ratio, width to depth ratio, entrenchment ratio, and sinuosity with respect to site potential.

Because this reach is characterized by degrading conditions with eroding banks, apparent excess percent fines, and possible pool filling, the above target conditions must be met to address both habitat alterations and sediment related impairments. Target values for the functioning riparian community can be similar to riparian targets developed for Arrastra Creek (Table 5-4). Target values to address channel conditions can be similar to Arrastra or Poorman Creek targets, supplemented by literature values. These literature values should be based on the stream's potential using the Rosgen classification system and associated parameter ranges (Rosgen, 1996).

Another performance-based target focused on habitat alteration impairments applies to potential fish passage barriers within Willow Creek. One fish passage concern at the Flesher Road (Highway 279) crossing is identified and discussed in Appendix E. This target requires that fish passage be re-established at desirable migration points as identified by fisheries biologists.

Table 5-11. Additional Targets to Address Additional Habitat and Sediment Impairments in Willow Creek Drainage.

Water Quality End Point/Target	Existing Condition	Departure from Target or Percent Change Needed to Satisfy Target
Establish native riparian community and establish dynamic proper functioning condition based on stream potential for incised reach below West Flesher Road	Not properly functioning based on riparian health limitations and degraded channel conditions	Significant departure from target conditions, not quantified
Culverts upgraded to allow fish passage where such passage is considered of significant importance	Assessments indicate that at least one culvert location (Highway 279 crossing) causes a fish passage barrier	Not quantified

5.4.2 Total Maximum Daily Load

The 49-point grid sampling and biota results suggest that large reductions in sediment loading are not necessary to meet target conditions throughout most of the drainage. The Willow Creek sediment TMDL will be consistent with the Arrastra Creek and Blackfoot River sediment TMDLs since roads and eroding banks are probably the two most significant sources of excess fine sediment loading from human activities. Therefore, the Willow Creek sediment TMDL is expressed as a 30% decrease in sediment delivery from roads (including Highway 279) and a 75% reduction in bank erosion associated with human impacts. Note that this reduction is not based on the total bank erosion load since the assessment results did not provide this type of information. It is instead consistent with the percentage of human related bank erosion considered controllable along the Blackfoot River main stem (Appendix F).

5.4.3 Allocations and Land Use Indicators

5.4.3.1 Allocations

The allocations for the Willow Creek sediment TMDL are presented in Table 5-12. The allocation for sediment delivery from roads is the 30% reduction applied to roads in other portions of the watershed to meet the Blackfoot River TMDL (Section 5.1.2). The allocation applied to accelerated bank erosion from human activities is a 75% reduction. As discussed above, this reduction is not based on the total bank erosion load since the assessment results did not provide this type of value. It is instead consistent with the percentage of human related bank erosion considered controllable along the Blackfoot River main stem (Appendix F). The assessment results did not identify many existing grazing or other impacts leading to bank erosion, and historic assessment results did not identify significant bank erosion concerns (DEQ, 2003). The intent is to address bank erosion in the main stem as well as tributary drainages, including Sandbar Creek, since bank erosion within tributaries has the potential to contribute to excess fines in the Willow Creek main stem (and ultimately the Blackfoot River). Efforts to implement BMPs along Willow Creek and tributaries to Willow Creek, as discussed in Section 6.0, can reduce this bank erosion and satisfy the intent of this allocation.

Note that the Table 5-12 bank erosion allocation is not applied to the reach between the West Flesher Road and Sandbar Creek until channel dimensions meet target values within Table 5-11. This is because additional bank erosion may be part of the natural recovery process for this reach as the stream attempts to increase sinuosity and build a new floodplain. To facilitate this effort, a performance-based allocation is developed. This performance-based allocation is based on two components. The first component involves continued implementation and evaluation of grazing BMPs. The goal is to protect riparian vegetation and avoid damage to developing floodplain areas. The second component is removal of any floodplain restriction associated with the upstream bridge crossing at West Flesher Road. The assessment results (Appendix E) identified this bridge crossing as a potential floodplain barrier. Limiting flood flows could hinder recover of the downstream impaired reach while at the same time increasing sediment loading risk due to culvert failure. Therefore, to satisfy this second performance-based component of the allocation, the bridge crossing should be able to at least pass a 25-year flood with minimal pooling.

Physical restoration of all or portions of the impaired reach between West Flesher Road and Sandbar Creek is also an option. This could include anywhere from complete design and construction of a new channel to riparian plantings in recovering areas. Prior to any significant physical channel restoration efforts, a feasibility study should be performed to evaluate the aquatic life gains, the risks involved with physical stream restoration, and overall costs and benefits. Input from fisheries biologists and water quality specialists, as well as key stakeholders, will be a critical component of any such decisions. An additional recommendation associated with recovery of this stream reach is to allow continued downstream beaver colonization. Downstream beaver dams may contribute to grade recovery and help restore floodplain and ground water levels, which would assist with riparian recovery.

The performance-based road sanding allocation is based on ongoing efforts by the Montana Department of Transportation to incorporate BMPs. This is applied in the same manner as for the Blackfoot River allocation associated with road sanding (Section 5.1.3.1). Similar to the Blackfoot River, it is anticipated that the BMPs, once implemented, will ultimately lead to a percent reduction of road sand loading to Willow Creek consistent with the sediment TMDL reduction of 30% for roads.

Allocations are not developed for the habitat impairment target associated with fish passage. The highway and other road building activities responsible for fish passage impairments are inherently linked to the corrective actions as described in Section 5.4.1.2.

Table 5-12. Allocations for Willow Creek.

Sediment Source Category	Allocations
Sediment Delivery from Roads	30% reduction of sediment loading from all roads in the watershed
Accelerated Stream Bank Erosion from Human Impacts in the Willow Creek Drainage	75% reduction in eroding banks load associated with human impacts; not applied to reach between W. Flesher Rd and Sandbar Creek until channel dimensions meet target values
Historic impacts to channel above Sandbar Creek and below W. Flesher Rd crossing	Performance-based; a) continued implementation and evaluation of grazing BMPs; b) remove floodplain restriction by ensuring passage of at least a 25-year flood with minimal pooling at the W. Flesher Rd crossing
Road Traction Sanding	Based on development and implementation of road sanding BMPs (performance-based allocation)

5.4.3.2 Land Use Indicators

All the same land use indicators applied to the Blackfoot River also apply to the Willow Creek drainage. Willow Creek has a relatively large percent of area with elevated potential for sediment loading, but did not have significant recent harvest based on 1992 through 1999 information. In fact, there was little harvest within the whole watershed within this time period. This suggests that hillslope and water yield indicators are not exceeded and additional analyses regarding hillslope erosion BMP implementation or water yield may not be a priority. On the other hand, the road density indicator has been exceeded. Landowners should evaluate their existing culvert capacities and overall risks of failure and subsequent sediment loading potential.

5.5 Sandbar, Beartrap, Mike Horse Creeks and the Upper One-Mile of the Blackfoot River

Sandbar Creek, Beartrap Creek, Mike Horse Creek, and the upper one-mile of the Blackfoot River are all impaired due to habitat alterations. The target condition for these streams is a restored channel in the locations where mining activities and highway encroachment have degraded habitat conditions. Target and restoration objectives include the following:

- Establishment of a functioning, native riparian community;
- Development of dynamically stable channel configuration, with appropriate ranges of substrate type, pool/riffle ratio, width to depth ratio, entrenchment ratio, and sinuosity with respect to site potential.

Consequently, the goal is to restore the stream to a stable dimension, pattern, and profile that is in dynamic equilibrium such that the stream system neither aggrades nor degrades. The reconstructed channel will also provide higher quality habitat for fish and aquatic life.

Surrogate allocations address the extent to which mining and road building activities have altered channel morphology and habitat condition in these streams. These reaches will be restored to a functioning stream as described above. Compliance with the channel restoration target will be based on assessment work documenting achievement of each of the above objectives. Additionally, biota targets for periphyton and macroinvertebrate, as described in Table 5.1 for the Blackfoot River, also apply.

SECTION 6.0
WATER QUALITY AND HABITAT IMPROVEMENT PLAN: IMPLEMENTATION STRATEGY

This section presents the overall strategy to achieve long-term land and water conservation goals of the Blackfoot Challenge and TMDL targets. The restoration of water quality and habitat conditions in the Blackfoot Headwaters Planning Area can be achieved through a variety of management or restoration strategies that fall into two categories: watershed-wide management activities to promote overall upland and stream health, and targeted strategies to address observed impairments on 303(d) listed streams.

There is considerable overlap in the Blackfoot Challenge's conservation objectives and the goals of the TMDL plan. However, some of the Blackfoot Challenge's concerns, such as weed management, lie outside the TMDL process. Nevertheless, this implementation plan provides a blueprint for addressing the full range of conservation issues including objectives for upland erosion management, weed management, grazing management, riparian health, road management, fisheries management, and other watershed health concerns. As a result, the voluntary activities presented here will result in full support of beneficial uses as described by numeric targets on impaired streams as well as meeting the Blackfoot Challenge's objectives for overall watershed health.

An important consideration in development of this restoration plan was the amount of specificity that was possible based on the available data. The large size of the Blackfoot Headwaters Planning Area presented a constraint in the development of highly detailed restoration plans. It was difficult to describe adequately conditions across such a large area as the vastness of the watershed precluded assessment of listed streams in their entirety. Instead, aerial photo analyses allowed for identification of sub-reaches, which provided the basis of a stratified approach. Field evaluations occurred in varying proportions of these sub-reaches within budgetary and time constraints. This approach allowed for development of a reach-based restoration plan that targets conditions observed in the reach. Still, the plan is flexible to account for conditions present in non-sampled portions of these sub-reaches that may require additional or different actions to meet restoration objectives. Site-specific assessment of each restoration strategy will determine its feasibility with respect to site constraints, cost, environmental benefit, and stakeholder support. Restoration strategies will be prioritized based on benefit and feasibility.

6.1 Watershed-Wide Long-Term Management Strategies

This portion of the plan provides system-wide restoration strategies to meet the qualitative goals of maximizing the long-term health of the Blackfoot upland, river, and tributary resources as well as specific goals of the TMDL process. These management strategies will be accomplished through voluntary cooperative private-public resource stewardship led by the Blackfoot Challenge and its partners.

6.1.1 Management of Erosion-Prone Hillslope Areas

This section of the plan identifies upland areas that due to steep slopes and highly erodible soils have the potential to deliver high sediment loads to streams if bare mineral soil is exposed and inadequate erosion control applied. Since vegetative cover plays a critical role in preventing hillslope erosion, the management strategies address land use practices that have the potential to expose bare mineral soil. The plan aims to decrease production and delivery of sediment from erosion-prone hillsides identified as sediment sources. The strategy to prevent or reduce erosion and sediment delivery in these areas is to implement best management practices (BMPs) when conducting forestry, grazing, and other land management activities.

Forestry Best Management Practices for Montana (Logan, 2001) is a voluntary program that requires that landowners be aware of unstable or erosion-prone areas when conducting forestry activities. If activities in these areas are unavoidable, managers should employ appropriate techniques to minimize the extent of the disturbance and apply erosion control practices on disturbed soils. For example, selection of appropriate harvesting systems (i.e., cable logging from roads on steep slopes rather than using tractors) and the reduction in the number of roads will reduce the area of disturbance. Where disturbance occurs, implementation of forestry BMPs will control erosion. For example, placement of logging slash (tree limbs, etc.) on the ground in erosion prone areas creates ground cover and prevents erosion. Lastly, retention of streamside buffers, as required under the Streamside Management Zone law, encourages deposition of any eroded soils prior to entering streams.

To address grazing-related disturbance, grazing best management practices (prescribed grazing) will be implemented as part of a range or allotment management plan. These plans are required on all land leased by Plum Creek Timber and the US Forest Service.

As forestry, grazing or other projects are developed in the areas identified as higher-risk in this TMDL, landowners will be encouraged to tailor their activities to address the unique hazards in these areas to prevent erosion and sediment delivery to streams. The Blackfoot Challenge will provide educational materials to landowners that will show where the higher-risk erosion areas are located in the watershed. Landowners can then incorporate this information into their land management planning.

6.1.2 Action to Decrease Sediment Loading and Improve Fish Passage

Surveys of road conditions indicate improvements and BMPs will reduce loading of sediment to streams from these sources. The USFS provided a detailed list of road improvements identified for the Poorman Creek drainage (Appendix K). Activities include replacing undersized culverts, improving blading practices, and reconfiguring roadbeds and ditches as necessary to decrease sediment load to streams. Promotion of a similar approach by the USFS and other major landowners for all forest roads in the planning area will ensure that the road crossing sediment load allocations are satisfied.

On county and private roads, the plan promotes actions that will improve road conditions. This includes identification of and completion of road improvements to replace undersized culverts, mitigate bridge impacts on streams, and other actions to decrease sediment load to streams particularly at stream crossings. The plan also encourages the careful design and placement of new roads in subdivisions as well as routine maintenance of all subdivision roads to reduce sediment loading to streams. The goal is to apply the same or similar BMP standards to county and other private roads as are applied to roads built for timber harvest purposes. Identifying fish passage barriers on existing roads, and preventing creation of new barriers due to new road building activities is also an important goal.

Montana Department of Transportation (MDT) incorporates best management practices into their sanding efforts. These BMPs will vary from area to area, but in the upper Blackfoot may include the following:

1. Identification of sensitive areas where additional BMPs may be warranted;
2. Reduce the speed of plowing (when safe to do) to decrease the distance that snow/sand mix is blown from the highway;
3. Increase the use of chemical deicers and decrease the use of road sand, as long as doing so does not create a safety hazard or cause undue degradation to plant and water quality – a new combination sander/deicer with 800 gallon capacity has been added to the Lincoln section this year;
4. Improve maintenance records to better estimate the use of road sand and chemicals, and to estimate the amount of sand recovered in sensitive areas;
5. Continue to fund and manage MDT research projects, which will identify the best designs and procedures for minimizing road sand impacts to adjacent bodies of water, and incorporate those findings into additional BMPs;
6. Work with county road agents to share information and coordinate state-county road BMPs, continuing to pass-though funds to counties for road weed control; and
7. Identify areas with poor soil cover and explore options for revegetation to promote the growth of non-invasive species.

6.1.3 Plum Creek Timber Company

Plum Creek's Native Fish Habitat Conservation Plan (Plum Creek Timber Company, 2000) will guide water quality restoration in the Blackfoot Headwaters on Plum Creek lands. The US Fish and Wildlife Service and National Marine Fisheries Service approved this plan under Section 10 of the federal Endangered Species Act (ESA). The plan addresses the needs of native trout listed under the ESA (e.g., bull trout, redband rainbow trout, etc.) as well as species not presently listed (e.g., westslope cutthroat trout). In exchange for incidental take coverage for bull trout under the ESA, Plum Creek has committed to implement 56 conservation measures on their land, which will minimize and mitigate impacts to native fish. Measures that Plum Creek will be implementing under their Native Fish Habitat Conservation Plan (NFHCP) in the Blackfoot Headwaters area that will support attainment of the restoration goals and TMDL are summarized as follows:

- The NFHCP designates Plum Creek lands in the Arrastra and Poorman Creeks (above Landers Fork Confluence) as High Priority Watersheds. With this designation, Plum Creek will upgrade all roads to meet state BMP standards (with some specific enhancements) by the end of 2010. This work will include improving general road drainage, reducing the length of road draining to streams, and adding supplemental filtration (e.g., slash filter windrows, silt fences, etc.) where drainage feature outfalls discharge too close to streams for effective filtration. Plum Creek lands in other watersheds in the Blackfoot Headwaters will have any necessary road improvements made by the end of 2015.

- Where fish passage barriers exist, they will be corrected prior to 2010 in high priority watersheds and 2015 elsewhere. This deadline may be extended if necessary to fully work out details with cost-share partners (e.g., USFS).
- New stream culvert installations will be designed to accommodate at least the 50-year peak flow.
- Roads that Plum Creek does not require for forest management will be abandoned (reclaimed) by the end of 2010.
- All roads will be periodically re-inspected for BMP conditions. In High Priority Watersheds, this will be at least every 5 years.
- While Plum Creek requires very few new roads in the Blackfoot Headwaters, should they be necessary they would be constructed to specific enhanced standards.
- In addition to standard state Streamside Management Zone regulations, Plum Creek will be providing extra riparian protection along some streams. Extra protection is targeted for watersheds that contain bull trout, streams with channel migration zones, and streams that have plane-bed forced pool riffle morphology. Riparian buffers must also be enhanced with additional leave trees when streamside roads inhibit recruitment on the opposite side of the stream.
- On Plum Creek grazing lands, grazing leaseholders must have an approved range management plan (RMP) each year. This plan describes the best management practices that will be applied to the range to maintain or improve conditions over time as necessary to achieve certain environmental targets set out in the NFHCP. These targets relate to the amount of livestock altered stream bank, riparian grass and shrub utilization, and riparian compaction. The RMPs typically describe the grazing system (deferred, rest rotation, etc.), water source development, fencing, etc. Additionally, the leaseholder and Plum Creek monitor the range twice annually.
- For more information on the NFHCP, the reader can visit Plum Creek's website at the following address: http://www.plumcreek.com/environment/fish.cfm.

6.1.4 Noxious Weed Management

Noxious weed infestations are pervasive in the upland areas and stream corridors of the Blackfoot River watershed. The noxious weed restoration strategy consists of an aggressive plan implemented through Blackfoot Challenge weed management program that currently coordinates the management of noxious weeds on 350,000 acres in the Blackfoot valley, designated weed management areas (WMAs). In the Blackfoot Headwaters Planning Area, the following additional strategies will be employed:

- Coordinate with existing and create new WMAs in the Blackfoot Headwaters to address watershed-wide and riparian weed management issues;

- Work with Lewis & Clark and Powell County weed boards and weed coordinators, assisting individual landowners with mapping of weeds, implementation of control measures, and obtaining additional funding to co-share chemical control, biological control, and revegetation; and
- Initiate riparian weed control projects in areas of bank erosion and local support.

6.1.5 Forest Stewardship and Grazing BMPs

The Blackfoot Challenge, in coordination with State and Federal agencies, will work with landowners on forest stewardship and grazing BMPs to meet the goals of this watershed restoration plan and TMDL. Several agencies provide technical assistance to private forest landowners interested in maintaining their timberlands including the Department of Natural Resources (DNRC) Service Forestry Bureau, Montana State University (MSU) Extension's Forest Stewardship Program, Lewis and Clark Conservation District, North Powell Conservation District and the Natural Resources and Conservation Service (NRCS). Together, these entities possess both the technical expertise and local knowledge to promote conservation and restoration efforts.

The Blackfoot Challenge, through its Conservation Strategies Committee, will be developing a cooperative forest stewardship program to promote sustainable timber and grazing management throughout the Blackfoot River watershed. Private and public landowners will be able to pool their resources and share management techniques to maximize timberland recovery and sustainable harvesting to retain a timber economy important to the rural lifestyle of the area. Grazing leases on public lands and Plum Creek Timber lands have helped to sustain the rural livestock industry. Effective grazing management strategies are critical to sustaining the long-term health of grazing lands. The Blackfoot Challenge, through its Conservation Strategies Committee, will offer technical assistance to private landowners seeking help with grazing management plans, in cooperation with its technical partners. This restoration strategy includes:

- Providing ongoing technical support to Blackfoot landowners on sustainable forest stewardship and grazing management BMPs; and
- Developing a cooperative forest stewardship program to promote sustainable timber management watershed-wide in a way that does not contribute to excessive sediment loading.

Specific BMPs that may be employed in the Blackfoot Headwaters Planning Area are presented in Table 6-1. Additional BMPs and land, soil and water conservations practices may also apply on a case-by-case basis. Agricultural BMPs will be consistent with acceptable standards such as Montana Conservation Practice Standards from NRCS Technical Guidance (DEQ, 2001).

Table 6-1. Summary of BMPs and Management Techniques.

Human Disturbance Type	BMP and Management Techniques	References
Grazing	Design a grazing management plan and determine the intensity, frequency, duration, and season of grazing to promote desirable plant communities and productivity of key forage species.	MT DNRC 1999
	Maintain adequate vegetative cover to prevent accelerated soil erosion, protect stream banks and filter sediments. Set target grazing use levels to maintain both herbaceous and woody plants. No grazing unit should be grazed for more than half the growing season of key species.	MT DNRC 1999 MT NRCS 2002
	Create riparian buffer exclosures through fencing.	MT DNRC 1999
	Ensure adequate residual vegetative cover and regrowth and rest periods. Periodically rest or defer riparian pastures during the critical growth period of plant species.	MT DNRC 1999
	Distribute livestock to promote dispersion and decomposition of manure and to prevent the delivery of manure to water sources.	MT DNRC 1999
	Alternate a location's season of use from year to year. Early spring use can cause trampling and compaction damage when soils and stream banks are wet. If possible, develop riparian pastures to be managed as a separate unit through fencing.	MT DNRC 1999 MT NRCS 2002
	Provide off-site high quality water sources.	MT DNRC 1999
	Periodically rotate feed and mineral sites.	MT DNRC 1999
	Place salt and minerals in uplands, away from water sources (ideally ¼ mile from water to encourage upland grazing).	MT DNRC 1999
	Keep salt in troughs and locate salt and minerals in areas where soils are less susceptible to wind or water erosion.	MT DNRC 1999
	Monitor livestock forage use and adjust strategy accordingly.	MT DNRC 1999
	Create hardened stream crossings.	MT DNRC 1999

Table 6-1. Summary of BMPs and Management Techniques.

Human Disturbance Type	BMP and Management Techniques	References
	Encourage the growth of woody species (willow, alder, etc.) along the stream bank, which will limit animal access to the stream and provide root support to the bank.	MT DNRC 1999
Forestry	Follow Montana Streamside Management Zone (SMZ) laws and voluntary wildlife guidelines and other forestry related BMPs. Montana's SMZ regulations require buffer widths that are 50 or 100 feet for streams with an adjacent slope of less than 35% and greater than 35%, respectively. Within the SMZ, in Class 1 streams, no more than 50% of trees greater than 8 inches in diameter are removed (maintaining a minimum of 10 trees per 100 feet of the SMZ). In Class 2 streams a minimum of 10 trees per 100 feet of SMZ must be left.	MT Dept of State Lands 1994 MT DNRC 1995 MSU Extension Service 2001
	The following practices are prohibited within the SMZ: broadcast burning, operation of wheeled or tracked equipment except on established roads, clearcutting, road construction (with the exception of stream and wetland crossings), storage or handling of hazardous materials, side-casting of road materials, and depositing slash in surface water.	MT Dept of State Lands 1994

Table 6-1. Summary of BMPs and Management Techniques.

Human Disturbance Type	BMP and Management Techniques	References
Invasive weeds	In areas where invasive weeds are present across several properties, develop cooperation among landowners and develop an integrated weed management plan. This can be accomplished through the establishment of a Weed Management Area (distinguishable areas based on similar geography, weed problems, climate, and human use patterns), which can provide a channel of communication among landowners and a conduit for funding sources. Work with the Blackfoot Challenge Weed Management Group to determine the best management alternative (cultural, biological, physical, and chemical).	Duncan 2001
	Educate landowners and recreational users as to weed identification and prevention techniques.	Duncan 2001
	Prevent establishment and spread by keeping site-disturbing vehicles on designated trails or roads, keeping animals free of weed seed when possible, and developing an early detection program.	Duncan 2001
	Inventory the species and extent of the infestation.	Duncan 2001
Floodplain Development	Floodplain buffer.	
	Bank line grading and revegetation.	
Bank hardening/riprap/revetment	Limit to demonstrated infrastructure threat. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of upper bank, and to provide shading and cover habitat.	
Mining (placer piles)	Reconfigure channel floodplain cross sections to ensure floodplain connectivity and access.	
	Riparian restoration.	
W:D ratio	As possible, encourage vegetative reinforcement of banks to prevent stream overwidening and w:d ratio increases.	

6.1.6 Drought and Water Conservation

Certain streams, notably the lower portion of Poorman Creek and Arrastra Creek in the Blackfoot Headwaters, suffer from dewatering and the effects of drought. Dewatering is a type of habitat alteration that negatively influences fish and associated aquatic life by reducing the amount and quality of available habitat for fish. Low flows can also contribute to an accumulation of excess fines on streambed surfaces due to a lack of flushing. Restoration strategies include:

- Implementation of the Blackfoot Challenge water conservation plan;
- Working with landowners in the lower Poorman Creek drainage to address dewatering; and
- Investigate causes and solutions to dewatering in Arrastra Creek.

6.1.7 Conservation of Intact Landscapes

Maintaining large intact landscapes protects the natural resources and rural lifestyle of the Blackfoot River watershed. Development pressures associated with these lands include construction of new roads, elimination of vegetative cover, and subdivision. These alterations to the landscape can increase runoff and sedimentation to streams, and reduce wildlife habitat. Restoration strategies to maintain the intact landscape in the Blackfoot include:

- Projects such as the Blackfoot Community Plum Creek Project to encourage large acreage ownership in the transfer of lands to adjacent landowners;
- Conservation easements to sustain working ranches and allow for expansion of working ranches; and
- Protection of critical wetlands and other areas of high natural resource values through North American Wetlands Conservation Act (NAWCA) grants and other funding sources.

6.2 Watershed-Wide Stream Corridor Restoration Strategies

Within the river corridor, a number of opportunities exist to improve stream function, riparian condition, fish habitat, and water quality. The TMDL planning effort identified numerous conditions along stream corridors that affect water quality, riparian health and function, fish habitat, and geomorphic stability. These include conditions such as eroding banks, encroachment of structures or roads on the floodplain, riparian degradation from grazing, infestation of noxious weeds, and presence of fish barriers. This section provides general prescriptions to address these conditions throughout the watershed for all streams, not just those identified as being impaired on the 303(d) list.

6.2.1 Revegetation

The revegetation of cleared riparian/floodplain areas with native vegetation will reinforce and anchor stream banks and over bank surfaces. In general, woody riparian under story species are most effective at generating root masses that effectively increase stream bank resiliency. However, large trees are desirable for large woody debris and shade. Vegetated riparian banks also act to filter and hold fine sediment during periods of high flows. Revegetation restoration includes:

- Maintenance of a functioning native riparian and streamside vegetative community through riparian management techniques including revegetation and grazing BMPs.
- Establishment of woody debris concentrations that reflect typical recruitment rates within a stream environment.

6.2.2 Riparian Buffer

The implementation of a riparian buffer zone to limit stream encroachment from vegetation clearing and development can facilitate the management of the stream system as a channel/floodplain corridor rather than simply as a channel environment. Riparian buffers can also facilitate the growth of over story trees, which function as a source of large woody debris and provide shade as well as nutrient inputs to the channel. This riparian restoration plan encourages Lewis & Clark, Powell and Missoula counties to develop a consistent policy on appropriate setbacks from streams for habitable structures. This plan encourages:

- Establishing a minimum riparian buffer from the floodplain for all habitable structures to allow for natural channel migration and avoid the need for shoreline armoring to protect structures built too close to the migrating channel;
- Providing technical assistance to county commissions and conservation districts in developing maps that delineate the riparian buffer and creating a process for landowner setback exceptions; and
- BMPs for vegetative management within the riparian buffer of 100 feet from the floodplain to promote long-term riparian health and avoid erosion and sedimentation.

6.2.3 Riparian Grazing BMPs

Streamside areas provide high quality forage for livestock and these areas often sustain impacts in the absence of effective management schemes. This plan calls for implementation of grazing best management practices to restore the structure and function of riparian communities. A number of alternatives exist for managing livestock in riparian areas. Furthermore, the Blackfoot Challenge land steward and the Natural Resource Conservation Service technical staff are available to work with landowners to develop grazing management plans appropriate for their operations. The plan calls for technical assistance and support to landowners wanting to avoid riparian degradation and bank trampling. Specific BMPs include:

- Temporary exclusions where impacts are severe enough that several years of rest is required;
- Placement of riparian areas in conservation easements for extended periods; and
- Rotational grazing or cross fencing.

6.2.4 Fish Passage Barrier Removals

Numerous in-channel structures are potential fish passage barriers on Blackfoot River tributaries. These occur on forest roads, county roads, and private roads providing access to residences. Fish passage barrier restoration strategies include:

- Locate and perform fish passage assessments on all road crossings over stream segments where maintaining fish passage is a priority.
- Based on a priority list, culverts and other structures that create a barrier to fish migration will be inventoried and replaced with passable structures, except in streams where a barrier is desirable to prevent encroachment of brook trout into streams with westslope cutthroat trout populations.
- These activities will occur in consultation with fisheries biologists from MFWP and the USFS.

6.2.5 Non-Structural Erosion Control

Montana regulates streambed and bank disturbance with two permitting processes. One is the Natural Streambed and Land Preservation Act (310 Permit). This permit is required of private entities that want to undertake work that would modify the bed or immediate banks of perennial streams, and is administered by local Conservation Districts. The second is the Stream Protection Act (124 Permit), which applies to state and federal agencies, county and city governments and is administered by the Montana Department of Fish, Wildlife and Parks.

In addition, federal 404 permits, administered by the US Army Corps of Engineers, are required for activities along navigable waters. The USFWS and EPA are also involved in this process. The goal of these permit programs is to minimize adverse effects on shoreline and in-stream resources from human activities.

Installations of hardened erosion control structures can negatively affect long-term river function. Complete arrest of bank erosion eliminates the rejuvenating processes of channel migration and sediment cycling is lost, resulting in negative impacts on fish habitat. Although stream bank erosion control structures (revetments) can reduce localized sediment sourcing from bank erosion, their long-term adverse impact on overall channel function makes them undesirable management options. Channel migration is necessary for large woody debris recruitment that provides critical components of channel complexity and associated habitat elements such as pools resting areas, and cover. The restoration strategies focus on management practices that facilitate natural reinforcement of channel banks by riparian vegetation. The restoration plan encourages CDs, counties and local planning boards to promote:

- Non-structural erosion-control except to protect existing road and bridge infrastructure at risk, and even then mitigating down-stream erosion.
- Riparian buffer and revegetation in erosion areas.
- Case-by-case review of bank erosion focus areas working with landowners on non-structural erosion control solutions.

6.3 Restoration Strategies for 303(d) Listed Streams

This section presents specific restoration activities for the main stem of the Blackfoot River and it listed tributaries. The objective of these activities is to ensure fulfillment of load allocations established in Section 5.0 and achievement of full support of beneficial uses as defined by the numeric targets. This section addresses area-specific restoration activities for listed streams.

Delineation of sub-reaches on 303(d) listed streams facilitates planning. The Blackfoot River within the Blackfoot Headwaters Planning Area consists of seven major reaches delineated in the aerial photo analyses and field assessments (Figure 10). Geomorphic form (slope, sinuosity, cross section) and process (transport capacity, rates of change) provided the basis for delineation of these reaches. Each reach has designated activities intended to remedy problems identified in that reach. A delineation of sub-reaches on the 303 (d) Listed tributaries facilitates planning and prioritization of restoration activities.

Watershed-wide long-term management strategies (Section 6.1) and stream corridor restoration strategies (Section 6.2) apply across all streams as sound management practices. Consequently, even though weed management may not be identified specifically below, it is a prescribed restoration activity for all reaches. In addition to the general management strategies, specific restorations strategies will be applied on the 303(d) listed streams to address specific sediment and habitat impairments where needed. Finally, there may be channel restoration projects, yet to be identified, that are consistent with the Water Quality and Habitat Plan and will be incorporated into the plan at a later date.

6.3.1 Blackfoot River (Landers Fork to Nevada Creek)

Reach Prioritization

The first component of the restoration plan is prioritization of reaches for restoration activities. A simple analysis allowed for ranking of reaches in terms the human-induced sediment loading from eroding banks. This was a summation of the length of eroding bank associated with the different types of human influence and calculation of the percent of the reach. Reaches were ranked by the extent to which human factors increase bank erosion in each reach. Analyses to support these rankings included correlations with human influences and bank erosion (Appendix F). In summary, the data indicate that on assessed reaches on the main stem of the Blackfoot, grazing followed by road/railroad crossings are the most significant source of bank erosion, followed by revetments, logging, and building.

Based on data and analysis contained in Appendix F, restoration efforts will be concentrated within Reaches 5 and 6, where the primary source of sediment loading is associated with human activities. These reaches form a continuous 24-mile channel segment that extends from river mile 42 near Lincoln, to river mile 18, which is located near the Highway 141 Bridge crossing. Within this 24-mile channel segment, primary impacts to the Blackfoot River and its floodplain to be managed include grazing and road encroachment (Table 6-2). Human influences occur along approximately 30% of eroding banks in these reaches. The river deposits that underlie the floodplain and terrace environments within this area tend to be relatively fine grained; as a result, accelerated bank erosion results in entrainment of excessive fines, which is detrimental to fisheries.

Table 6-2. Total Combined Blackfoot River Bank Lengths Affected by Human Sources; Percent Refers to Relative Percentage of Each Type of Human Disturbance.

Human Influence	TOTAL ERODING BANK LENGTHS	% of Total Eroding Banks; All Reaches
Revetment	5549	8.7
Buildings	3454	5.4
Pavement	1451	2.3
Road/Railroad	15697	24.6
Pipes	676	1.1
Landfill/Trash	556	0.9
Park/Lawn	532	0.8
Grazing	31580	49.6
Logging	4227	6.6
Mining	0	0
Total	63,722	100

This section presents a restoration plan for the main stem of the Blackfoot River. Table 6-3 provides a summary of the reach ranking and restoration strategy of each reach. The objective of these activities is to ensure fulfillment of load allocations established in Section 5.0 and achievement of full support of beneficial uses as defined by the numeric targets.

Table 6-3. Summary of Identified Impacts and Proposed Treatment Strategies, Blackfoot River Study Reaches.

Major Reach	River Miles	Primary Identified Human Disturbance Factors	Priority Ranking	Human Yield (tons/mile)	Percent of banks affected by disturbance	Treatment/ BMP Strategies
BR1	55.1-70.0	Upper watershed mining, minor revetments and bank armoring	7	8.4	1.5	Incorporate geomorphic channel restoration into metals remediation strategies.
BR2	49.5-56.2	Roads, minor revetments and bank armoring, noxious weeds	5	28.41	3.8	Revegetate severely eroding stream banks and adjacent over bank areas. Implement weed management plan.
BR3	48.1-49.5	Roads, grazing, floodplain clearing and construction, noxious weeds, limited LWD; low vegetative cover and extensive bare ground	4	28.41	No data	Implement floodplain buffer to limit encroachment from clearing/development. Revegetate severely eroding stream banks and adjacent over bank areas. Implement weed management plan.
BR4	42.3-48.1	Roads, grazing, logging, floodplain development, rock and root wad revetment, and noxious weeds	3	99.7	22.8	Implement floodplain buffer to limit encroachment from clearing/development. Revegetate severely eroding stream banks and adjacent over bank areas. Encourage riparian grazing BMPs and riparian buffers. Implement weed management plan.
BR5	32.1-42.3	Grazing, logging activities, revetments, roads, and knapweed.	2	194.72	29.3	Encourage riparian grazing BMPs and riparian buffers. Revegetate severely eroding stream banks and adjacent over bank areas. Implement weed management plan.

Table 6-3. Summary of Identified Impacts and Proposed Treatment Strategies, Blackfoot River Study Reaches.

Major Reach	River Miles	Primary Identified Human Disturbance Factors	Priority Ranking	Human Yield (tons/mile)	Percent of banks affected by disturbance	Treatment/ BMP Strategies
BR6	18.1-32.1	Grazing, roads, revetments and riprap, and upland logging activities	1	223.62	31.2	Encourage riparian grazing BMPs and riparian buffers. Revegetate severely eroding stream banks and adjacent over bank areas.
BR7	0-18.1	Grazing, roads, floodplain development and bank armoring	6	27.25	11.5	Encourage riparian grazing BMPs and riparian buffers. Revegetate severely eroding stream banks and adjacent over bank areas.

Reach BR1 (Priority Ranking 7)

Reach BR1 is located in the uppermost watershed area, and consists of approximately 15 miles of Blackfoot River. Beneficial use support determinations for this reach concluded that 303(d) listing for sediment or habitat alterations is warranted appropriate for the uppermost mile affected by the Mike Horse tailings dam failure and other mining impacts. The restoration strategy for this reach is the integration of channel and habitat restoration activities described in Section 5.5 into the Upper Blackfoot Mining Complex restoration efforts.

Reach BR2 (Priority Ranking 5)

Reach BR2 is located upstream of Landers Fork confluence, and identified impacts to the seven mile reach include roads, revetments, livestock use, and noxious weeds. Although sediment and associated causes of impairment were not determined to be impairing beneficial uses, a number of management concerns were apparent. These include contributions of sediment from human sources and noxious weeds, which will be addressed through watershed wide conservation activities described in Section 6.1. There are no additional, reach specific restoration activities identified for this reach.

Reach BR3 (Priority Ranking 4)

Although this reach lies within the impaired reach of the Blackfoot River (Landers Fork to Nevada Creek), natural disturbance from the Landers Fork is the primary factor shaping observed conditions. As a result, there are no new specific restoration objectives for Reach BR3. Still, there are opportunities to manage the stream corridor to the benefit of the Blackfoot River in this reach. Observed problems include limited riparian cover, cleared floodplain areas, road development, noxious weeds, and riparian grazing. Fundamental restoration opportunities in this reach include enhancement of the riparian/floodplain corridor to improve riparian cover and LWD recruitment. Therefore, the watershed-wide and river corridor management strategies developed for the watershed will be applied in this reach.

Reach BR4 (Priority Ranking 3)

Reach BR4 is approximately 6 miles long, extending from the mouth of Swede Gulch to Stemple Pass Road Bridge. Restoration strategies for this reach address reductions in sediment loading from human sources and improved riparian health and function. The estimated human disturbance-related sediment yield from Reach BR4 is 100 tons/mile/year. Human disturbance affects approximately 23 percent of the eroding bank length. The reach has a third place rank in restoration priority based on this yield estimate. The identified human disturbances within this reach include floodplain development, revetments, grazing, timber harvesting, and noxious weed infestations.

To meet TMDL targets and restore in-stream conditions to full support of beneficial uses, specific restoration objectives apply to reach BR4. Therefore, this reach will be managed as a bank erosion priority focus area to address habitat alterations and increased sediment loading. This entails working with landowners to develop site-specific restoration plans to enhance the existing native riparian vegetative community through riparian management, noxious weed control, establishment of a riparian buffer, and promote recruitment of woody debris.

Reach BR5 (Priority Ranking 2)

Reach BR5 is approximately 10 miles long, extending from Stemple Pass Road Bridge to the upper canyon area. The estimated human-disturbance related sediment production within Reach BR5 is about 195 tons/mile/year, which renders the reach a high priority with regard to restoration benefit. Identified human disturbances in reach BR5 include grazing, road encroachment, revetments, timber harvesting, and noxious weeds.

Similar to BR4, this reach will be managed as a bank erosion priority focus area by working with landowners on site-specific restoration plans. These plans will result in the restoration of the native riparian community through riparian management. In addition, there may be opportunities to improve habitat for fish by reducing width-to-depth ratios and converting extensive run environments to riffle/pool sequences. Ideally, vegetation management will be sufficient in restoring fish habitat to its potential in this reach. However, there may be opportunities where mechanical stream restoration is feasible and desirable. These will be determined on a site-by-site basis with input from landowners and fisheries managers.

Reach BR6 (Priority Ranking 1)

Reach BR6 is approximately 14 miles in length, extending from the upper canyon area downstream to the mouth of the canyon near the Highway 141. Sediment and related causes of impairment negatively affect beneficial uses warranting the implementation of restoration strategies intended to facilitate achievement of TMDL targets. Identified disturbances in Reach BR6 include grazing, road encroachment, and revetments. Sediment production estimates indicate approximately 224 tons/mile of sediment production within this reach is associated with human disturbance. Furthermore, approximately 31% of the eroding banks are affected by human disturbance. Due to the extent of human disturbance and associated yields, Reach BR6 is the highest priority reach in terms of restoration benefit. The fundamental approach to restoration in Reach BR6 is similar to that of Reach BR5, which is designed to reduce fine-grained sediment sourcing related to human impacts to improve fisheries habitat conditions downstream.

Restoration objectives for reach BR6 are similar to BR5. These include managing this reach as a bank erosion priority area and increasing the structural composition and vigor of riparian vegetation through BMPs and setbacks. More intensive restoration activities such as bioengineered bank stabilization and channel restoration may be appropriate for some portions of this reach. Feasibility of more intensive interventions will be determined on a site-specific basis using input from landowners and fisheries managers.

Reach BR7 (Priority Ranking 6)

Reach BR7 is approximately 18 miles in length, extending from the Highway 141 Bridge to the Nevada Creek confluence. Restoration strategies will facilitate achievement of TMDL targets and load allocations. Identified human disturbances in the reach consist of grazing, road encroachment, and revetments. An estimated 27 tons/mile of sediment produced in the reach is associated with human disturbance factors.

Ostensibly, successful restoration of Reach BR7 will be achieved largely through the realization of sediment load reductions upstream. In addition, prescribed restoration activities in this reach will be based on its designation as both a bank erosion priority focus area and woody debris recruitment focus area. This designation requires working with landowners on restoration plan for site-specific management strategies to enhance riparian condition and function. Enhancement of in-stream habitat for fish will occur through promoting recruitment of large woody debris through riparian management. Alternatively, placement of woody debris is an option to promote formation of pools thereby decreasing the dominance of glide habitat. As with other mechanical interventions, landowner involvement and input from fisheries managers will guide these decisions.

Landers Fork

Natural factors were determined to be the overwhelming influence on the Landers Fork. However, there are still opportunities to mitigate the effects of human activities on the Landers Fork and ultimately the Blackfoot River. Because Landers Fork is such a significant natural sediment source, this area will be handled a High Sediment Source Area with special management and monitoring strategies developed to protect the natural floodplain and to minimize human-induced erosion in the high volume sediment delivery area.

6.3.2 Arrastra Creek

USFS monitoring segments Arrastra Creek into three sub-reaches that extend from the confluence with the Blackfoot River upstream approximately 5 miles (Table 6-4). Current conditions within Arrastra Creek warrant development of a sediment TMDL. Identified impacts within this system include excess bedload in the channel cross section resulting in aggradation and flow infiltration; riparian clearing, noxious weed infestations, potential culvert conveyance insufficiencies, and fine sediment deposition (Table 6-4).

Restoration activities for Arrastra Creek include management of both upland vegetation and stream corridor management activities. The sediment model described in Appendix M provides justification for careful management of upland vegetation. This model identified the Arrastra Creek sub-watershed as having significant area at high risk of sediment production and delivery. Consequently, the Arrastra Creek watershed will be managed as a high sediment risk area.

Other specific restoration activities will be developed in conjunction with landowners along the stream corridor. Activities will include development and implementation of plans to address sediment through riparian protection, revegetation, riparian BMPs, and replacement of culverts to ensure adequate sediment/flow conveyance. In addition, encouragement of sufficient riparian buffers is warranted for Arrastra Creek. The excess bedload condition within Arrastra Creek is not associated with bank erosion and in-channel sediment sourcing. Field documentation of both excess bedload and active riparian clearing suggests that the process of sediment interception by vegetation has been impaired within the riparian zone of Arrastra Creek. Therefore, implementation of no cut riparian buffers along with other BMPs will likely restore beneficial use support in Arrastra Creek.

Table 6-4. Identified Impacts and Recommended Restoration Strategies, Arrastra Creek.

Major Reach	River Miles	Identified impacts	Treatment Strategies
AC1	2.0-4.7	Excess bed load, culvert blockages, noxious weed infestations, fine sediment deposition, and bank instability	Implement weed management plan. As necessary to achieve flow/sediment conveyance, replace/modify culverts.
AC2	0.75-2.0	Excess bed load, riparian clearing, and noxious weed infestations	Implement weed management plan. Encourage riparian buffers.
AC3	0.0-0.75	Excess bed load, noxious weed infestations, and high sediment loads	Implement weed management plan. Encourage riparian buffers.

6.3.3 Poorman Creek

The primary identified degraded conditions on Poorman Creek include noxious weed infestations, fish passage barriers, placer mine spoils and valley bottom disruption, landscaping and riparian clearing, grazing impacts, siltation, and dewatering (Table 6-5). Conditions on Poorman Creek warrant development of TMDL for sediment, and significant additional opportunities exist for stream restoration and improvement of channel/floodplain function.

Restoration activities planned for Poorman Creek address the various limiting factors identified for this stream. First, Poorman Creek will be addressed as a riparian focus area where the Blackfoot Challenge and agencies will work with landowners to improve livestock grazing and other activities that have a negative effect on riparian vegetation. In addition, reaches disturbed by placer mining, restoration activities may include mechanical restoration of a stable channel configuration, as is feasible following a cost-benefit analysis. Efforts to address dewatering in Poorman Creek have been ongoing and involve working with irrigators to increase water use efficiency to maintain in-stream flows.

Specific activities associated with placer mining and riparian focus area designation are as follows. Within the riparian corridor, strategies based upon weed control, riparian grazing BMPs, and no-cut timber buffers, should facilitate riparian recovery. In Reach PC4, impacts include extensive placer mining and placer spoil placement along the riverbank. Within this reach, EMAP data indicate that pool habitat encompasses less than 5 percent of the assessed channel length. The lack of pool habitat in Reach PC4 is likely associated with placer mining and spoils accumulations on the riverbank. Historic mining of the active channel bed has resulted in destruction of pool environments as well as isolation of floodplain area behind the spoils.

Consequently, restoration strategies in Reach PC4 should include a reconfiguration of the channel cross section and profile to increase geomorphic complexity, which would include the construction of pool environments and incorporation of large woody debris.

Table 6-5. Identified Impacts and Recommended Restoration Strategies, Poorman Creek.

Major Reach	River Miles	Identified impacts	Treatments/Strategies
PC1	12.7-14	Noxious weeds	Implement weed management plan. Assess needs for abandoned mine reclamation.
PC2	10.5-12.7	Passage barriers and noxious weeds	Implement weed management plan. Assess and remove existing fish passage barriers.
PC3	8.6-10.5	Passage barriers and noxious weeds	Implement weed management plan. Assess and remove existing fish passage barriers.
PC4	2.3-8.6	Passage barriers, placer mine tailings, floodplain isolation, riparian clearing, grazing, heavy infestations of noxious weeds	Restore areas impacted by placer mining based on the findings and cost-benefit analysis. Encourage riparian buffers. Implement weed management plan. Assess and remove existing fish passage barriers. Encourage riparian grazing BMPs.
PC5	0-2.3	Dewatering, grazing, and noxious weeds	Implement weed management plan. Reconfigure existing diversion system to maintain in-stream flows and increase water use efficiency. Encourage riparian grazing BMPs.

In addition to these stream corridor activities, the USFS identified numerous road improvements and BMPs to reduce sediment loading from roads, increase connectivity, and improve fish habitat (Appendix K). The USFS and county are responsible for completing these activities on their roads. The Blackfoot Challenge will work with private landowners with culverts and other road features that present a sediment risk or passage barrier to streams in the Poorman Creek drainage.

6.3.4 Willow Creek

Several perturbations along Willow Creek require restoration activities to meet TMDL planning objectives (Table 6-6). These include impacts from grazing, channelization from roads, and fish passage barriers. Specific remedies to address these impacts are as follows:

- Work with private landowners to implement grazing BMPs;
- Mitigate road and bridge crossing impairment to natural floodplain functions;
- Assessment and removal of fish passage barriers;
- Assess grade stability and restore channel to provide for grade stability; and
- Where feasible, restore/enhance wetland areas to facilitate grade control.

Table 6-6. Identified Impacts and Recommended Restoration Strategies, Willow Creek and Sandbar Creek.

Major Reach	River Miles	Identified Impacts	Recommended Treatments and Strategies
WC1	2.8-6.1	Fish passage barriers, localized channel downcutting, noxious weed infestations, grazing impacts, channel encroachment by West Flesher Road	Implement riparian grazing BMPs. Evaluate potential for increasing wetland areas and beaver populations. Assess grade stability and restore channel to limit bank erosion and infiltration. Implement weed management plan. Mitigate Highway 279 and bridge impacts.
WC2	0.8-2.8	Noxious weed infestations	Implement weed management plan.
WC3	0.0-0.8	Noxious weed infestations	Implement weed management plan.
Sandbar	All	Channel instability at Highway 200 crossing	Assess needs for abandoned mine reclamation. Incorporate geomorphic channel restoration into metals mitigation strategies. Reconfigure highway crossing to improve channel stability upstream of road.

6.3.5 Sandbar Creek

Mining activities and road encroachment present alterations that require restoration on Sandbar Creek. This plan addresses channel instability resulting from channelization by Highway 279. Specific restoration strategies for Sandbar Creek include:

- Evaluation and reconfiguration/reconstruction of the channel just upstream of Highway 279 to provide sufficient conveyance under the road, to limit upstream ponding, and to develop geomorphic habitat types in the channel section that is currently ditched; and
- Incorporation of geomorphic principles into any restoration plan designed for metals to optimize that geomorphic function and biologic productivity.

Reclamation associated with mining activities is covered in the metals TMDL (Hydrometrics et al., 2003).

SECTION 7.0
ADAPTIVE MANAGEMENT

Adaptive management has been defined as "an innovative technique that uses scientific information to help formulate management strategies in order to 'learn' from programs so that subsequent improvements can be made in formulating both successful policy and improved management programs" (Halbert, 1993). The National Research Council strongly recommends the adaptive approach for TMDL development as a means to make progress toward achieving water quality goals while relying on monitoring and experimentation to reduce uncertainty (Natural Research Council, 2001). Moreover, adaptive management is an important component of TMDL development and implementation in Montana. Water quality restoration planning and TMDL development efforts throughout the Blackfoot Headwaters Planning Area will benefit from the adaptive approach to manage costs and achieve success.

A significant source of uncertainty concerns the inherent variability of natural conditions in headwater environments. High variability limits the statistical certainty in making decisions. Climatic conditions can also influence certainty. For example, much of Montana has been experiencing prolonged drought. This could influence both vegetative parameters and streambed siltation over the short-term. Wildfire and floods are other types of natural occurrences that have the potential to shape conditions in the watershed for decades or longer. For example, the effects of the 1964 flood on the Landers Fork provide an example of the extent and duration that natural events can have on streams since impacts are still evident (Appendix I).

Given the realities of human resource and budgetary constraints, watershed restoration plans must continue despite a degree of uncertainty. The adaptive management approach lends itself to this scenario as it involves continued monitoring and refinement of targets based on new information. Therefore, the monitoring approach developed for the Blackfoot Headwaters Planning Area was designed to provide the feedback necessary to evaluate both the relative contributions of sediment from various sources and the efficacy in the implementation plan in achieving water quality goals.

7.1 Adaptive Management Approach to Targets

The numeric targets were developed to represent desired conditions and achievement of water quality standards. These targets represent a source of uncertainty. Specifically, there is uncertainty regarding whether the reference condition was appropriate for a given stream and whether the target(s) will be achievable. The adaptive management approach to watershed planning allows for continual evaluation of stream conditions and targets. Through this process, targets may be changed to reflect the potential of a given stream. For example, it is possible that despite implementation of all remedies, a stream does not meet its numeric target for percent fines, indicating that the target is not achievable. Alternatively, implementation of management practices may result in improvements beyond initial target criteria. This implies a greater potential than initially thought possible and can justify a more stringent target to ensure continued beneficial use support.

As part of the implementation monitoring described in Section 8.0, targets will be evaluated at least every five years. This evaluation will include a consideration of target suitability and could result in a modification to targets based on identification of more suitable reference or least impaired conditions. Also, further evaluation may identify that there is a better indicator parameter to address an impairment. Further evaluation may also identify additional impairments not effectively addressed by the existing targets. Either of these situations can justify new and/or replacement target(s) to ensure full beneficial use support concerning sediment and/or habitat impairments.

7.2 Adaptive Management Approach to TMDLs and Allocations

There are several sources of uncertainty with regard to TMDLs and allocations. A significant source of uncertainty has to do with the pollutant source assessment, pollutant load determinations, and determination of relative source impacts. This is partly due to field methods and data collection procedures, as well as modeling approaches and assumptions within models. This uncertainty is addressed to some degree by applying allocations to a number of significant loading source categories and identifying land use indicators for additional potentially significant source categories.

Another form of uncertainty has to do with the assumption that the load reductions and performance-based activities defined for each stream in Section 5.0 will result in meeting target conditions. This assumption necessitates a phased TMDL approach. Per this phased approach, as restoration efforts continue and loading reductions are achieved, implementation monitoring will occur to evaluate progress toward meeting targets as further described in Section 8.0. If it looks like greater reductions in loading or improved performance is necessary to meet targets, then a new TMDL and/or new allocations will be developed based on achievable reductions via application of reasonable land, soil and water conservation practices. On the other hand, it is possible that the stream will satisfy all targets and be considered fully supporting regarding sediment impairments, even if the TMDL and/or some load allocations have not been satisfied. This stresses the point that meeting the targets represents compliance with applicable water quality standards.

SECTION 8.0 MONITORING STRATEGY

Monitoring is an important component of watershed restoration, a requirement of TMDL development, and the foundation of the adaptive management approach. This monitoring plan for the Blackfoot Headwaters Planning Area is a multi-strategy effort designed to address specific TMDL concerns such as attainment of restoration targets and load allocations. Moreover, the monitoring strategy designed for this sediment TMDL, like other aspects of this water quality and habitat restoration plan, exceeds the programmatic requirements by incorporating the range of issues of concern to the Blackfoot Challenge. Participation of a number of planning partners including a variety of state and federal agencies, stakeholders, and other parties provides a key element to this plan that increases its value by providing a multi-disciplinary approach and local knowledge. Furthermore, this plan incorporates ongoing monitoring efforts in the basin to ensure consistency with other management concerns of the Blackfoot Challenge.

The principles of adaptive management provide a foundation for the monitoring plan presented here. A well-designed monitoring plan facilitates the adaptive approach by providing feedback on the efficacy of restoration activities, the relative contributions of sediment from various sources, and feasibility of attaining targets. Within this adaptive framework, monitoring results provide the technical justification to modify restoration strategies, numeric targets, or load allocations when appropriate. Similarly, lessons learned from monitoring results may be applied in other watersheds to facilitate other watershed planning efforts.

The monitoring strategy is broken down into two main categories: implementation monitoring and additional assessment and watershed characterization monitoring. Implementation monitoring is required to assess the effectiveness of future restoration activities, to assess whether compliance with water quality standards has been obtained by evaluating progress toward meeting restoration targets, and to assist with any adaptive management decisions as needed. Implementation monitoring to assess progress toward meeting restoration targets is required by the TMDL rules (§§75-5-703(7) & (9)), and is also an integral component of the implicit margin of safety incorporated in the sediment TMDLs developed in this restoration plan.

The additional assessment and watershed characterization category of this monitoring strategy has several potential roles. First, this category can address additional data needs for more complete delineation of sediment or habitat impaired stream segments throughout the headwaters planning area. Furthermore, additional assessment monitoring can lead to better delineation of specific sources of sediment impairment and refinement of load allocations in some drainages. Finally, additional assessment improved understanding of the aquatic life and other beneficial uses needing protection. This component of the monitoring strategy adds to the adaptive management approach and allows for continued refinement of any or all aspects of the TMDL and watershed restoration plan.

Section 8.0 monitoring activities identify where DEQ has a responsibility to perform or fund a given type of monitoring. Where a monitoring activity is not required by DEQ, the Blackfoot Challenge may pursue the monitoring activity depending on resource availability and overall priorities. Under these conditions, the DEQ, as well as other stakeholders, may provide significant technical or financial assistance.

8.1 Coordination of Water Quality Monitoring within the Blackfoot River Watershed

Ongoing assessment, monitoring, and restoration efforts in the Blackfoot Headwaters Planning Area provide a mechanism for facilitating restoration and monitoring activities. Since the 1990s, the Blackfoot Challenge and its partners have been working to restore the health of the Blackfoot watershed through fisheries and stream restoration as well as landscape level conservation. The Clean Water Act and TMDL mandates in Montana lead the Blackfoot Challenge into TMDL planning when, in 2001, the Blackfoot Challenge established a habitat and water quality restoration committee (HWQRC) to oversee TMDL development and to ensure broad stakeholder involvement. A Water Quality Monitoring Work Group (WQWG) was created in 2002 to coordinate the network of water quality monitoring efforts in the basin and to establish a comprehensive, basin-wide water quality-monitoring program.

The Blackfoot Challenge recognizes that monitoring is a critical component of water quality and TMDL planning, implementation and evaluation. To date, the monitoring workgroup has identified four primary water quality-monitoring needs in the Blackfoot basin:

1) Monitor basin-wide water quality status and time trends;
2) Identify pollution sources and water quality impairment mechanisms for 303 (d) listed streams requiring restoration to meet state water quality standards and thus satisfy any TMDL development requirements;
3) Evaluate the individual and cumulative effectiveness of restoration projects; and
4) Establish reference information for high quality streams in the watershed that can serve as templates for restoration of impaired waters.

The Monitoring Work Group is developing and implementing a Blackfoot Watershed Water Quality Monitoring Network to meet multiple objectives including status and trends, TMDL, and restoration project monitoring. The workgroup coordinates the partnership monitoring efforts; advises on grant funds and contracts for technical work; oversees monitoring associated with TMDLs and restoration projects; facilitates technical and stakeholder involvement; and advises on monitoring education outreach and field sites. The following public and private agencies serve on the Blackfoot Challenge Monitoring Work Group: Blackfoot landowners, EPA, USGS, USFS, USFWS, BLM, DEQ, FWP, DNRC, Plum Creek Timber Company, Big Blackfoot Chapter of Trout Unlimited, Trout Unlimited, conservation districts, and TMDL Consultants.

The following list summarizes TMDL implementation goals of the Blackfoot Water Quality Monitoring Workgroup:

- Utilize the Blackfoot Challenge HWQRC and its water quality monitoring workgroup (WQWG) to coordinate implementation of the Blackfoot headwaters water quality and habitat/TMDL for sediments monitoring strategy;

- Refine and implement a Blackfoot Watershed Water Quality Monitoring Network, incorporating TMDL monitoring needs into the work program; and
- From TMDL related monitoring data evaluate targets, allocations and assess effectiveness of implementation plan in achieving water quality goals.

8.1.1 Implementation Monitoring

The objective of the implementation monitoring plan is to address three components of the sediment TMDL developed for the Blackfoot Headwaters Planning Area. These are: 1) assess progress toward attainment of the restoration targets as required by TMDL regulations, 2) assess overall progress toward meeting allocations, and 3) assess the effectiveness of specific restoration activities. The following sections detail these activities as they relate to TMDL development and watershed planning objectives.

8.1.1.1 Implementation Monitoring Focused on Restoration Targets

Implementation monitoring to assess overall progress toward meeting the restoration targets identified in Sections 5.0 of this plan will include monitoring a combination of physical stream conditions (both channel and riparian) and biological community measures. Implementation monitoring will be done at least once every five years as defined by the TMDL regulations, with additional monitoring performed as needed to ensure timely evaluation of completed restoration activities in a particular drainage. DEQ is responsible for this type of implementation monitoring although other entities may perform significant aspects of the monitoring and it is expected that the overall effort will be closely coordinated with the monitoring workgroup. The monitoring workgroup will be involved with the final overall target monitoring plan development as needed to refine target locations or other monitoring details as necessary.

Monitoring parameters and methods vary slightly according to 303(d) listed stream. Table 8-1 is a summary of minimal target compliance monitoring parameters and likely monitoring locations. All monitoring efforts are to be done using standard DEQ sampling and analyses protocols, or sampling and analyses protocols as approved by DEQ. This is particularly important for analysis of biological target conditions where a given protocol is necessary to ensure proper sample size for clinger taxa richness determinations. The existing protocol (Bukantis, 1998) involves the traveling kick net macroinvertebrate collection method and laboratory sub-sampling. As noted in Section 5.0, the DEQ may update the biological indicators and metrics used for beneficial support determinations, as well as sample and analysis protocols. These updated biological indicators, under the direction of DEQ, may replace one or more of the biological targets identified in Section 5.0.

Because local reference conditions provide the basis for some target development, monitoring may also include measurements in reference streams to ensure an appropriate baseline comparison condition. Significant environmental factors such as drought, floods, or fires can affect both reference and impaired stream conditions throughout a watershed, and may be important factors in determining target achievability. In addition, improving watershed conditions in reference streams may justify a more protective target condition based on similar improving trend expectations within impaired streams beyond the anticipated improvements that will be achieved via meeting load allocations.

Additional assessments on streams in the Blackfoot Headwaters Planning Area may provide auxiliary information in refining targets for tributaries in the Blackfoot Headwaters Planning Area. For example, DEQ in conjunction with EPA, conducted full EMAP assessments in Keep Cool Creek, a tributary to the Blackfoot River located within the Blackfoot Headwaters as part a regional initiative. These data will become available in the near future.

In many cases, more sampling may be desirable to better measure progress or to establish an improved baseline condition. This is particularly true for the McNeil Core sampling, where yearly sampling on many streams helps establish overall watershed trends and can help evaluate relative impacts from natural events such as recent large fires in the Copper Creek and other drainages during 2003. Therefore, additional McNeil core sampling may occur within an adaptive management approach to assist in refinement of targets or evaluate the impacts of natural disturbance. Additional McNeil Core sampling is also required to track and possibly refine reference conditions as discussed in Section 5.1.1.

When evaluating target compliance, it is possible to have conditions where the median values satisfy the targets in Table 5-1, but indicate extremely low fines within the stream. This could be an indication of a different kind of impairment that could be associated with an overall reduction in appropriate spawning habitat. The assessment results do not indicate this type of human-related impairment in the system, but a lack of spawning locations for sampling or very low fines values relative to reference conditions should be a warning to evaluate further the potential cold-water fish support status in the stream.

Table 8-1. Monitoring Locations and Parameters to Evaluate Target Compliance.

Stream(s)	Parameter(s)	Location(s)[1]	Sample Method	Sample Period
Blackfoot River above Landers Fork; Mike Horse Creek; Beartrap Creek; Sandbar Creek; Willow Creek; Poorman Creek	Dynamically stable channel, functioning riparian, overall proper functioning condition, percentage of pools within anticipated range for Rosgen stream type	Blackfoot: Whole length above Upper Marsh (upper 1 mile of river); Mike Horse and Beartrap: lower reaches; Sandbar: just above highway crossing and in upper mine impacted reach; Willow: downcut reach above Sandbar; Poorman: Placer mined reaches based on results of additional benefits analyses	Proper Functioning Condition or equivalent; benchmarked cross sections with substrate type; width to depth ratio, and entrenchment ratio; sinuosity measures	Low Flow
Blackfoot River (Landers Fork to Nevada Creek); upper one mile of Blackfoot River; Arrastra Creek; Poorman Creek; Willow Creek; Sandbar Creek; Mike Horse Creek; Beartrap Creek	Macroinvertebrate & periphyton assemblages (includes clinger taxa richness data)	Blackfoot: three representative locations; Arrastra: one to two representative lower site locations; Poorman: two to three representative locations with at least one in the lower reach (PC5); Willow: one to two representative sites with at least one in the downcut reach above Sandbar Creek; other streams to be monitored in reaches with channel restoration	Standard DEQ protocol	Low Flow, summer to early fall
Blackfoot River (Landers Fork to Nevada Creek); Arrastra Creek; Poorman Creek; Willow Creek (optional)	McNeil core sampling	Existing sample locations used by Forest Service; or equivalent spawning locations;	Existing McNeil Core procedure used by Forest Service or equivalent	Low flow; post runoff (typically during late summer or fall)
Arrastra Creek; Poorman Creek	Riparian health; width to depth and any other channel related targets	Arrastra: all three reaches plus one or two representative upstream reaches; Poorman: lowest reach above spring creek and two to three upstream representative reaches	Modified EMAP, R1/R4, or an equivalent method with monitoring workgroup input	Low flow; summer to early fall
Poorman Creek; Willow Creek	49-point grid toss fines	Same locations as for riparian health measures	Grid toss or equivalent method	Low flow following runoff

1: Locations, particularly those for macroinvertebrate and periphyton sampling, are to be coordinated with similar or identical sampling to be done for metals TMDL target compliance.

8.1.1.2 Implementation Monitoring Focused on Meeting Load Allocations

The other category of implementation monitoring addresses assessments evaluating attainment of allocations. In the event that numeric targets are not met, this type of monitoring supports the adaptive framework for either refining the numeric targets or altering restoration activities geared at achieving the targets. Montana State Law (75-5-703(7) & (9)), requires that if the target-related monitoring discussed above demonstrates that water quality standards have not been achieved within 5 years after approval of a TMDL, then DEQ is required to conduct a formal evaluation. The evaluation will investigate the 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 practices 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.

To facilitate this review, the DEQ may need to evaluate progress toward meeting load allocations presented in Section 5.0. This would be coordinated with ongoing Blackfoot Challenge monitoring activities discussed below.

The Blackfoot Challenge is concerned with long-term land and water management throughout the watershed and is committed to evaluating impacts associated with changes in land use, water use, fires, floods, and droughts. The Blackfoot Challenge, through its Habitat and Water Quality Restoration Committee, will take a leadership role in reviewing major changes in the watershed, evaluating progress in meeting allocations, and satisfying management strategies. These activities will subject to available funding and overall priorities of the Blackfoot Challenge and will be carried out as part of DEQ's 5-year assessment. Potential focus areas are listed below; many of which will likely require use of aerial assessment methods for evaluation purposes.

- Elevated sediment yield areas.—Monitor the relative changes in high and low cover percentages associated with timber harvest or other land clearing activities within each drainage; also monitor grazing and timber harvest impacts in these high risk areas since a lack of grazing or timber harvest BMPs can significantly increase sediment erosion.
- Equivalent clearcut area (ECA).—Monitor overall ECA values within drainages and calculate potential impacts on peak flows via increased water yield.
- Bank erosion focus areas.—Monitor changes in stream bank erosion from human impacts in focus areas. This may include a statistical sampling or a focused effort to identify all stream banks with the potential for reduced erosion and then tracking progress (BMP implementation) toward reducing erosion rates for these bank locations. An inventory similar to what was done on the Blackfoot River may be repeated to some extent, although it would likely be in a streamlined form.
- Dewatered streams.—Monitor changes in flows in de-watered streams, particularly Poorman Creek.
- Forest roads.—Work with the Forest Service and other landowners to evaluate progress toward reducing sediment erosion at road crossings, to upgrade undersized culverts to pass

increased flood flows and to also provide fish passage where desirable; track floodplain passage improvements on Forest Service road crossing over Willow Creek.
- County and subdivision roads.— Work with stakeholders to implement erosion BMPs, reduce chance of culvert failure, and reduce the potential for undesirable fish passage barriers.
- Stream restoration.—Track progress on restoration of streams impacted by Upper Blackfoot Mining Complex mining activities in coordination with metals TMDL implementation; track evaluation of restoration efforts on placer-mined area on Poorman Creek; track restoration of Sandbar Creek.
- Riparian zones.—Monitor changes in development along riparian zones throughout the watershed; ensure maintenance or improvement of riparian health through grazing BMPs or other protective measures

To help achieve some of the above allocation/implementation monitoring, the Blackfoot Challenge, through its Conservation Strategies Committee will maintain a GIS Database Library of key values and analyze changes in these values over-time including:

- Community values such as rural intactness (grazing acres and fallow acres), population demographics (population and households), economics (employment and income), and land statistics (parcel size, land values, growth rates, developable lands, viewsheds (elevation, river);
- Agricultural values such as timber (commercial, coverage), range land (native grass and scrub land), croplands (pasture/hay - grass, legumes, mixes for livestock, small grains, NRCS soil data, public vs. private lands; and
- Biological values such as buffers and wilderness areas and migration corridors, vegetation types such as riparian (woody), wetlands and lakes, and native grasslands; wildlife components such as big game species (elk, moose, bighorn sheep, white-tailed deer, mule deer), threatened and endangered species (bald eagles, grizzly bears, wolves, lynx, bull trout); and native fish (westslope cutthroat trout).

The Blackfoot Challenge, through the Monitoring Work Group, will track and report on changes in upland and stream conditions and assess the overall health of the watershed through:

- Status and Trends monitoring project;
- State of the Basin Report, and other focused evaluations.

The DEQ will work closely with the Blackfoot Challenge as part of the monitoring work group to ensure coordination of all TMDL implementation monitoring under DEQ's responsibility.

8.1.1.3 Implementation Monitoring Focused on Specific Restoration Projects or Activities

There will be a periodic review of the effectiveness of specific restoration activities and actions in achieving TMDL plan objectives. Many of these may be covered as part of the overall tracking of allocations discussed above, although in some cases there may be expanded site specific monitoring to further evaluate water quality improvements. The site specific monitoring will often be required as part of the project funding agreement, and would typically be performed by the consulting firm or agency implementing the project, often in coordination with the Blackfoot Challenge, the DEQ, or another involved agency such as FWP. Examples include:

- Verifying and quantifying riparian improvements and reductions in bank erosion in areas where projects such as rotational grazing BMPs have been implemented.
- Monitoring channel conditions over time to evaluate the success of specific in-stream channel restoration activities. This can include pool and other habitat measures as well as measuring the success of riparian improvements. Photo points and cross-sectional measures can also provide critical data.
- Evaluate success and overall maintenance of road BMPs.
- Monitor changes in aquatic life and fisheries populations in restoration reaches to evaluate success.

8.2 Additional Assessment and Watershed Characterization Monitoring

As previously discussed, additional assessment and watershed characterization monitoring may provide useful information in an adaptive management framework. For example, these monitoring activities can address additional data needs for more complete delineation of sediment or habitat impaired stream segments throughout the headwaters planning area. Furthermore, supplemental monitoring may result in better delineation of specific sources of sediment impairment or refinement of load allocations in some drainages. Finally, these additional monitoring activities may provide an improved understanding of the aquatic life and other beneficial uses to be protected. The following sections describe potential assessment activities prioritized as high, medium, or low monitoring priorities.

8.2.1 High Priority Monitoring Opportunities

During this TMDL and water quality and habitat restoration improvement planning efforts, a number of supplemental monitoring activities emerged as high priorities. These included additional assessments of biological and water chemistry, and evaluation of other potentially limiting factors such as fish passage barriers and dewatering. Finally, natural disturbance such as wildfires may have a lasting effect on water and habitat quality. This sub-section details plans to monitor these high priority supplemental monitoring concerns.

- Fish communities are key water quality indicators and a designated beneficial use. Montana Fish, Wildlife & Parks will monitor fish populations according to their established schedule and as additional funding allows. Fisheries investigations may include population estimates, redd counts, and fish movements through the basin. Fisheries evaluations will assist in assessing the effectiveness of restoration activities as part of an adaptive approach, but are not required under the 5-year DEQ assessment.

- Nutrient enrichment was a probable cause of impairment on the 1996 303(d) list for the Blackfoot River. The available data did not confirm this impairment; however, additional data would have been useful in strengthening this determination.

Therefore, to provide better documentation of beneficial use support associated with nutrients, DEQ will work with the Blackfoot Challenge and the monitoring work group to evaluate nutrient parameters in the section of the Blackfoot River above Landers Fork. Nutrient monitoring may also be pursued in other locations, as is currently being done in the Blackfoot River above the mouth of Nevada Creek, to support nutrient TMDL development in lower reaches of the Blackfoot River and for the Clark Fork River.

- Undersized culverts and culvert failures are a substantial concern throughout the Blackfoot Headwaters Planning Area. Further investigation would facilitate identification of undersized culverts and fish passage barriers that restrict fish movement or are a potential source of sediment loading. This should be a responsibility of the specific landowner for the crossing(s) of interest, although assistance from MFWP in evaluating the potential for undesirable passage barriers will be of considerable benefit. Not all culverts and locations are high priority, but many locations on key migratory streams or in areas with a potential for a high sediment load should be treated as high priority.

- Evaluation of flow regime in Landers Fork also emerged as a monitoring priority in this planning effort. Evaluation should focus on the role of land use, aggradation following a large flood, and mechanical channel alterations following flood events in influencing maintenance of surface flows. Historical data indicate that Landers Fork, near the lower bridge, used to go dry whereas that does not appear to be the situation in recent years. The objective of evaluating the surface water hydrology is to determine management strategies to promote maintenance of surface flows to support the resident fishery and sustain connectivity to Copper Creek for spawning bull trout.

- Evaluation of large woody debris and pool formation over time is a high priority for areas impacted from flooding or land uses that have limited large woody debris recruitment to several streams. For example, the Landers Fork and several other assessed stream reaches had relatively low values of large woody debris. This information will provide a better understanding of reference conditions and fish habitat capabilities as well as potential impacts from historical and onging land uses.

- The wildfires of 2003 resulted in another high priority monitoring activity for the Blackfoot Headwaters Planning Area. In the Copper Creek drainage, over 18,000 acres burned with the majority rating within the high severity category. The impacts of these fires on sediment loading should be closely monitored to evaluate fire related impacts, particularly on beneficial uses and other target indicators developed as part of the sediment TMDLs downstream. This will not only help with implementation of this TMDL, but could also help with TMDL development in downstream areas below Nevada Creek (the Middle and Lower Blackfoot TMDL Planning Areas).

8.2.2 Medium Priority Monitoring Opportunities

In addition to the high priority supplemental monitoring activities described above, a number of lesser priority monitoring opportunities emerged. These activities have the potential to refine load allocations and delineation of sediment sources in the watershed. The medium priority monitoring options will be addressed contingent on acquisition of funds and balanced with other planning priorities in the basin.

- With evaluation of potential upland sources of sediment production, Moose Creek and Sauerkraut Creeks emerged as areas with substantial potential to produce and deliver sediment. Furthermore, local fisheries professionals noted highly turbid flows in the streams during runoff events. Note that both of these streams have had evidence of significant land clearing. Furthermore, Sauerkraut Creek has also had significant recent placer mining. DEQ will conduct monitoring of these two creeks for possible 303 (d) listing as sediment impaired streams, although any such assessment work will be prioritized in recognition of DEQ's current assessment and TMDL development workload.

- Another medium priority monitoring activity is evaluation of sediment contributed from eroding banks. This would address a source of uncertainty in estimating sediment loads from bank erosion is related to bank retreat rates in the upper Blackfoot River. Consistent with the adaptive management approach described above, bank pins at several representative banks could be used to evaluate bank retreat rates on severely loading banks on the main stem of the Blackfoot River. This would allow for calibration of sediment load allocations associated with human impacts on eroding banks along the Blackfoot River.

- Evaluation of sediment contributed from tributaries is another medium priority monitoring activity that would enhance the ability to model sediment inputs in the basin. This would address the uncertainty associated with predicting sediment loads from natural and human sources, a difficult endeavor in the Blackfoot Headwaters Planning Area due to a lack of hydrologic data as well as measurements of suspended and bed load. Sampling of sediment loads during runoff conditions would allow for an estimation of the sediment loading and would also provide data that could be used for calibration of the SSDM model.

- Additional stream habitat assessment work, similar to the modified EMAP and bank erosion inventories, would also enhance the understanding of stream conditions in the Blackfoot Headwaters Planning Area. Areas of interest would include possible reference or "least-impacted" tributaries in the watershed. Also, additional stream habitat assessment work would help refine riparian and channel width to depth targets within Poorman Creek and Arrastra Creek. Additional targets associated with percent pools or other important fish habitat indicators could be desirable in these and possibly other streams. Much of this work can be addressed as part of the five-year implementation monitoring focused on restoration targets.

Finally, the Blackfoot Challenge working with the Monitoring Work Group will look for opportunities to fund ongoing monitoring to answer uncertainties in the Sediment TMDL and other program areas. These efforts may not always be required for TMDL monitoring, but would improve our understanding of the Blackfoot Headwaters system. The above list is not intended to cover all such monitoring activities, and it is anticipated that additional monitoring projects will be identified through time and that many of these projects may be of a relatively high priority in comparison to those listed above.

SECTION 9.0
PUBLIC INVOLVEMENT

Public involvement is a component of TMDL planning efforts supported by EPA guidelines and Montana State Law. Public involvement is desirable to ensure development of high quality, feasible plans and increase public acceptance. The Blackfoot Challenge has provided for public involvement throughout the planning process to address public and private landowner needs and concerns. The Blackfoot Challenge will encourage ongoing involvement by the public and stakeholders in the implementation of the Blackfoot Headwaters Water Quality and Habitat Restoration Plan.

Activities that have facilitated public involvement include mailings, press releases, and meetings to apprised stakeholders in the Blackfoot Headwaters Planning Area about the progress of the project. An open house in Lincoln held prior to the 2002 field assessment provided time for stakeholders to learn first-hand about the project and was used to solicit comments regarding community and stakeholder concerns. In addition, the draft plan was available on the Internet to solicit comment and review from the Blackfoot Challenge Habitat and Water Quality Restoration Committee and stakeholders.

An additional opportunity for public involvement is the 30-day public comment period following acceptance of the TMDL plan by DEQ. This public review period extended from December 26, 2003 through January 30, 2004. A public meeting on January 21, 2004 in Lincoln, Montana provided an overview of the Blackfoot Headwaters Sediment TMDL and an opportunity to solicit public input and comments on the plan. Public response was supportive of the plan. Participants were encouraged to provide any written suggestions to DEQ for incorporation in the plan as appropriate. Appendix N includes the public comments received and the DEQ response to these comments.

DEQ provides another opportunity for public comment during the biennial review of the 303(d) list. This includes public meetings and opportunities to submit comments either electronically or through traditional mail. DEQ announces the public comment opportunities through several media including press releases and the Internet.

SECTION 10.0
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FIGURES

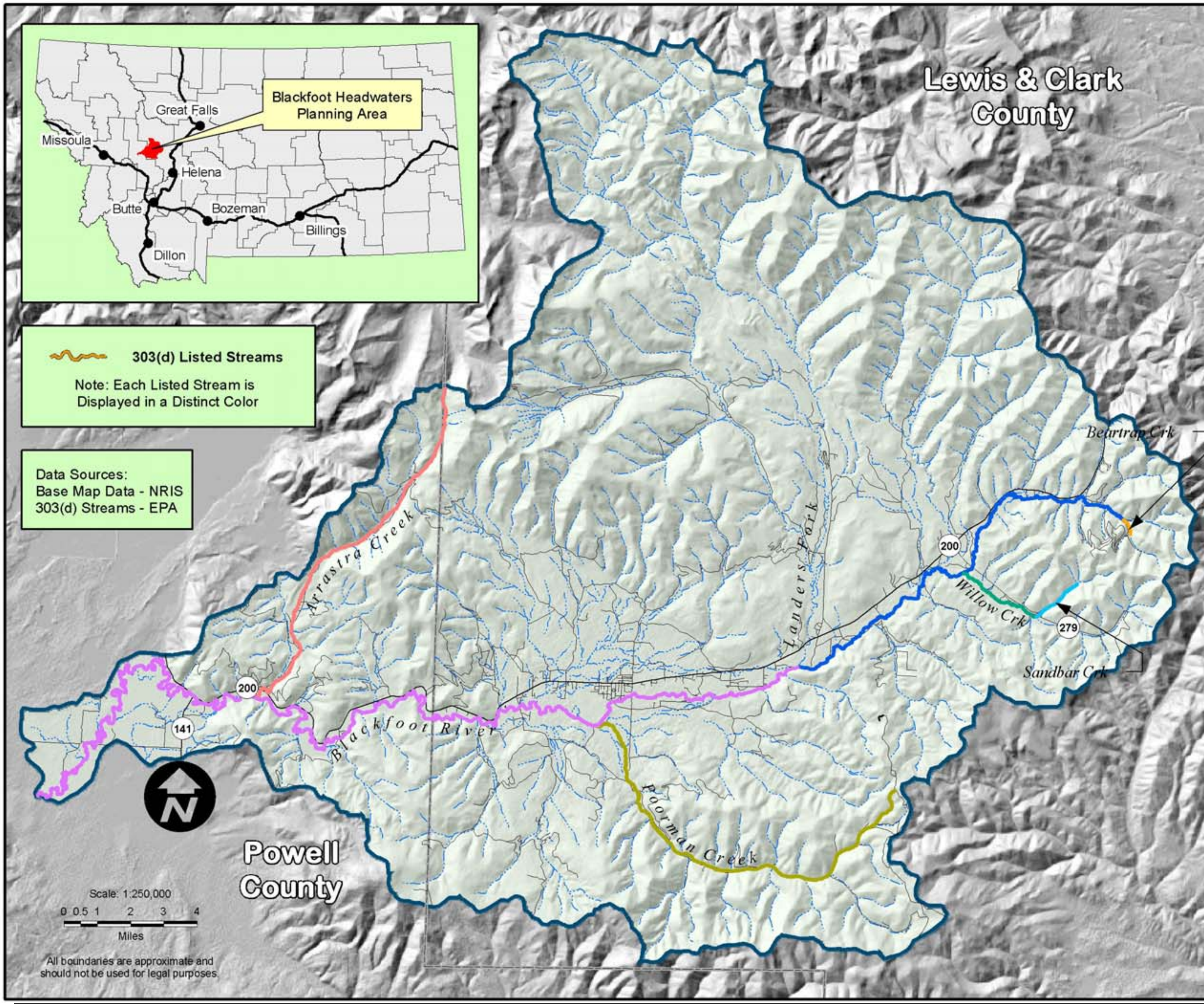

Figure 1: Map of the Blackfoot Headwaters Planning Area.

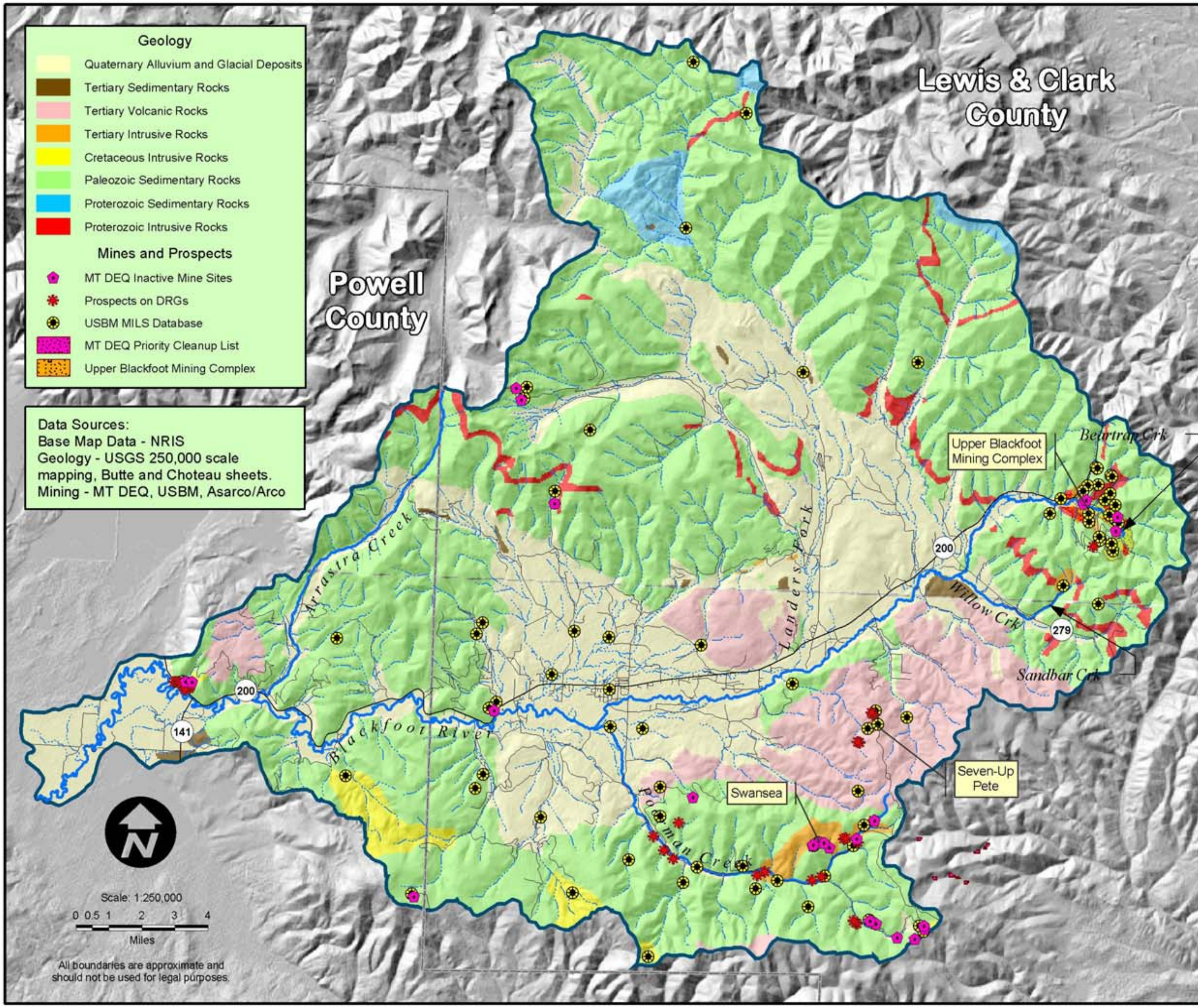

Figure 2: Geology of the Blackfoot Headwaters Planning Area.

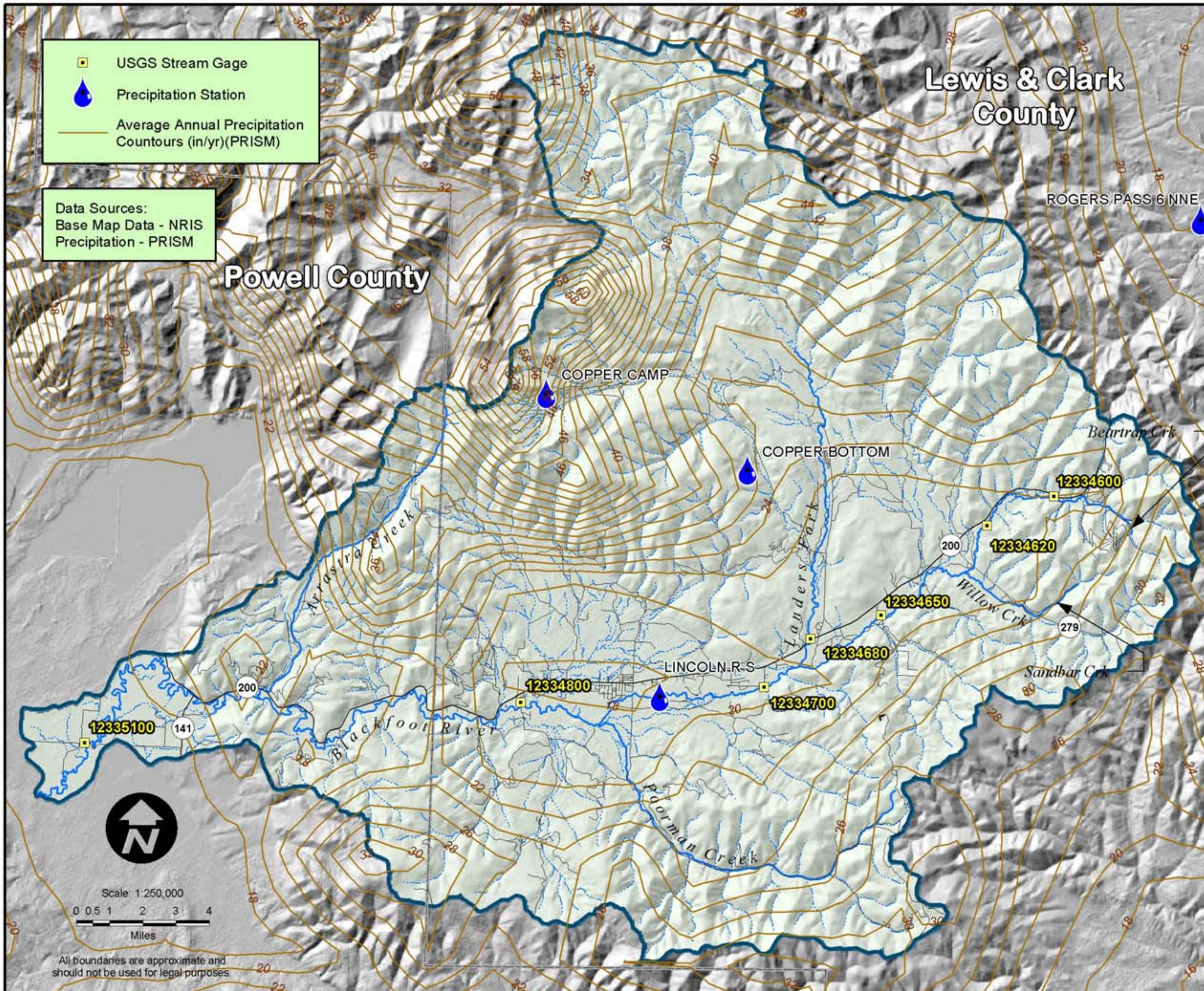

Figure 3: Climate and Hydrologic Stations in the Blackfoot Headwaters Planning Area.

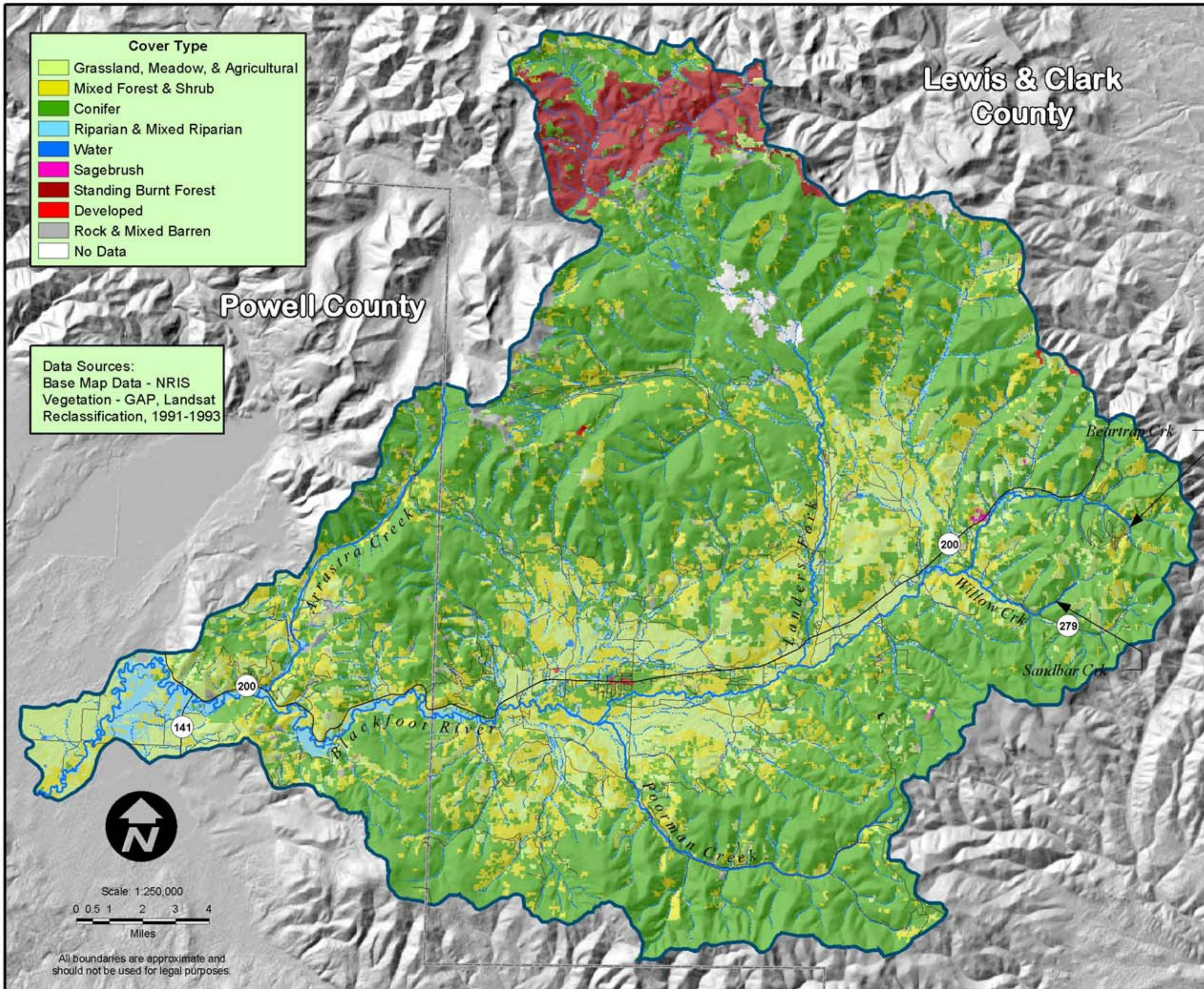

Figure 4: Distribution of Major Vegetation Types in the Blackfoot Headwaters Planning Area.

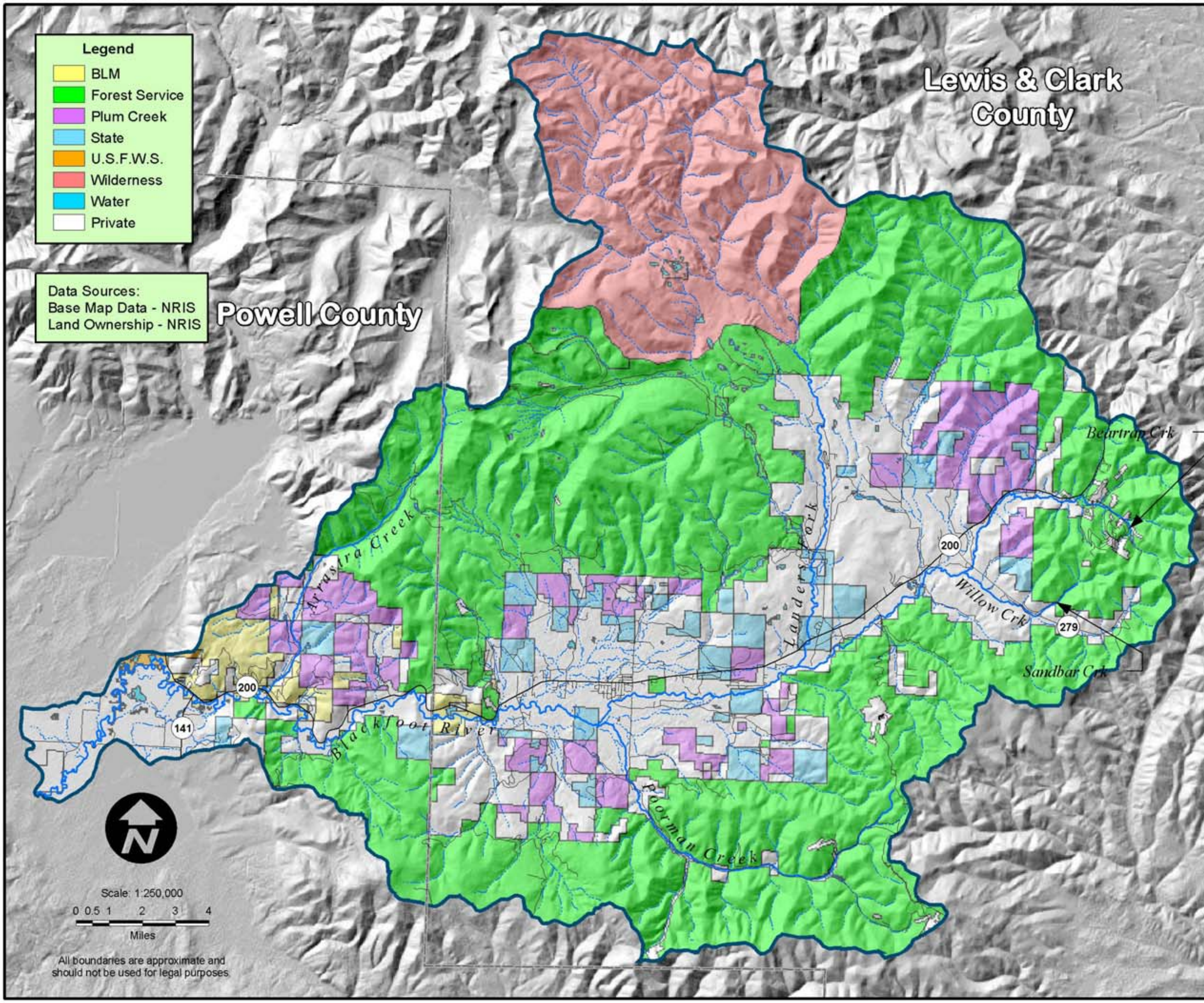

Figure 5: Land Ownership in the Blackfoot Headwaters Planning Area.

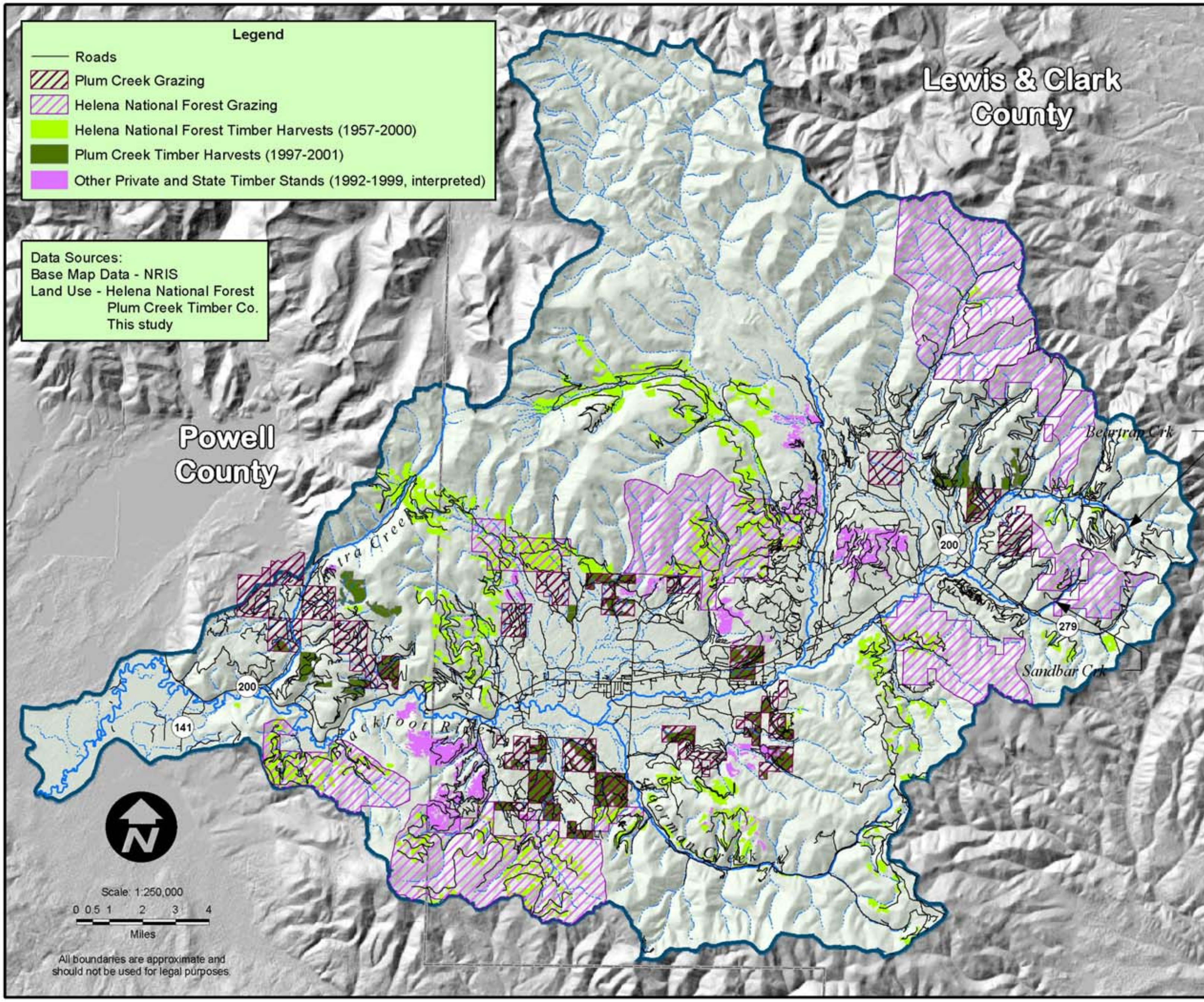

Figure 6: Land Use in the Blackfoot Headwaters Planning Area.

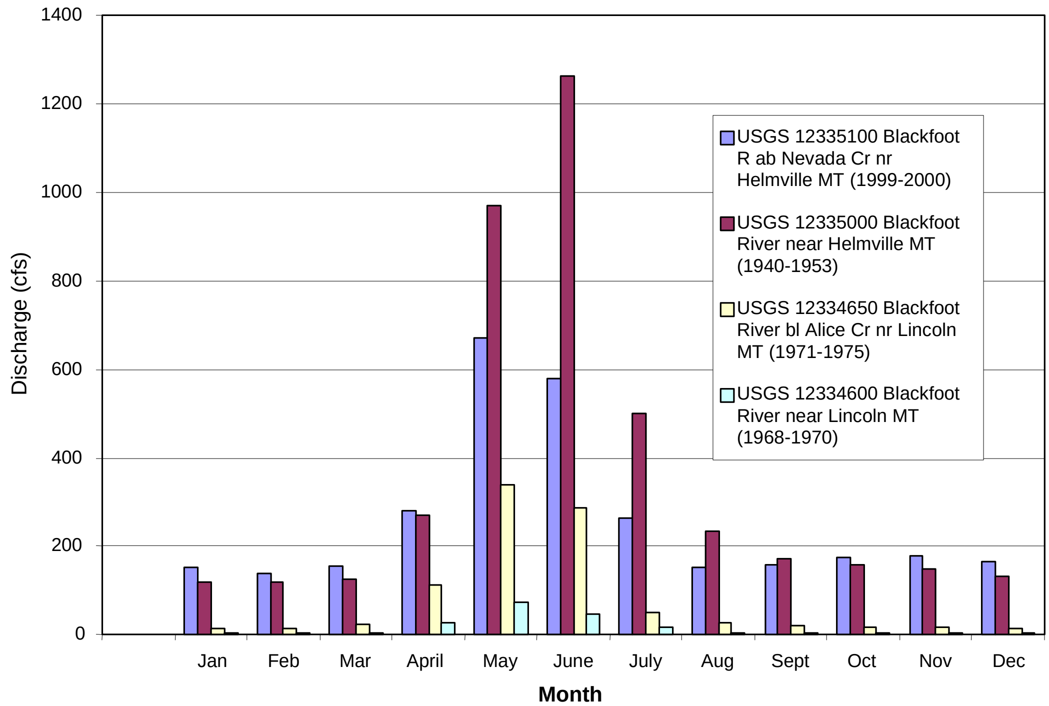

Figure 7. Average Monthly Discharged Measured at Gaging Stations in the Blackfoot Headwaters Planning Area.

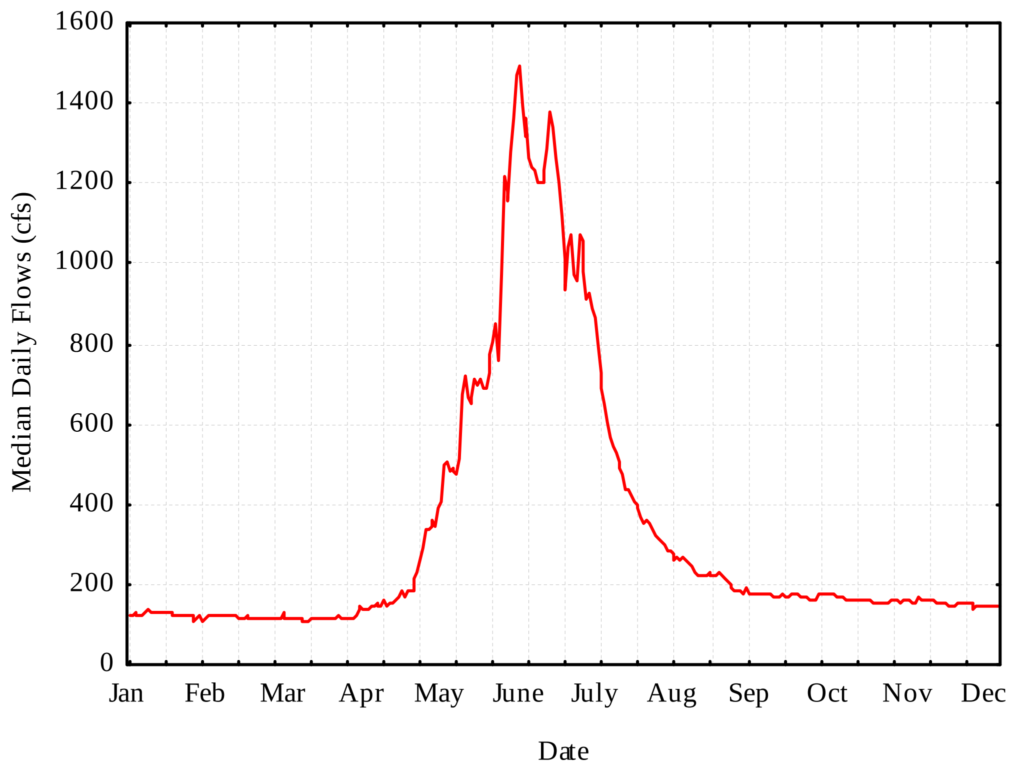

Figure 8. Median Daily Flows Measured at USGS Gage 1233500 (Helmville Bridge).

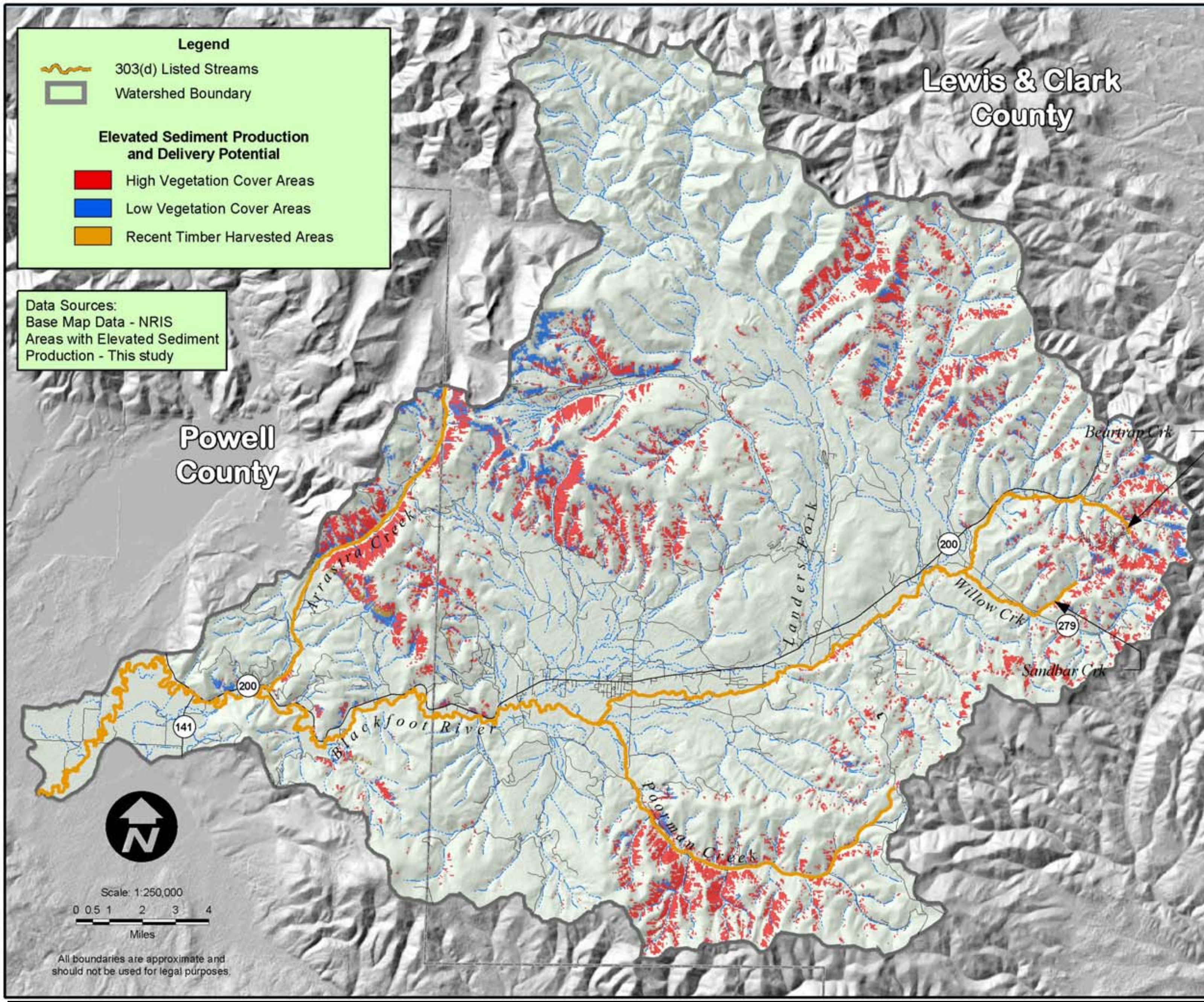

Figure 9: Major Sub-watersheds of the Blackfoot Headwaters Planning Area and SSDM Model Results.

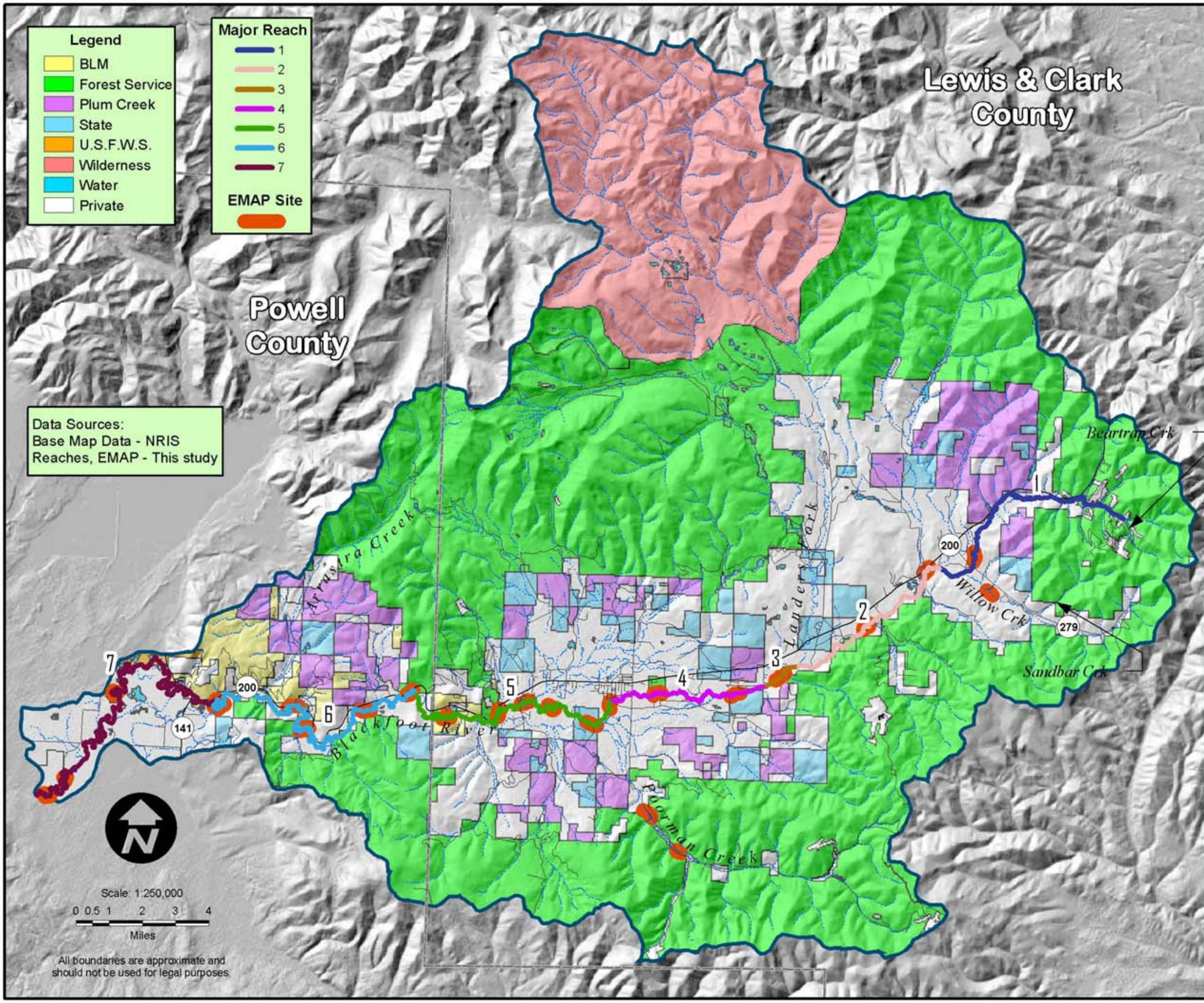

Figure 10: Reach Delineation on the Blackfoot River.

APPENDICES

APPENDIX A
HABITAT AND WATER QUALITY RESTORATION COMMITTEE (2003)

Name	Affiliation
Bob Anderson	Hydrometrics Consulting, Blackfoot Challenge Consultant
Duane Anderson	Natural Resources Information System
Nancy Anderson	Bureau of Land Management & Blackfoot Challenge Board
Tina Bernd-Cohen	Blackfoot Challenge Executive Director
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Jo Christiansen	Bureau of Land Management
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Tara Comfort	Missoula Conservation District
Julie DalSoglio	Environmental Protection Agency
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Kevin Ertle	U.S. Fish and Wildlife Services
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Dave Helig	Natural Resources Conservation Service
Cora Helm	Montana Dept. of Transportation
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Name	Affiliation
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Tony Liane	Dept. Natural Resources & Conservation & Blackfoot Challenge Board
Mack Long	MT Fish, Wildlife & Parks & Blackfoot Challenge Board
Tim Love	U.S. Forest Service & Blackfoot Challenge Board
Jim Lovell	Confluence Consulting, Inc.
David Mannix	Helmville Rancher & Blackfoot Challenge Board
Dave Marshall	DTM Consulting, Inc.
Mike McLane	Dept. of Natural Resources & Conservation
Alan McNeal	Blackfoot Challenge Land Steward
Rich Moy	Dept. of Natural Resources & Conservation
Greg Neudecker	U.S. Fish and Wildlife Service, Blackfoot Challenge Board, & BBCTU
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Tom Pick	Natural Resource Conservation Service
Ron Pierce	Montana Fish, Wildlife and Parks
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Mike Roberts	Dept. of Natural Resources & Conservation
Jim Robinson	Dept. of Natural Resources & Conservation
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Skip Rosquist	U.S. Forest Service
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Melanie Scott	U.S. Forest Service
Denny Sigars	Plum Creek Timber Company & Blackfoot Challenge Board
Ron Shields	Big Blackfoot Chapter of Trout Unlimited
Ron Steg	Environmental Protection Agency
Stan Sternberg	Montana Dept. of Transportation
Jim Stone	Ovando Rancher & Blackfoot Challenge Chair
Bo Stuart	U.S. Forest Service
Brian Sugden	Plum Creek Timber Company
Larry Urban	Montana Department of Transportation
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APPENDIX B
MACROINVERTEBRATE AND PERIPHYTON ASSESSMENTS

Evaluations of periphyton and macroinvertebrate community composition are commonly used methods of assessing beneficial use support for associated aquatic life. For the Blackfoot Headwaters Planning Area, a number of sources provide assessments of macroinvertebrate and periphyton assemblages. The most recent data are from a sampling effort conducted in June 2001 on the mainstem of the Blackfoot River and the listed tributaries (Bahls, 2001; Bollman, 2001). Macroinvertebrate assessment data from 1988 and 1989 augment information for the mainstem of the Blackfoot River (McGuire, 1991). This appendix addresses results from biological assessments that relate to siltation (or excess fines) and habitat alteration in the Blackfoot Headwaters Planning Area.

Periphyton assessments include analysis of diatom associations. For diatom associations, performance on the siltation index allows inference into the extent that deposition of fine sediment is impairing aquatic life (Bahls et al., 1992). This metric is a measure of the relative abundance of motile diatoms in the sample. Motile diatoms can maintain their position in depositional environments and theoretically have a competitive advantage when deposition of fine sediment is significant.

Metrics calculated for periphyton samples collected on the Blackfoot River suggested conditions ranging from minor impairment and full support of beneficial uses to severe impairment and non-support of beneficial uses (Table B-1). Relatively high proportions of abnormal cells indicated metals toxicity at the uppermost two stations on the Blackfoot River. None of the samples from the Blackfoot River indicated siltation as a limiting factor; however, metals contamination may have been masking other impairments at the upper two sites.

Diatom associations did not indicate siltation on Poorman Creek (Table B-1). The siltation index was well within the range of full support for the upper and lower sites. At the middle sampling station, the siltation index was slightly elevated and suggested minor impairment from siltation, a condition still consistent with full support of beneficial uses.

Diatom associations sampled on Arrastra Creek, Sandbar Creek, and Willow Creek did not give indications that siltation was a significant impairment to beneficial uses. Both Willow Creek stations indicated only minor impairment from siltation. Similar to the Blackfoot River samples, some of these samples did provide evidence for metals or other toxic constituents that may be masking other water quality problems in these streams.

Macroinvertebrate communities respond to siltation in several ways. For example, because fine sediment fills interstices where macroinvertebrates reside, it can limit biomass of invertebrates. In recent years, richness of clinger taxa emerged as means to assess impacts of siltation on benthic communities. These taxa have fixed retreats or adaptations for attachment to surfaces in flowing water (Merritt et al., 1996) and deposition of fine sediment limits habitat suitability for clingers. Preliminary metric development for Montana mountain streams suggests clinger taxa richness greater than 14 is consistent with non-impairment while clinger richness less than 6 indicates severe impairment and non-support of a beneficial use (Wease Bollman, Rhithron

Biological Assessments, personal communication). Values between 6 and 14 are consistent with moderate impairment and partial support of the aquatic life beneficial use.

Community level metrics calculated for macroinvertebrate associations collected on the Blackfoot River and selected tributaries suggest that these sites range from full support (non-impaired) to partial support (either slightly or moderately impaired) of beneficial uses (Table B-3). As with periphyton associations, metals contamination may be responsible for the relatively low scores on the upper Blackfoot and Sandbar Creek.

Table B-1. Results of Periphyton Analyses for the Blackfoot River and Poorman Creek (Bahls, 2001).

Species/Metric (Pollution Tolerance Class)	Station										
	BlkftR-01		BlkftR-02		BlkftR-03		PoorC-01		PoorC-02		PoorC-03
Achnanthidium minutissimum (3)	25.11		10.13		16.03		1.67		25.94		17.32
Diatoma vulgaris (3)					15.81						
Hannaea arcus (3)			10.13		0.00						
Meridion circulare (3)	2.01		4.00				46.77		1.01		14.84
Pseudostaurosira brevistriata (3)	11.72				3.14						
Staurosira construens (3)	8.26		12.00		8.41		0.84		0.10		3.38
Synedra rumpens (2)	28.35		10.13		1.57				0.30		6.54
Synedra ulna (2)	1.12		3.13		2.02		16.75		4.86		4.47
Number of Cells Counted	448.00		400.00		446.00		418.00		494.00		459.00
Shannon Species Diversity	3.37		4.47		4.56		2.83		4.33		4.42
Pollution Index	2.50		2.57		2.72		2.55		2.56		2.56
Siltation Index	13.06		15.75		18.16		13.64		26.85		16.12
Disturbance Index	25.11		10.13		16.03		1.67		25.94		17.32
Number of Species Counted	39.00		46.00		62.00		27.00		46.00		54.00
Percent Dominant Species	28.35		12.00		16.03		46.77		25.94		17.32
Percent Abnormal Species	11.40		6.63		0.90		1.08		2.23		0.76
Percent Epithemiaceae	0.00		1.37		1.91		0.60		0.00		0.00
Similarity Index		39.86		43.56				25.73		51.74	

Table B-2. Results of Periphyton Analyses for the Arrastra Creek, Sandbar Creek, and Willow Creek (Bahls, 2001).

Species/Metric (Pollution Tolerance Class)	Station										
	AraC-01		AraC-02		SbrC-01		SbrC-02		WilC-01		WilC-02
Achnanthidium minutissimum (3)	20.23		16.33		19.74		86.48		4.03		5.14
Diatoma mesodon (3)	3.04		0.20		51.91		1.75		2.65		7.55
Fragilaria vaucheriae (2)	0.21		3.37						0.42		24.40
Gomphonema angustatum (2)	25.58		4.80		0.12				0.53		0.66
Hannaea arcus (3)	1.26		49.18						1.70		1.53
Staurosira construens (3)	2.73		2.14		0.60		4.78		27.60		3.28
Synedra rumpens (2)	0.10		2.35		9.69		2.33		13.59		14.99
Number of Cells Counted	477.00		490.00		418.00		429.00		471.00		457.00
Shannon Species Diversity	3.86		2.78		2.36		0.96		4.01		4.12
Pollution Index	2.59		2.77		2.73		2.92		2.55		2.35
Siltation Index	2.94		1.94		7.54		2.80		21.02		15.32
Disturbance Index	20.23		16.33		19.74		86.48		4.03		5.14
Number of Species Counted	51.00		30.00		23.00		16.00		51.00		46.00
Percent Dominant Species	25.58		49.18		51.91		86.48		27.60		24.40
Percent Abnormal Species	3.67		0.51		3.71		10.26		0.64		0.22
Percent Epithemiaceae	0.21		0.00		0.24		0.00		0.00		0.00
Similarity Index		33.99				26.98				45.55	

Table B-3. Macroinvertebrate Association Metrics Calculated for Samples Collected on the Blackfoot River and Selected Tributaries.

	Blkft1	Sandbar1	Sandbar2	Willow1	Willow2	Blkft2	Poor1	Poor2	Poor3	Arrastra1	Arrastra2	Blkft3
METRICS	METRIC VALUES											
Ephemeroptera richness	0	6	0	5	7	7	8	6	9	6	8	10
Plecoptera richness	2	6	5	4	3	1	3	3	3	1	4	5
Trichoptera richness	2	3	0	5	6	5	3	10	6	1	4	6
Number of sensitive taxa	2	5	3	3	4	1	3	10	9	4	4	3
Percent Filterers	0	1	0	16	1	2	0	1	0	0	0	6
Percent tolerant taxa	16	2	0	9	18	2	4	3	4	0	4	6
	METRIC SCORES											
Ephemeroptera richness	0	3	0	2	3	3	3	3	3	3	3	3
Plecoptera richness	2	3	3	3	2	1	2	2	2	1	3	3
Trichoptera richness	1	2	0	3	3	3	2	3	3	0	2	3
Number of sensitive taxa	2	3	2	2	3	1	2	3	3	3	3	2
Percent filterers	3	3	3	1	3	3	3	3	3	3	3	2
Percent tolerant taxa	1	3	3	2	1	3	3	3	3	3	3	2
TOTAL SCORE (max+18)	9	17	11	13	15	14	15	17	17	13	17	15
PERCENT OF MAX	(50)	(94)	(61)	72	83	78	83	94	94	(72)	94	83
Impairment classification*	(MOD)	(NON)	(SLI)	SLI	NON	SLI	NON	NON	NON	(SLI)	NON	NON
USE SUPPORT	(PART)	(FULL)	(PART)	PART	FULL	PART	FULL	FULL	FULL	(PART)	FULL	FULL
*Classification: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired.												

Richness of clinger taxa as an indicator of siltation provided somewhat different results than periphyton associations. Numbers of clinger taxa were depressed at several sites including two on the Blackfoot, Sandbar Creek, Poorman Creek, and Arrastra Creek (Figure B-1). The Arrastra 1 results could be due to a small sample size versus an impairment (Bollman 2001), whereas the other locations had appropriate sample sizes (total number of organisms). Similar to periphyton metric results, metals contamination may be masking the impacts of siltation on the upper Blackfoot site and Sandbar Creek. Still, low richness of clinger taxa on the other streams may be an indication of accumulations of fine sediment limiting habitat for these organisms.

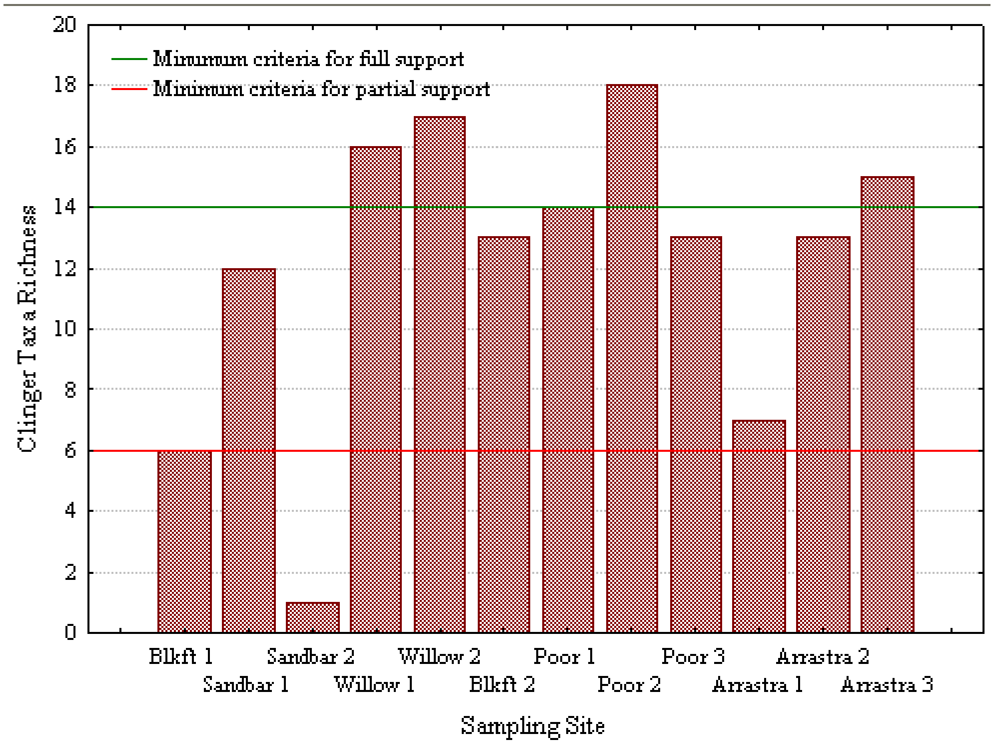

Figure B-1. Richness of Clinger Taxa Observed at Sampling Stations on the Upper Blackfoot River and its Tributaries (Bollman, 2001).

Macroinvertebrate assessments conducted by McGuire (1991) predate the use of richness of clinger taxa in evaluating siltation. Still, these analyses provide best professional judgment on biological integrity and potential impairments at two locations on the Blackfoot River (below Landers Fork and the Nevada-Ogden Road Bridge). At the station below the confluence with the Landers Fork, benthic macroinvertebrates demonstrated indications of drought-induced stress, probably the result of the natural tendency of flows to go subsurface in this losing reach, but no obvious indications of siltation.

In contrast, the sampling station at the Nevada-Ogden Road Bridge showed substantial impairment from deposition of fine sediment. McGuire (1991) considered the relatively low density of aquatic macroinvertebrates, low percentage of filter feeding invertebrates, and the relatively high abundance of the mayfly *Rhithrogena* sp. as indications of siltation at this location. Furthermore, he cited Spence (1975) who found similar faunal composition at this site in 1971 and 1972.

Based on results of the macroinvertebrate and periphyton samples collected in the upper Blackfoot River watershed, we made several conclusions with regard to indicators of siltation. For metals impacted streams (Sandbar Creek and the uppermost site on the Blackfoot River) metals contamination was the overwhelming influence on these communities and may have masked indications of siltation. For the other two sites on the mainstem of the Blackfoot River, biological indicators gave mixed results. Diatom associations did not demonstrate indications of siltation, although depressed richness of clinger taxa at the middle site supports a listing for siltation. Macroinvertebrate community composition in the 1970s and 1980s supported a determination of impairment from siltation at the lowest site. Biological indicators for Arrastra and Poorman creeks were similarly equivocal with some disagreement between the diatom and macroinvertebrate metrics for siltation.

Because DEQ uses a weight of evidence approach, the failure of one assemblage to indicate impairment does not necessarily preclude listing a stream for a given pollutant. These results are just one factor among many that DEQ uses in evaluating streams. For example, measures of streambed composition, and identification of potential sediment loading are other types of evidence used in these assessments. Note that streambed composition is an indicator of support of propagation of cold-water fisheries due to the relationship between percent fines and survival to emergence. Despite conflicting evidence for siltation, these assemblages should be monitored continually as part of the TMDL monitoring plan.

APPENDIX C
AERIAL PHOTO ASSESSMENT METHODS AND RESULTS

An aerial photo analysis conducted in early summer 2002 consisted of several components. Initial steps entailed acquisition and preparation of aerial imagery for the watershed. The available data supported a number of analyses including a Rosgen Level I Classification (Rosgen, 1996), percent cover of riparian vegetation, and an assessment of channel change over time. Finally, aerial assessment efforts conducted by several other investigators in the Blackfoot Headwaters Planning Area provided supplemental information on watershed conditions. This section provides a description of the methods and results of these analyses.

Imagery Acquisition, Preparation, and Interpretation

Aerial imagery from a number of sources provided the spatial data for aerial photo assessments in the basin. USGS digital orthophoto quarter quad quadrangles (DOQQ), obtained from Natural Resources Information Service (NRIS), were the primary data source for the aerial photo analyses. These data were available in MrSID compressed format, mosaiced by full quadrangle and covered the entire upper Blackfoot watershed using aerial photography collected during August 1995. In addition to electronically available data, hard copy aerial photos from the US Forest Service (USFS) and Natural Resources Conservation Service (NRCS) provided supplementary images for this analysis. USFS images included 1:15,640 scale, natural color aerial photography flown on August 19, 1988 covering much of the study area and 1:24,000 color aerial photography (flown on August 2, 1979) covering a smaller portion of the watershed. We used 1978 vintage black and white aerial photos obtained from the NRCS to fill gaps in the 1979 aerial photos. The NRCS provided black and white aerial photography from portions of the watershed collected in 1990. We limited hard copy photo acquisition to the reaches of the 303(d) listed streams as well as the Landers Fork.

There were several gaps in aerial photo coverage. Most notable was the first 10 miles of the main stem Blackfoot River upstream from the confluence with Nevada Creek. In addition, images from a small area around Lincoln, and a small area near the confluence of the Blackfoot River and Alice Creek were not available. We used 1999 panchromatic 5-meter resolution IRS satellite imagery obtained from the Helena National Forest to fill gaps in the lower reaches of the main stem upper Blackfoot River. In addition, these images were also useful in assessing upland areas for evidence of mass wasting.

The 1995 DOQQs served as a stable base for comparison of the three vintages of imagery. We scanned hard copy air photos scanned at 300-600 dpi, then georeferenced to the DOQQs. Since there is significant overlap of the scanned images, with photo distortion greatest at the edges, the photos were not edge matched or mosaiced. Digitizing features from the photos was therefore restricted to the central portion of the photos to minimize error. All photo preparation, digitizing, and analysis of results was performed using geographic information system (GIS).

Stream centerlines and the active stream channel area (active floodplain) were visually digitized for all three vintages of imagery where discernable. Because areas where streams were consistently less than 1-2 meters wide are generally not visible on this resolution of imagery, digitization efforts concentrated on the main stem of the Blackfoot River and the Landers Fork. Little digitizing was possible on Arrastra, Poorman, and Willow Creeks. For regions where digitization of streams was not possible, National Hydrography Network (NHD) digital data served as a surrogate. In some locations, the active stream channel was discernable but the stream centerline was not visible. This was most prevalent in losing reaches of the Blackfoot River and the Landers Fork. All digitized and NHD data were captured as GIS data layers in the Montana State Plane, NAD 83, meters coordinate system.

Data Analysis

Rosgen Classification

We applied the Rosgen Level 1 classification methods (Rosgen, 1996) within the GIS framework to all digitized stream centerlines as well as NHD data. Calculations of slope and sinuosity within the GIS also supported these classification efforts. Slope of the stream channels was calculated using 10 m DEM data compiled in the GIS for the Phase I TMDL Assessment. Sinuosity was calculated within the GIS as the ratio between the actual channel length and valley length. The level of incisement, and therefore width/depth ratio was not discernable on the imagery precluding its use as part of the Rosgen Level 1 classification.

An important product of Rosgen Level I Classification was the delineation of sub-reaches. Presence of significant infrastructure, such as bridges, was another factor used in delineation sub-reaches. This resulted in 44 sub-reaches covering the 103 miles of 303(d) listed streams and the Landers Fork for an average sub-reach length of 2.34 miles.

Riparian Canopy Cover

Assessing riparian cover was an important component of aerial photo analyses. We visually estimated riparian cover for both the right and left banks of the digitized and NHD streamlines using a buffer zone of 150 feet from the active stream channel. Riparian cover estimates were within four ranges or classifications (0-25%, 25-50%, 50-75%, or 75-100%). We recorded these visual estimates in the attribute tables of the digitized or NHD streamlines data layers along with comments regarding the nature of the vegetation.

Channel Change over Time

Digitization of active stream area polygons allowed for analysis of channel changes over time. Following completion of digitization, we split the active stream area polygons by reach breaks and calculated active stream channel areas were for each of the vintages of imagery by sub-reach. Comparisons among vintages permitted analysis of the change in these areas over time.

Review of Past Assessments

A brief review of several previously conducted assessments occurred concurrently with the aerial assessment. There were two objectives of this portion of the assessment. First was to determine if useful information was available in these sources. The second objective was to determine if a promising methodology for sediment TMDL development existed for streams similar in size and condition to the upper Blackfoot River watershed.

Whitehorse Associates

In 1996, Whitehorse Associates of Smithfield, Utah produced a report titled: *Ecological Classification, Upper Blackfoot River Basin, Montana for the Seven Up-Pete Joint Venture*. The purpose was to create an ecological framework for baseline monitoring of habitats and the effects of land use. The report drew heavily on GIS technology for analysis and map creation. Whitehorse Associates provided two GIS data layers for use in the Blackfoot Headwaters Phase I TMDL Assessment. These are: 1) valley bottom type, and 2) reach state. These investigators interpreted valley bottom type from aerial photography from both 1988 and 1995. Used in conjunction with general land type data, glacial and fluvial valley bottom types could be distinguished. Glacial valley bottom types delineate areas prone to erosion, particularly those in the upstream reaches of the Landers Fork. Reach state was also derived from aerial photography and was an attempt to characterize stream bank stability. The resolution of these data was too coarse to be useful for this study. Also of interest but unavailable was a GIS coverage of riparian vegetation types. However, this coverage was corrupt and unrecoverable. A few sample maps of this vegetation data from a hard copy of this report were georeferenced for comparison with the DOQQs. Correlation between easily identified vegetation stands on the DOQQs and the Whitehorse vegetation maps was inconsistent and determined to be unacceptable for this study.

Fish Wildlife and Parks

In 1999, Montana FWP, in conjunction with the BLM, conducted a reconnaissance level riparian health and eroding bank assessment of the lower half of the main stem of the Blackfoot River. A botanist and a fish biologist conducted this assessment from canoe, and focused on determining riparian community types, qualitative estimates of condition, and distribution of noxious weeds. This culminated in creation of two GIS data layers to record the distribution of natural and human eroding banks as well as overall riparian health. Both are included in the CD-ROM accompanying this technical memo and were used to guide location of eroding banks in the subsequent field assessment.

Helena National Forest

The Helena National Forest created a Microsoft Access database application designed to catalog and characterize the valley bottom areas within HNF jurisdiction. Unfortunately, most of the main stem Blackfoot River is on privately owned land and was not included in this inventory. As a result, these data have limited applicability for this study.

Field Assessments (Summer 2002)

The Blackfoot Headwaters physical assessment occurred from July 29 through August 16, 2002 with expertise provided by volunteers from state and federal agencies. The aerial photo assessment provided the basis for reach selection. The Confluence/DTM project team developed the study design and provided oversight and other technical assistance to assessment teams.

These field assessments included a number of methodologies designed to provide quantitative assessments of fluvial geomorphology, streambed composition, fish habitat, human influences, and riparian structural composition. Reconnaissance level geomorphic assessment provided supplemental information on a number of tributaries.

APPENDIX D
FIELD ASSESSMENT METHODS

Field assessment methods were conducted mainly following the Environmental Monitoring and Assessment Program (EMAP) protocols developed by the EPA (2001) for physical habitat characteristics and the layout of sampling reaches measuring 2000 feet in length. Field parameters included measurement of maximum bank full depth, bank full width, and percent cover in three riparian cover classes (over story, under story, and ground cover) on 10 transects per reach. In addition, this assessment included a proximity-weighted index of human influence for each cross sectional transect. Woody debris counts occurred between transects using standard EMAP protocols. Measurement of percent surface fines focused on pool tail outs using the grid toss method (Overton et al, 1997). The most significant modification of the EMAP method was applying thalweg profile measurements from the standard USFS fish habitat methodology (Overton et al, 1997) to measure proportion of habitat types in the reach.

Field crews conducted EMAP assessments on 21 reaches on the Blackfoot River, 2 on Poorman Creek, and one on Willow Creek. Of the Blackfoot River EMAP reaches, two were on reference reaches. These were reaches identified as “least-impaired” during aerial photo analyses. Field observations confirmed this status for the reference reaches.

Following methods described by Kaufmann et al (1999), data collected along cross sectional transects and the thalweg profile provided the basis for calculation of a series of reach-wide metrics or descriptors (Table D-1). These metrics are typically site level means for the various measurements and standard deviation. The sum of the lengths of different channel units within each 2000-foot reach described proportions of each reach comprised of riffles, pools, glides, and runs.

Table D-1: Metrics Calculated for Modified EMAP Reaches.

Category	Descriptors/Metrics	Description
Channel Morphology Summaries	% Pools % Riffles % Glides % Runs	Sum of the length of the different channel unit types divided by the reach length and multiplied by 100.
Channel Cross Section and Bank Morphology	Bank full Width Bar Width Width to Depth Ratio Entrenchment	Calculation of site level means, standard deviations, median, and upper and lower quartiles from data collected during channel/riparian cross section characterization.
Siltation	% fines (<0.06 mm)	Calculation of site level percentages of fine particles using the grid toss methodology.
Woody Debris	% big woody debris % small woody debris	Calculation of the total volume and number of pieces (in 4 size classes) within each site. Extrapolated to pieces and volume per 100ft.
Riparian Vegetation Structure	% big trees % small trees % woody shrubs and saplings % herbs, grasses, forbs (> 1.6 feet) % woody shrubs and seedlings (< 1.6 feet) % herbs, grasses, and forbs (< 1.6 feet)	Calculation of site level means for riparian vegetation cover types.
Human Influence	Disturbance index of each of the 11 human influence components.	Calculation of proximity weighted disturbance indices.

APPENDIX E
FIELD ASSESSMENT RESULTS

Channel Morphology Summaries

Proportions of EMAP reaches comprised of the various channel unit types varied among streams and reaches (Figure E-1). Typically, stream reaches possessing a mixture of channel unit types provide superior habitat for fish and aquatic life than reaches dominated by a single type. Glide habitat dominated reaches 6 and 7, including the least-impaired reference reach for 6. Glides are shallow, monotonous channel types that do not provide cover for fish. Similarly, these areas have poor sediment transport capabilities and have the potential to accumulate sediment.

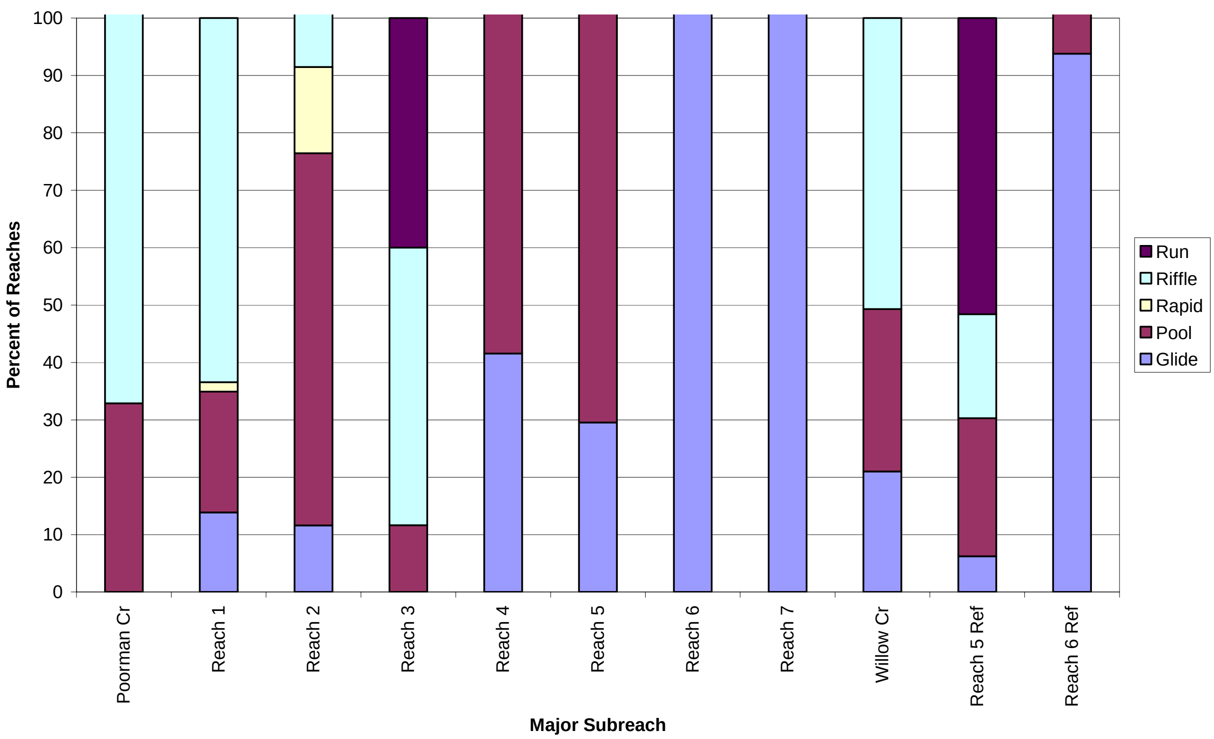

Figure E-1. Percent of Sub-Reaches Comprised of Different Channel Unit Types Using Data Collected During EMAP Reach Assessments.

Channel Cross Section Metrics

Metrics calculated for measurements made at channel cross sections illustrate differences in channel morphology among streams and among sites on streams. Bank full widths and width-to-maximum depth ratios measured on the uppermost portions of the Blackfoot River were relatively low (Figure E-2, Figure E-3). These conditions changed dramatically due to contributions from the Landers Fork then leveled off below Lincoln. Contributions from the Landers Fork were probably responsible for the large bar widths measured in this reach (Figure

E-4). Width-to-maximum depth ratios on Poorman and Willow Creeks were relatively low, which suggests that these channels are not overly wide where assessed.

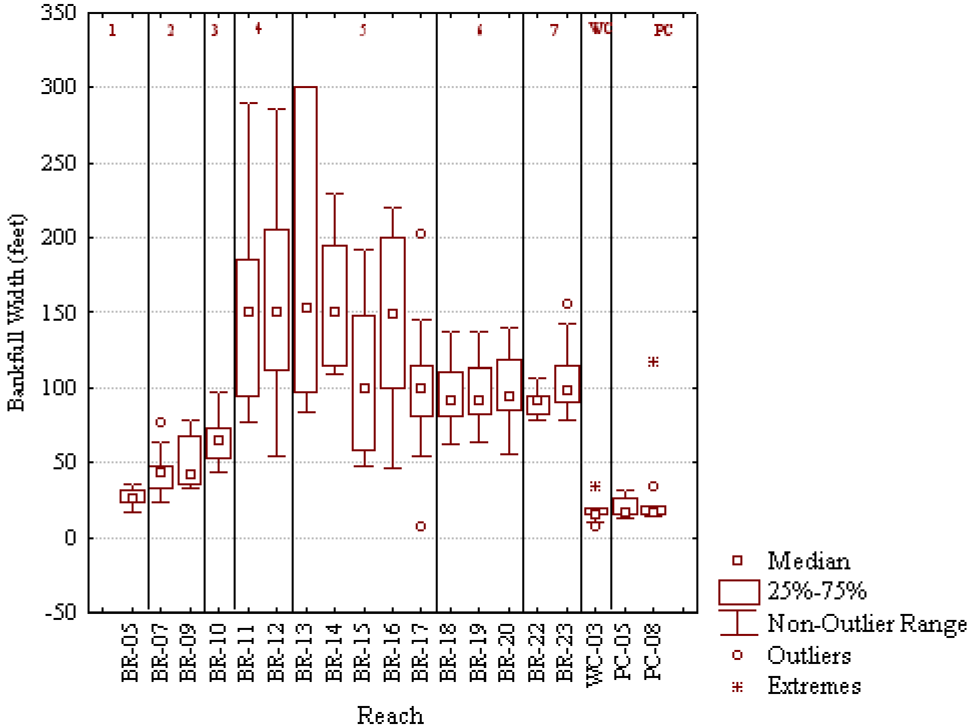

Figure E-2. Bank full Widths Measured on EMAP Reaches on the Upper Blackfoot River, Poorman Creek, and Willow Creek.

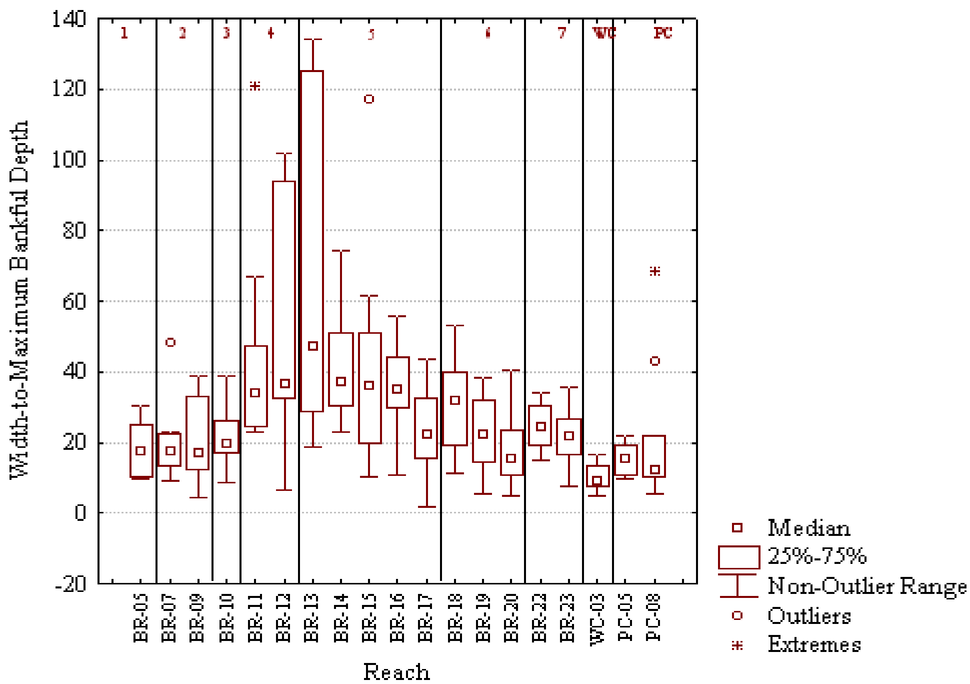

Figure E-3. Bank full Width to Maximum Bank full Depth Ratios Measured on EMAP Reaches on the Upper Blackfoot River, Poorman Creek, and Willow Creek.

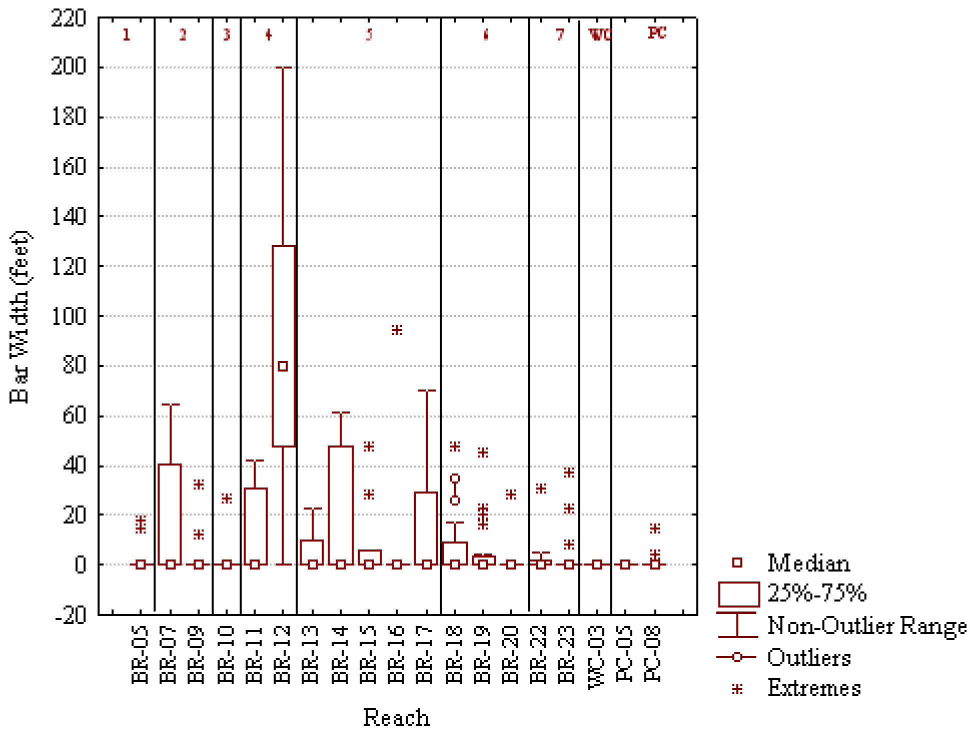

Figure E-4. Bar Widths Measured on EMAP Reaches on the Upper Blackfoot River, Poorman Creek, and Willow Creek.

Siltation

Sampling surface fines using a 49-point grid provides a quick way of assessing accumulations of fine sediment on streambed surfaces (Overton et al, 1997). We focused efforts on pool tails because these habitat types are preferred spawning areas for trout. Because pool habitat was limited in some reaches on the Blackfoot River, we combined percent fines estimates for the sub-reach of the stream.

Reaches of the Blackfoot River varied in terms of accumulations of fine sediment as measured with the surface fines grid (Figure E-5). The EMAP Reach 6 had the highest level of fine sediment, often exceeding 60% of the streambed sampled. Although this reach is identified as a reference reach, this would only apply to certain parameters such as riparian health. Using a reach of a potentially impaired stream segment for percent fines measures is typically not recommended due to the varying depositional nature of sediment. Reach 3 had the highest degree of siltation; however, this may be an artifact of sampling error due to the rarity of pools in this section. Surprisingly, Reach 7 had relatively low levels of surface fines. This finding contradicts field observations of thick accumulations of fine sediment throughout this reach.

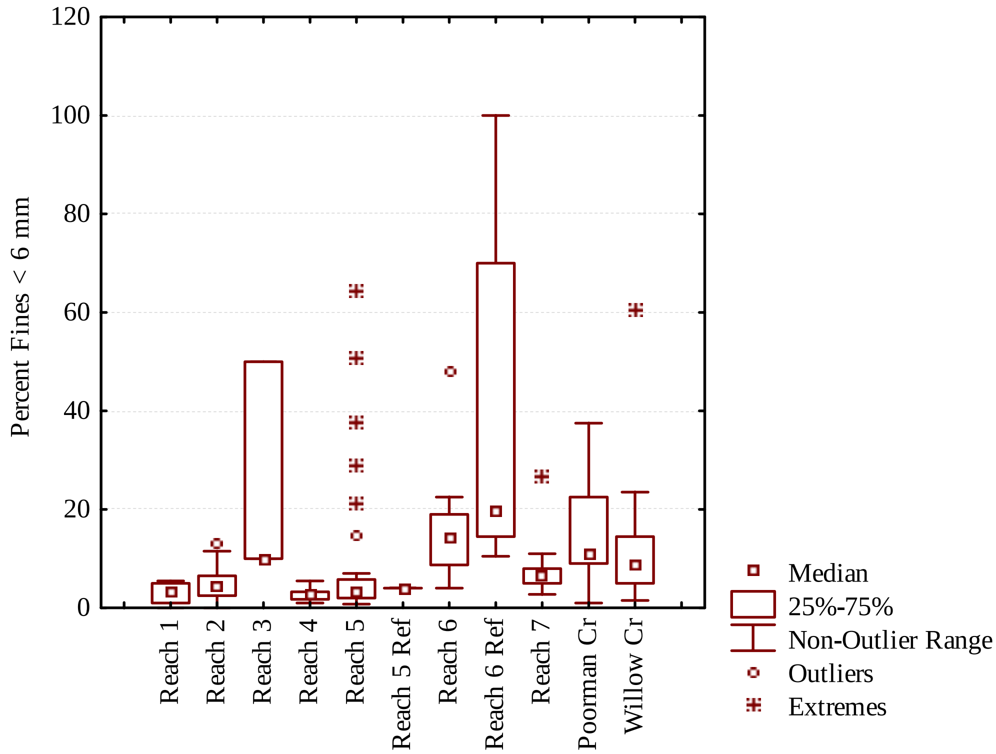

Figure E-5. Percent Fines < 6 mm in Diameter Sampled on EMAP Reaches on the Blackfoot River, Poorman Creek, and Willow Creek.

Volume of Woody Debris

The volume of woody debris of different size classes varied among EMAP sites and among streams in the Blackfoot Headwaters Planning Area (Figure E-6). The upper reaches of the Blackfoot River main stem, Poorman Creek, and Willow Creek had relatively low volumes of woody debris. On the Blackfoot River, volumes of wood increased below the confluence of the Landers Fork and persisted through sub-reach 6. Much of this wood occurred in debris jams associated with large pools. In the lower sub-reach, the volume of woody debris dropped markedly. Woody debris was not a significant component in Poorman and Willow creeks.

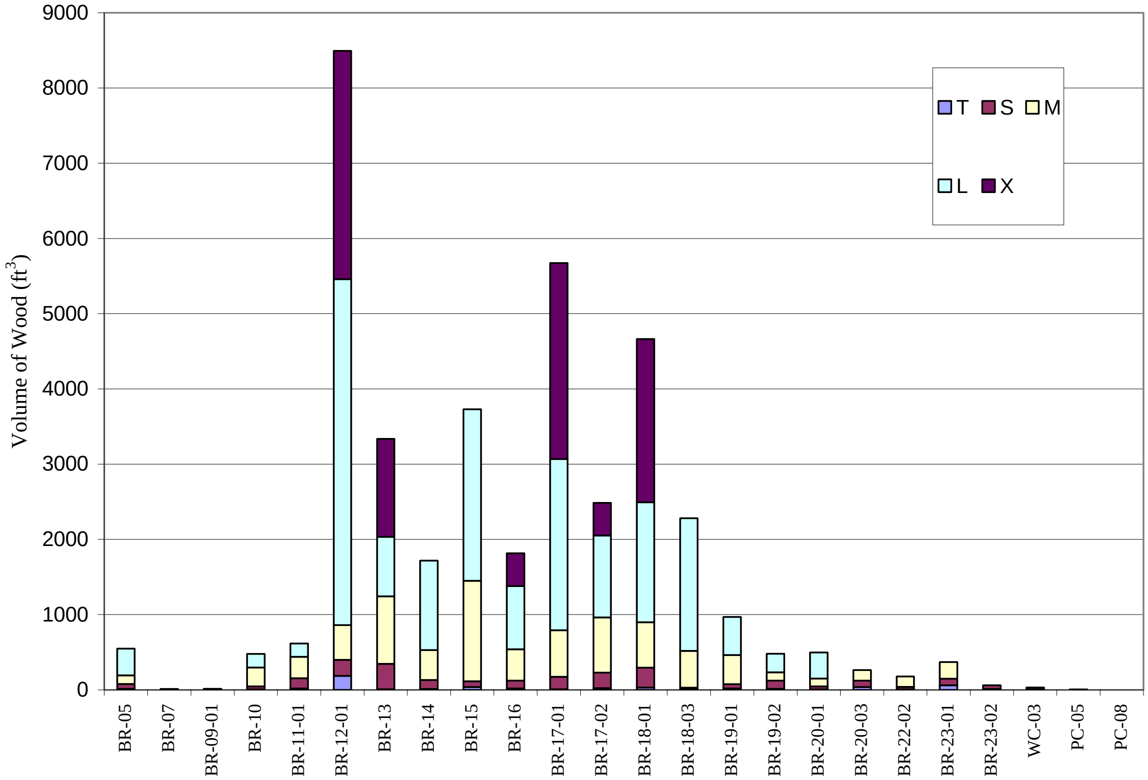

Figure E-6. Total Volume of Woody Debris in 5 Size Classes in EMAP Reaches on the Blackfoot River, Willow Creek, and Poorman Creek.
[T = very small (length 1.5m to 5m, diameter 0.1m to 0.3m); S = small (length 5m to 15m, diameter 0.3m to 0.8m); M = medium (length > 5m, diameter = 0.3m to 0.8m); L = large (length >5m, diameter >0.6m); X = very large (length >15m, diameter >0.8m)]

Structural Composition of Riparian Vegetation

EMAP riparian assessments evaluate the percent cover of three different cover classes (over story, under story, and ground cover). Over story canopy cover (big and small trees) comprised a relatively small component of the riparian vegetation (from 0% to 40%) along the upper Blackfoot River, Poorman Creek, and Willow Creek. Throughout the surveyed area, under story woody shrubs and non-woody groundcover (grasses and forbs) dominated riparian vegetation cover types (Figure E-7). Grasses and forbs do not provide substantial bank stabilization or protection due to the relatively shallow rooting depth. The predominance of bare ground in the riparian area varied considerably (between 5 and 35%) within the surveyed area of the Blackfoot River. Bare ground comprised 20% of the riparian area in Poorman Creek, and close to 15% in Willow Creek. Along the Blackfoot River, Reach 1 exhibits the highest degree of structural diversity (presence of all vegetative life forms), Reach 2 exhibiting the lowest.

There are a number of implications for reduction of cover types measured in this analysis. For example, relatively low cover of large and small trees may reflect a lack of potential large woody debris in a given reach. These cover classes also function to increase the structural integrity of banks and provide shading to the stream surface. Similarly, riparian shrubs, as measured cover of woody under story vegetation may reflect grazing pressure and indicate structural bank integrity. Low ground cover combined with relatively high levels of bare ground also suggests disruption of the sediment and nutrient filtering properties of streamside vegetation.

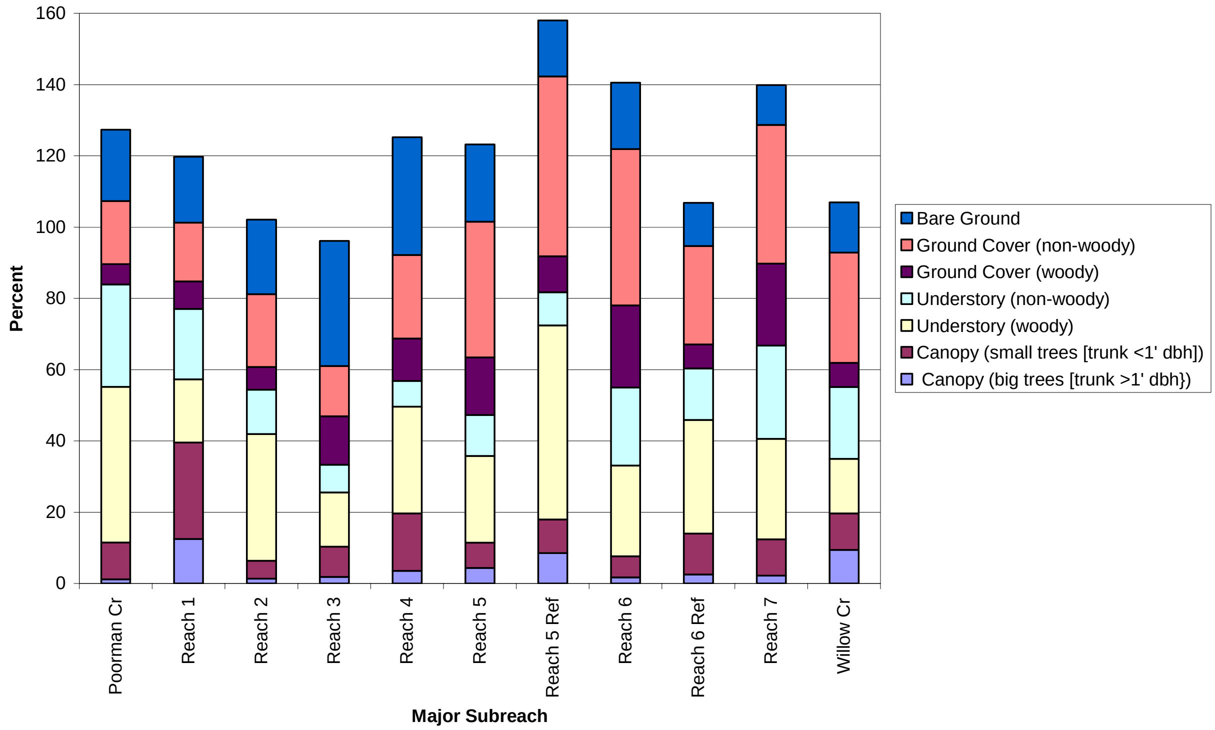

Figure E-7. Percent of Riparian Vegetation Types (Bare Ground, Ground Cover, Under story, Canopy) for EMAP Sites on the Upper Blackfoot River.

Human Influence

Human influences observed in the proximity of the EMAP sites include mining, logging, grazing, roads, pavement, and bank hardening (Figure E-8). Infrastructure such as roads, pavement, or buildings on the riverbank occurred at the majority of sites (80%) on the Blackfoot River. Infrastructure was also a factor on Willow Creek. Presence of roads or pavement also tended to correlate with the presence of bank hardening materials. Evidence of mining activity was only significant at one location on Poorman Creek. Evidence of logging activities was observed at four sites along the Blackfoot River, while evidence of agricultural activities was observed at 40% of sites along the Blackfoot.

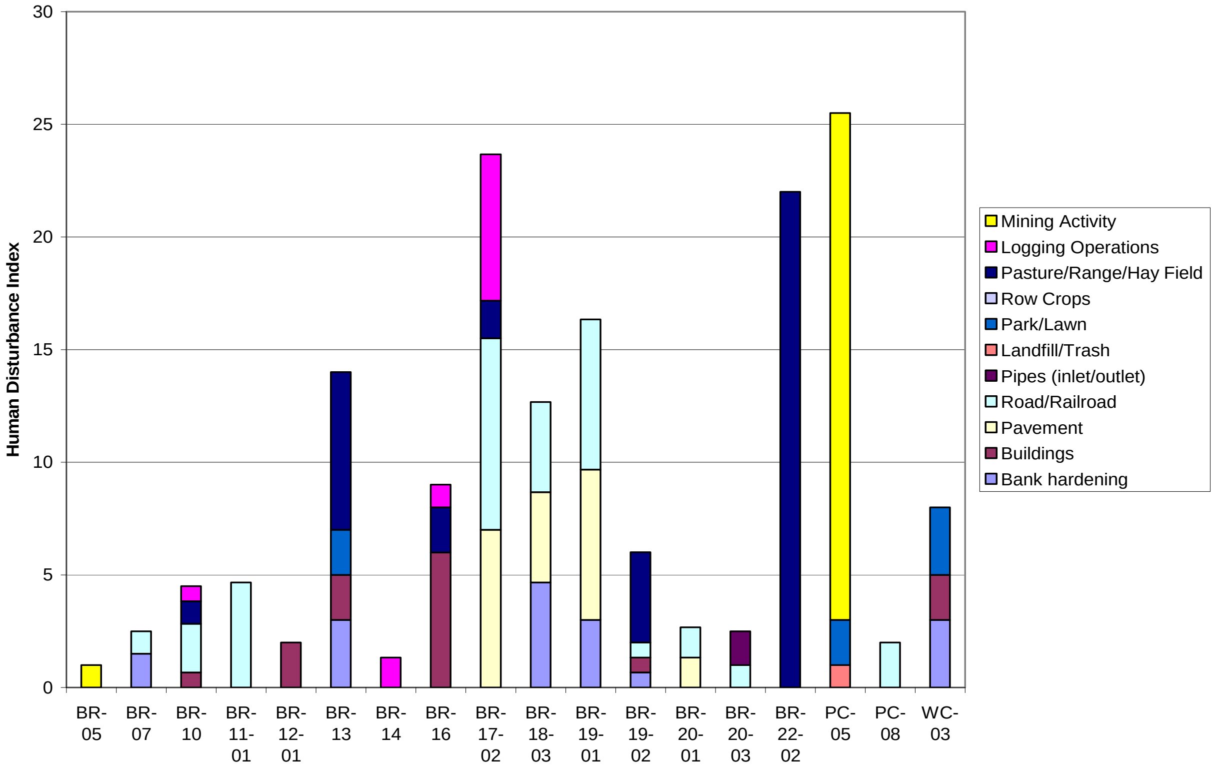

Figure E-8. Sum of the Proximity Weighted Human Disturbance Index for EMAP Sites Along the Upper Blackfoot River.

The human influence index is an interpretive tool in evaluating other observed conditions in assessed sub-reaches. For example, sub-reaches with a relatively high degree of livestock use and logging had low cover of most riparian cover types compared to an internal reference condition. This suggests that these land-uses may be responsible for reduced riparian cover and that management activities may increase riparian cover and the functional attributes of riparian vegetation.

Reconnaissance Stream Condition Inventory

Field crews conducted reconnaissance level investigations on several reaches of 303(d) listed tributary streams, including Poorman, Willow, and Arrastra creeks. Landers Fork was also the subject of a reconnaissance level investigation to assess the role of human activities in influencing sediment loading (see Appendix I). The objective of reconnaissance level investigations was to characterize these channel segments with regard to channel type, geomorphic stability, and potential impairment. The assessment included a documentation of channel stability indicators, verification or revision of Level 1 channel classification results, characterization of potential impairments, discussion of potential remedies, and identification of potential reference reach sites. On Willow and Arrastra Creeks, observers conducted a proper functioning condition (PFC) assessment (Prichard et al, 1998). Results of reconnaissance assessments are incorporated into geomorphic assessments.

Stream Geomorphology

Methods

Characterization of the fluvial geomorphic conditions and processes in the Blackfoot Headwaters Planning Area relied on synthesis and review of field data collected in 2002 and the analysis of aerial photos. The field data included information derived from erosion inventories, EMAP assessments, field reconnaissance, photographs, and commentary extracted from data collection forms and field maps. This information, in combination with sub-reach classifications and calculated channel gradients, was then utilized to consolidate the 23 preliminary field sub-reaches into major reaches of similar geomorphic character. The channel classifications reflect the results of a Rosgen Level 1 classification adjusted upon field review. This resulted in delineation of seven major reaches on the main stem Blackfoot River from RM 70 near the mouth of Anaconda Creek downstream to RM 0 at the confluence of Nevada Creek.

Results

Blackfoot River

The upper Blackfoot River watershed has characteristics typical of headwater environment, and as such, the geomorphic characteristics of the stream network are highly variable. On the main stem of the Blackfoot River, the upstream-most reaches evaluated (Reaches 1 and 2) are largely stable, single thread channels potentially impacted by a tailings pond failure upstream. Still, field observations suggest these reaches appear to have recovered from any historic sediment pulse. The lower end of Reach 2 extends to the Landers Fork confluence. The geomorphic character of the Blackfoot River changes markedly at this point, due the contribution of relatively large volumes of sediment from the Landers Fork. The increased sediment delivery owes to sourcing and transport of sediment derived from non-cohesive glacial deposits in the Landers Fork drainage area. For the first mile downstream of the confluence (Reach 3), the channel is moderately confined, and thereby capable of effectively transporting sediment. Downstream of that point, however, the channel widens significantly into a transitional meandering/braided system characterized by extensive sediment storage, lateral channel shift, and avulsion (Reach 4).

The most geomorphically complex segments of the system are located in Reaches 5-7, which are downstream of the zone of extensive sediment storage (Reach 4). Downstream of Reach 4, the bank full channel narrows and the channel transitions back to a single thread meandering stream (Reach 5). Reach 5 has extensive active bar deposition, lateral channel migration, and bank erosion, attributable to the delivery and storage of coarse bed load sediment. Both active floodplain and terrace surfaces, which commonly consist of relatively fine-grained over bank deposits, provide the boundaries of this reach. Erosion of these surfaces results in entrainment of fine sediment coupled with storage of coarse material on the bars. This process results on a continual downstream cycling of sediment via storage of coarse sediment in bar environments and concentration of fines derived from the channel banks. The sediment gradation becomes increasingly fine in the downstream direction, and deposition of this material is most notable in the lower portions of Reach 7, where it is especially deleterious to habitat for fish.

Table E-1 Summary of Blackfoot River Sub-Reach Characteristics.

Major Reach	River Miles	Channel Types	Average Slope	EMAP Data Sites	Erosion Inventory Data Sites	Average Bank Erosion Severity Rating	Total Fine Sediment Contribution
1	55.1-70.0	B, E	0.7%	BR-05	BR-05	3 (moderate-)	Slight
2	49.5-56.2	C, Cb, C4d	0.52%	BR-07, BR-09	BR-09	3.5 (moderate-)	Moderate
3	48.1-49.5	C4d	0.47%	BR-10	None		Slight
4	42.3-48.1	C4d, D4c	0.47%	BR-11, BR-12	BR-11, BR-12	8.2 (moderate+)	Moderate
5	32.1-42.3	C4, C4d	0.33%	BR-13, BR-14, BR-15, BR-16, BR-17(2)	BR-13, BR-17	8 (moderate+)	Severe
6	18.1-32.1	C4	0.09%	BR-18(2), BR-19(2), BR-20(3)	BR-19	8.8 (moderate+)	Severe
7	0-18.1	C5e	0.07%	BR-22, BR-23(2)	BR-22, BR-23	7.9 (moderate+)	Moderate

Reach 1

Reach 1 extends from the upstream extent of the assessment area near the mouth of Anaconda Creek, downstream to a point located just below the mouth of Willow Creek (Table E-1). This major reach unit consists of the uppermost seven sub-reaches of the main stem Blackfoot River (BR01-BR07). These sub-reaches reflect headwater environments, in which the channel is relatively small, as indicated by the mean bank full width of 27 ft (EMAP BR-05). The channel is also relatively steep, with an average slope of 0.70% through the entire reach. The alternating B and E channel types in Reach 1 reflect localized geomorphic variability with respect to channel confinement, sinuosity, slope, and floodplain access. Valley walls (B-channels) typically confine transport reaches. These transition into meadow areas (E-channels), characterized by low gradient, high sinuosity, and wide floodplain areas. Approximately 15% of the channel perimeter was bedrock according to the Erosion Inventory BR-05, which is a B-type channel segment.

The erosion inventory performed in sub-reach BR-05 rated the channel as geomorphically stable, although mine tailings were present in the reach (EMAP BR-05). In 1975, failure of a tailings impoundment at the Mike Horse Mine resulted in the release of an estimated 100,000 tons of mine tailings into the upper Blackfoot River. Within the assessed channel segments, there were no geomorphic indicators of systemic instability due to this event. However, in the uppermost sections of the main stem Blackfoot, near the mine, habitat degradation resulting from tailings deposition occurs within and along the channel margin. Downstream, it appears that the low gradient channel segments in open meadow areas have effectively absorbed excessive, short-term sediment loads, and thus limited historic destabilization of the reach. Currently, the severity of bank line erosion is moderate, with erosion/deposition patterns characterized by local sediment sourcing of sand and gravel- sized material. Storage of similar gradations in bar environments balances local sourcing of sediment.

Reach 2

Reach 2 extends from near the Willow Creek confluence downstream to the mouth of Landers Fork, and includes field sub-reaches BR-07 through BR-09. Within this reach, the Blackfoot consists of a single thread meandering channel (C), with local valley wall confinement (Cb-type), and local areas of bar deposition and split flow (Cd). A high valley wall on the south, and low sagebrush terraces to the north typically bound the river corridor in this reach. Noxious weeds were pervasive at both EMAP sites BR-07 and BR-09. Minor riprap and diking occurred at BR-07. The erosion inventory performed through the Aspen Grove Campground area identified significant bedrock control along the southern valley wall. Reach 2 had a largely stable to mildly aggrading channel, with a C4d channel classification (BR-09).

Reach 3

Reach 3 consists solely of project sub-reach BR-10, extending from the Landers Fork confluence downstream for approximately 1.5 miles. The mean width-to-depth ratio of the reach EMAP channel segment is 21.2, which is significantly less than reaches immediately downstream. Bedrock exposures on the south valley wall, and rock revetments and constructed berms/dikes on the north (right) bank are local confining features in this reach.

The relatively low width-to-depth ratio of Reach 3 (BR-10) indicates that the channel is largely capable of transporting sediment loads derived from the upper Blackfoot and Landers Fork. The relatively efficient transport capacity of the reach is likely due to lateral channel confinement, which narrows the channel corridor and maintains flow depths during discharge events. Locally, however, the channel corridor widens, and storage is evident in the form of multiple channel threads and very coarse grained bar formation, which results in the designation of the reach as a Cd channel type.

Reach 4

Reach 4 extends from the mouth of Swede Gulch to the Stemple Pass Road Bridge just south of Lincoln. This reach marks a significant increase in mean bank full width-to-depth ratios from 18 to 21 upstream in Reaches 1-3 to a range of 43 to 53 in Reach 4 (EMAP BR-11, BR-12). Reach 4 also had extensive sediment storage in bars, and secondary channels. The channel types range from C4d to D4c, which reflects the transitional meandering/braided conditions through the reach. The reach is somewhat steeper than downstream reaches; however, its average gradient (0.47%) is consistent with that of Reach 3 upstream. Bed substrate consists primarily of gravel and cobbles, however lower energy geomorphic environments (abandoned channels, high bar surfaces), are commonly capped with sand. Due to the coarse nature of the reach, fine sediment contributions to the river system are relatively minor.

Due to the extensive sediment storage in Reach 4, the bank full channel is relatively wide (150-160 ft). A several hundred-foot wide active channel corridor, which consists of coarse, variably vegetated sediment that is dissected by high flow channels, provides the boundary of the bank full channel. Erosion of the corridor margin and active channel migration and avulsion on lower floodplain surfaces downstream was significant against the steep southern valley wall in BR-11 as. This reach demonstrated extensive channel shifting in 2002 assessments relative to the 1995 base map aerial photography. Large woody debris was typically not a primary component of in-channel geomorphic features such as pools, as most LWD was stored outside of the primary channel thread.

Reach 4 has a dynamic plan form influenced by mobility of coarse substrate particles. The coarse nature of the substrate renders the sub-reach most susceptible to change during high flow events. Woody debris storage in the primary channel increases in the downstream direction through the reach; the lower portion of the reach has extensive woody debris stored both within and beyond the bank full channel. Secondary high flow channels are ubiquitous in over bank areas within the river corridor.

Reach 5

Downstream of Reach 4, the Blackfoot River transitions back to a single thread meandering channel in Reach 5. Reach 5 extends from the Stemple Pass Rd Bridge downstream to the upper section of the canyon near the Powell/Lewis and Clark County line. Reach 5 has a consistent slope of approximately 0.33%, and is a C4 channel type. Bank line erosion, mostly related to large-scale bend way migration, is relatively severe through the reach. Locally, however, extensive woody debris jams cause lateral instability that control bar locations and promote split flow. Relatively large amounts of woody debris are stored in Reach 5 in both the bankfull channel area, as well as in over bank environments.

Bank stratigraphy in the reach typically consists of lower bank gravels overlain by a cap of fine grained over bank deposits. Because of the fine-grained component of the actively eroding banks, there is significant contribution of fine sediment within this reach. Sediment gradations stored within bar environments consist primarily of gravel and cobbles. The abundance of fines in pool tail out environments provides evidence of the contribution of fine sediment from bank erosion.

Reach 5 consists of a highly dynamic corridor affected by the delivery of coarse sediment loads from upstream. Lateral channel migration and locally extensive erosion of the floodplain margin is evidence of ongoing widening of the active corridor in the reach. The active lateral erosion coupled with an intermediate channel slope results in transport conditions that entrain and effectively flush the majority of fines, resulting in gravel-dominated riffle/bar forms, with local accumulations of fines in pool environments.

Reach 6

The average channel slope of Reach 6 is 0.09%, which is an abrupt reduction from 0.33% in Reach 5. The reach extends through the canyon section of the project reach, from a point near the Powell/Lewis and Clark county line, to the point where lateral confinement is reduced just upstream of the Highway 141 bridge. Reach 6 is a single thread, sinuous C4 channel that shows distinct downstream trends in channel form. Sinuosity increases downstream through the reach, ranging from 1.5 (BR-18) to 2.1 (BR-20). Width-to-depth ratios decrease in the downstream direction, ranging from 31 (BR-18) to 18 (BR-20). The Blackfoot River locally abuts both Highway 200 and bedrock exposures as it flows intermittently along the north canyon wall. The valley bottom is confined.

Reach 6 has an extremely low slope, and relatively low-width-to-depth ratios maintain sediment transport capacities. The low slope in the confined canyon section suggests that a canyon obstruction or extensive beaver dam complexes may have historically impounded the sub-reach. The progressive development of a defined channel in the reach would explain the ongoing dynamics of sediment delivery, storage, and associated bank line erosion, channel migration, and corridor widening.

Reach 7

Reach 7 extends from the mouth of the canyon reach near the Highway 141 Bridge to the confluence with Nevada Creek. Within this reach, the Blackfoot River is extremely sinuous and fine-grained. Sinuosity ranges from 1.5 (BR-21), to 2.4 (BR22). The bank stratigraphy consists of fine sands and silts, buried woody debris, and secondary channel fills. Cohesive clays are commonly exposed in the channel bed and bank toe. Bank erosion is relatively severe, and is typically associated with bend way migration and pressure from point bar deposition. The most extensive bank erosion in Reach 7 occurred in the lowermost channel section (BR23). This reach was described as geomorphically unstable, with extensive deposition of fine sediment in pools and on bars.

The bank composition and form in Reach 7 suggests that fine grained over bank deposition in a low gradient environment historically dominated the system, perhaps in an expansive series of beaver dams. Currently, the fine-grained system can support a highly sinuous planform, and sediment storage in the tight bend ways imparts erosive pressure on the outer bank. Due to its fine-grained perimeter, sinuous planform, and low channel slope, Reach 7 is a storage zone for fine-grained material derived from upstream as well as from within the reach.

Arrastra Creek

Arrastra Creek is the western most tributary of the Blackfoot River within the Blackfoot Headwaters Planning Area. Both logging and livestock grazing have had a negative influence on Arrastra Creek. A summary of Arrastra Creek sub-reach characteristics is shown in Table E-2.

Table E-2. Summary of Arrastra Creek Sub-Reach Characteristics from Field Reconnaissance.

Reach	River Miles	Channel Types	EMAP Data Sub-reach	Erosion Inventory Data Sub-reach	General Channel Stability
AC1	2.0-4.7	Cb4	n/a	n/a	Aggradation
AC2	0.75-2.0	Cb4	n/a	n/a	Aggradation
AC3	0-0.75	C4/Ce5	n/a	n/a	Aggradation

Sub-reach AC1

Sub-reach AC1 extends from a locked gate at river mile 4.7 downstream to 2.0. Within this reach, Arrastra Creek consists of extensive point- and mid-channel bar deposits. Vegetation ranges from dense riparian to open lands in logged areas. Riparian communities typically consist of black cottonwood, alder, snowberry, dogwood, and occasional spruce and willow. At river mile 3.3, the Arrastra Main Road crosses the channel. The crossing consists of two culverts, each of which is 6 feet in diameter. For a distance of approximately 200 ft upstream of the culverts, the channel is braided (D4 channel type), which indicates that flow obstruction at the culverts has resulted in backwatering and sediment deposition upstream. Downstream of the crossing, the channel abruptly transitions to a C4b-type channel with few pools, diagonal bars, and primarily continuous shallow riffle bed forms. Width-to-depth ratios range from approximately 25-40, which suggests that the channel is over-widened due to high sediment loads. Infrequent woody debris jams create local pool and cover habitat. The riparian cover is variable; in areas where there has been historic logging and the riparian cover is limited, spotted knapweed infestations are extensive. Scattered areas of Canada thistle, hounds’ tongue, and musk thistle were also present. This channel segment downstream of the road crossing had significantly less flow than upstream areas during the field assessment (August 2002). Local residents reported that this section of channel commonly goes dry from November through May.

At river mile 2.4, a large wetland/pond complex is present on the left bank floodplain area (Frenchy's Pond). This pond contributes flow to Arrastra Creek. Downstream of the pond outlet, the channel is a C4 type, with better channel development, and a lower width depth ratio of 20-25. Willow, alder, and dogwood dominate the riparian community in this section. These stands show indications of heavy browse pressure. The upland areas beyond the pond have been extensively logged in recent years.

Sub-reach AC2

Sub-reach AC2 extends from a bridge crossing at river mile 2.0 downstream to river mile 0.75. The bridge at the upstream end of the sub-reach is approximately 15 feet wide and 3 feet above the channel bed. The sub-reach is a Cb4-type channel with a high volume of bed load storage. Active deposition and braiding is common upstream of debris jams. Limited bank erosion occurs on bend ways. Pools are infrequent. Selective logging on adjacent terraces has occurred in the past several years. According to local reports, this channel segment typically goes dry by November of each year. Commonly, as the flows recede, fish are stranded in isolated pools.

Sub-reach AC3

Sub-reach AC3 is located immediately upstream of the Blackfoot River confluence, and consists of a wide, shallow channel that has an approximate width-to-depth ratio of 50-60. The reach is a depositional zone, where beaver dams magnify aggradational trends and small debris jams. The riparian zone consists of dense alders and willows, and the waters edge supports sedges. Canada thistle is common in the riparian zone, whereas spotted knapweed infestations are common on dry, open terraces. Near the mouth, the channel bottom is muddy with dense growths of macrophytes. Livestock have access to the reach, but deleterious impacts were not apparent.

Poorman Creek

Poorman Creek is a major tributary of the Blackfoot River. It joins the Blackfoot just downstream of the town of Lincoln. A summary of Poorman Creek sub-reach characteristics is shown in Table E-3.

Table E-3. Summary of Poorman Creek Sub-Reach Characteristics.

Reach	River Miles	Channel Types	EMAP Data Sub-reach	Erosion Inventory Data Sub-reach	General Channel Stability
PC1	12.7-14.0	A3	n/a	n/a	Stable
PC2	10.5-12.7	B4	n/a	n/a	Stable
PC3	8.6-10.5	B4	n/a	n/a	Stable
PC4	2.3-8.6	B4/C4	PC05, PC08	n/a	Stable
PC5	0-2.3	Cb4	n/a	n/a	Minor Degradation

Sub-reach PC1

Sub-reach PC1 is located in the upstream portion of the tributary watershed, extending from the first Stemple Pass Road crossing approximately 1 mile upstream. Within this reach, Poorman Creek is a moderately confined, relatively steep, stable, A-type channel. A thin riparian fringe consisting primarily of spruce, alder, and golden currant borders the channel. Channel segments upstream of this sub-reach were not assessed, and abandoned mines may affect that area of the upper watershed.

Sub-reach PC2

Sub-reach PC2 flows from the first Stemple Pass Road crossing downstream approximately 2 miles to the confluence with South Fork Poorman Creek. Within this reach, the channel is a B4 type channel, as it is relatively steep, coarse grained, and confined. The upstream end of this reach consists of a newly installed, arched, corrugated metal pipe (CMP) culvert reinforced by riprap on both the upstream and downstream ends. Velocity reduction baffles installed on the floor of culvert to facilitate fish passage.

At the downstream end of Sub-reach PC2, the South Fork of Poorman Creek enters Poorman Creek from the south. The South Fork of Poorman Creek is a B4-type channel, which flows through a 3-foot diameter culvert prior to entering Poorman Creek. Just upstream of the confluence, Poorman Creek flows through a 3-foot diameter CMP culvert located at the South Fork Road crossing. Both of these culverts are potentially insufficient for high flows and are either perched, in the case of the South Fork crossing, or too low, as in the case of the Poorman Creek crossing, thus making them susceptible to washout.

Sub-reach PC3

Sub-reach PC3 extends from the South Fork Poorman confluence downstream for approximately 1.75 miles to the mouth of Rochester Gulch. The channel is a B4-channel type, and is similar in form to Sub-reach PC2. The riparian zone varies in width from 20 ft in confined areas to over 100 ft in less confined segments. Black cottonwood is present in the riparian zone, along with conifer, willow, dogwood, and alder. Approximately ½ mile downstream of the South Fork confluence, Poorman Creek flows under Stemple Pass Road through a set of three apparently undersized, side-by-side culverts, each of which is perched 10-12 inches on their downstream ends. These culverts are at risk of washout and are potential barriers to fish migration.

Sub-reach PC4

Sub-reach PC4 extends from the mouth of Rochester Gulch downstream for approximately six miles where Poorman Creek emerges from its canyon onto the unconfined valley bottom of the Blackfoot River. Within this reach, placer mining has been extensive, and the channel flows through placer spoil piles, as well as locally confined canyon sections. In some placer-mined segments, the channel has short aggradational reaches, and high width-to-depth ratios. In other sections, the channel has down cut into tailings, although these incised channel segments tend to be well vegetated and relatively stable. Minor bank erosion is limited to bend way cut banks. The riparian zone consists primarily of willows and alders. The lower end of the reach contains a large wetland/beaver dam complex. Heavy infestations of spotted knapweed, Canada thistle, and musk thistle infestations occur in this reach. Cattle and horses graze much of this reach.

Residential development in the sub-reach includes landscaping and riparian clearing. Approximately 1.25 miles downstream of Rochester Gulch, an off-channel fishpond has an intake from Poorman Creek in the form of a 5-foot high rock check dam that creates a passage barrier. Because the pond margin is less than 10 feet from the creek, and is perched approximately 5 feet above the bed elevation, there is potential for breaching of the pond into the creek. In the lower end of the reach, the Stemple Pass Road crossing near Gehring's Lumber consists of three culverts that may constitute a fish barrier. Downstream of the crossing, there is evidence of active grazing, and the channel width-to-depth ratio increases.

Sub-reach PC5

Sub-reach PC5 is the lowermost sub-reach on Poorman Creek, extending from the Poorman canyon mouth northward across an unconfined broad margin of the Blackfoot River valley, to its confluence with the Blackfoot River just downstream of Lincoln. Grantier Spring Creek, a tributary contributing to this reach, has a significant influence on the lower quarter mile of Poorman Creek resulting in flows and thermal regime typical of spring creeks. A short portion of the reach has a relatively coarse grained, moderately entrenched single thread channel (F4). This area is moderately incised, but there is little evidence of active down cutting. The total riparian corridor consists of juniper, black cottonwood, and Canada buffaloberry. Common weeds include musk thistle, Canada thistle, oxeye daisy, yellow toadflax, and spotted knapweed.

Active grazing and in-channel irrigation diversion structures are present in the lower portion of Sub-reach PC5. The first structure is located approximately ½ mile downstream of the mouth of Poorman Canyon. The second is located approximately ¼ mile further downstream. During the field investigation (August 2002), Poorman Creek was dry downstream of the second diversion structure. Bank erosion is active on outside banks along bend ways below the structures. Current plans are in place to reconstruct the irrigation system associated with these structures in an effort to reduce impacts associated with de-watering.

Willow Creek

Willow Creek is a tributary of the uppermost reach of the Blackfoot River. Mining activities and road development impact Willow Creek for some of its length. A summary of Willow Creek sub-reach characteristics is shown in Table E-4.

Table E-4. Summary of Willow Creek Sub-Reach Characteristics.

Reach	River Miles	Channel Types	EMAP Data Sub-reach	Erosion Inventory Data Sub-reach	General Channel Stability
WC1	2.8-6.1	Bc3-Cb4	n/a	n/a	Degradation
WC2	0.8-2.8	Cb4	WC01	n/a	Stable
WC3	0-0.8	Cb4	n/a	n/a	Stable

Sub-reach WC1

Sub-reach WC1 is extends from the Flesher Road Bridge crossing, which lies approximately 1.5 miles north of Flesher Pass, downstream to the Sandbar Creek confluence. At the Flesher Road crossing, the creek flows through a 5 ft diameter concrete pipe that is perched approximately 3 ft above its downstream plunge pool, creating a probable fish passage barrier. During the field investigation, fish were present in the plunge pool. Downstream of the crossing, the stream is a B3/B4 channel type, with an average width-to-depth ratio of 8-10. Black cottonwood, alder, with some willow, spruce, and lodgepole pine dominate the riparian corridor. Heavy infestations of spotted knapweed and lesser amounts of musk thistle and Canada thistle occur on terrace environments. In isolated areas, the channel margin consists of bedrock. Terraces have been locally cleared, and runoff from the highway has created isolated gully erosion on the highway embankment. Typically, the wide buffer present between the road and channel limits the delivery of sediment from the road to the channel.

At river mile 4.9, an underground cable lies across the channel course. A 6 ft wide swath of unreclaimed barren ground marks the path of the cable. Just downstream of the cable crossing, all of the channel flow (approximately 2 cfs during the field investigation) infiltrated, and the channel was dry for approximately 1500 ft, at which point the flow resurfaced. Willows exhibit heavy browsing from wildlife. Noxious weeds include Canada thistle, yellow toadflax, spotted knapweed, and musk thistle.

Approximately one mile downstream at river mile 4.0, the channel flows under West Flesher Road, through a 20 ft span timber bridge. The road embankment is perpendicular to the Willow Creek valley bottom, and forms a floodplain dike that is 7-8 ft in height. For a distance of approximately 0.5 miles upstream of the bridge, the channel bottom contains extensive wetlands and beaver activity. The riparian zone is 250-350 ft wide and dominated by willows. Downstream of the bridge, the channel is incised, and the riparian zone is limited to the entrenched channel margin. This area shows heavy pressure from grazing and browsing, with the most serious impacts apparently due to historical versus current grazing practices. During the field investigation, surface flows were infiltrating in this area, and resurfacing approximately ½ mile downstream. Riparian vegetation is severely limited in the dewatered reach, and becomes dense with willows where flow resurfaces. A single patch of common tansy occurred in an old corral.

Sub-reach WC2

Sub-reach WC2 extends from the Sandbar Creek confluence downstream for approximately 2.0 miles. The Sandbar Creek watershed was mined, and upland areas in the watershed have been disturbed locally. At the mouth of Sandbar Creek, Willow Creek consists of a wetland complex characterized by pools, multiple channels, and dense riparian vegetation. The riparian zone in this area varies in width from 100-600 ft. Approximately 1200 ft downstream from the confluence, the channel transitions to a single thread Cb4 channel type, with minor beaver activity. Noxious weed infestations are common.

Sub-reach WC3

Sub-reach WC3 extends from River mile 0.8 downstream to the confluence of Willow Creek with the Blackfoot River. This reach has a single thread, C4 channel dominated by pools and riffles. Recent, selective logging was evident in the over bank areas. Woody debris accumulations are common in the reach, and debris jams are locally present. Oxeye daisy is present in open areas along the channel margin.

Sandbar Creek

Mining activities have had a profound impact on Sandbar Creek. Mine tailings border the banks in the upper reaches and iron hydroxide covers much of the stream substrate. Remediation to address the source of these metals contaminated sediments is part of the metals TMDL (Hydrometrics et al., 2003). Mine wastes also have been used for road building purposes at a stream crossing, resulting in undesirable habitat alterations. Metals remediation work may also end up addressing these impacts as part of the effort to reduce metals loading to the stream. Near its mouth, Highway 279 channelizes approximately 200 ft of Sandbar Creek. Bank failure, flow impoundment, and loss of cross section definition characterize this channel segment.

APPENDIX F
CALCULATION OF SEDIMENT LOADS FROM ERODING BANKS

Methods

Estimation of sediment loads from eroding banks involved several steps and analyses. Field data collected during the erosion inventory of the field assessment of 2002 provided the basis for estimating sediment loading from eroding banks on the upper Blackfoot River. Teams of natural resource professionals inventoried a total of 23 miles, representing 32% of the total channel length. All eroding bank inventory data collected were digitized, attributed with information on length, height, and condition, and incorporated in the project GIS. To determine the yearly sediment load produced by eroding banks, we estimated an average rate of bank retreat using two methods. First, we determined rates based on a range of values from similar stream systems published in scientific literature. Second, we analyzed historic aerial photography and measured the offset in-stream centerline position between vintages of photography in select locations (see Appendix E). Results indicate general agreement between the two methodologies. This confirmation allowed using published retreat rates for analysis of sediment derived from eroding banks. These rates are presented in Table F-1.

Table F-1. Bank Retreat Rates Used for Banks of Varying Severity of Erosion.

	Migration Rate (m/y) Values in parentheses are in feet		
Condition	Zaroban and Sharp (2001)	Rosgen (2001)	Nanson and Hickin (1986)
Slight	0.032 (0.10)	0.061 (0.20)	0.10 (0.33)
Moderate	0.070 (0.23)	0.189 (0.62)	0.40 (1.31
Severe	0.183 (0.47)	0.335 (1.10)	0.70 (2.30)

Evaluation of the three sources of lateral migration rates of eroding banks indicates that the moderate values (Rosgen, 2001) are most appropriate to apply in this instance. The sediment TMDL described by Zaroban and Sharp (2001) was conducted in an area with a drier climate and lower discharge, than the upper Blackfoot. Nanson and Hickin (1986) conducted their analysis on 18 meandering river channels in western Canada. These rivers have non-cohesive substrate material, higher discharges than the upper Blackfoot, and relatively steep slopes. Rosgen (2001) examined lateral stream bank erosion rates for the Lamar River basin in Yellowstone National Park and a series of streams along the Colorado Front Range. These streams most closely resemble the upper Blackfoot in geomorphic setting.

The following are steps used to calculate total sediment load from eroding banks for all three of the published retreat rates:

- Retreat rates assigned to each eroding bank within the GIS;
- Extrapolate percentage of each type of bank, average height, and retreat rate to channel segments not inventoried;
- Determine bulk density of bank material from SSURGO soils databases for Powell and Lewis and Clark counties;

- Calculate tonnage of sediment produced yearly by each eroding bank (length × height × retreat rate × bulk density); and
- Sum the tonnage of sediment for the entire mainstem Blackfoot by sub-reach.

Results indicate eroding banks contribute a total of 34,492 tons/year of sediment to the Blackfoot River.

Figure F-1 and Figure F-2 illustrate the total sediment load by unit length for each erosion inventory site and the estimated total yearly sediment load contribution from each reach, respectively. In both figures, erosion inventory sites run from upstream (BR01) to downstream (BR23). BR01 through BR09 occur in the upper 303(d) listed reach of the Blackfoot River and sites BR10 through BR23 are in the lower listed reach (Figure F-2). Sites BR14 through BR23 cover the stretch from Poorman Creek to Nevada Creek, the reach identified in field assessments as being below the influence of the Landers Fork and potentially impaired by fine sediment. Sediment loads per mile were extrapolated from reaches inventoried (Figure F-1) to those not inventoried based on major reach break characteristics. This provided an estimated total yearly sediment load for each channel length along the Blackfoot River from Nevada Creek to the headwaters.

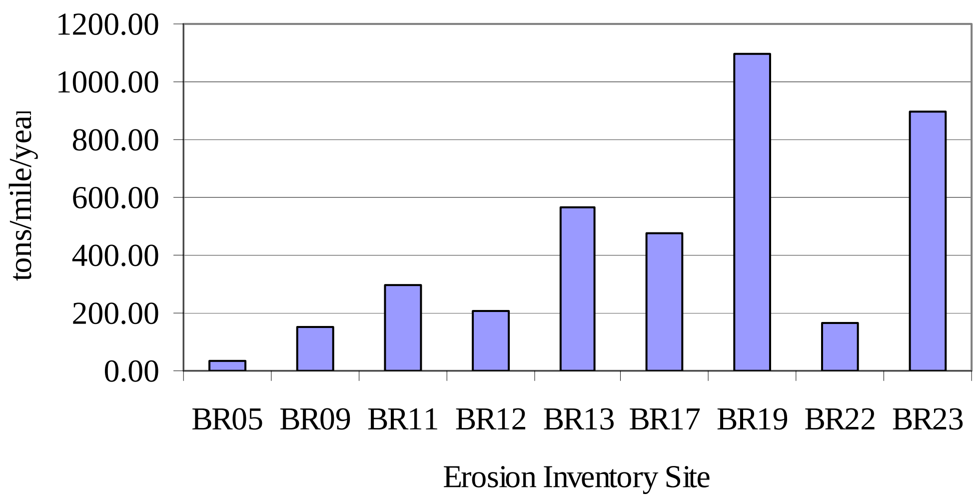

Figure F-1. Yearly Estimated Total Sediment Load by Erosion Inventory Site.

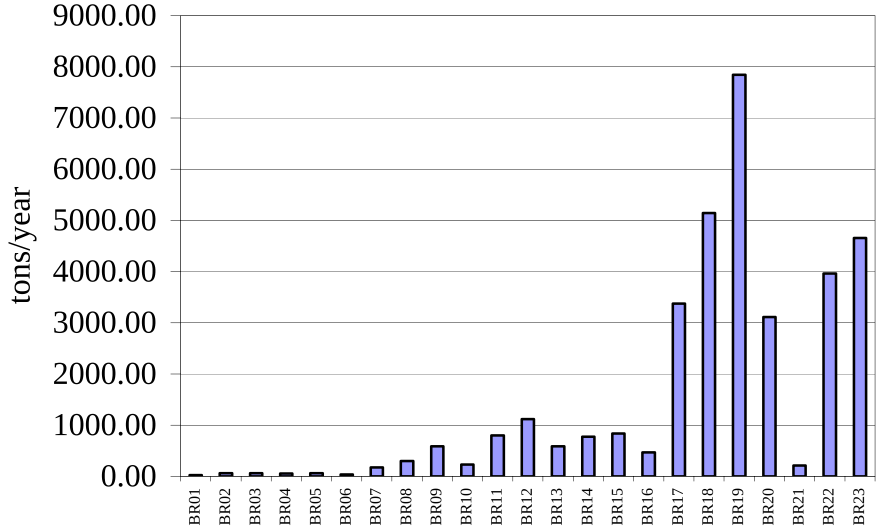

Figure F-2. Estimated Total Sediment Load by Channel Length.

Analysis of human influence data recorded during the 2002 field erosion inventories indicates a strong correlation between the cumulative human influence factor and eroding bank severity. (The cumulative human influence factor is the sum of the types of human influence at or near an eroding bank weighted by its proximity.) Figure F-3 illustrates this relationship. This strongly suggests that human influences are increasing sediment inputs along the stream corridor. The percentage of all eroding banks with an associated human disturbance ranges from approximately 6 to 47 percent by erosion inventory site (Figure F-4).

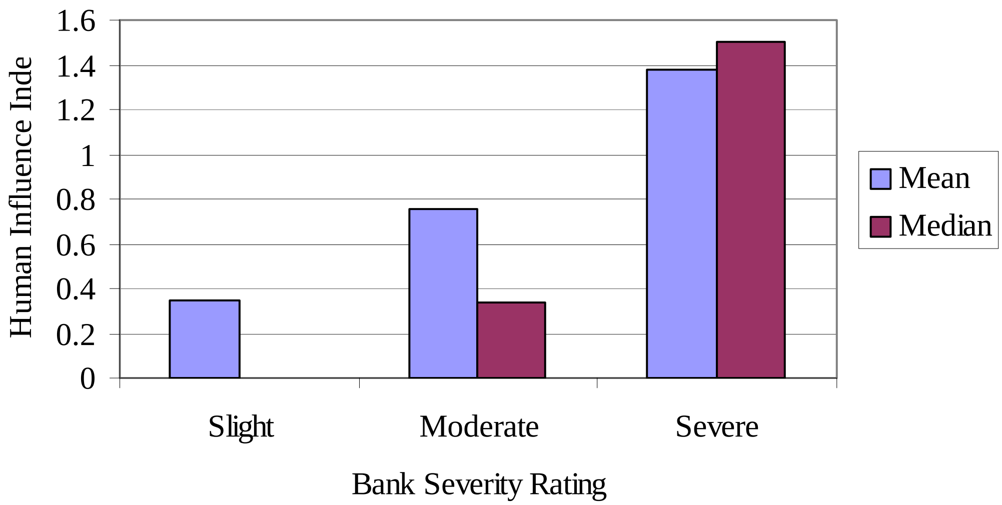

Figure F-3. Eroding Bank Severity Rating vs. Human Influence Index.

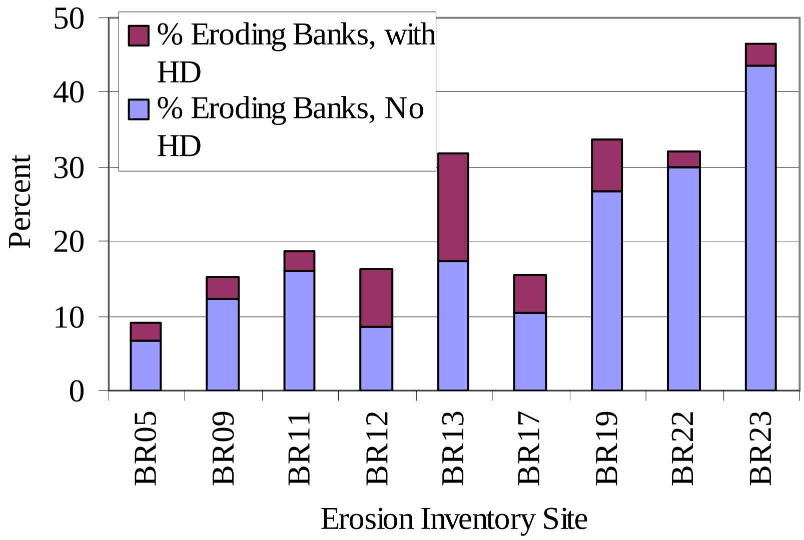

Figure F-4. Channel Length with Eroding Banks Associated with a Human Disturbance.

We used the percentage of banks with associated human disturbance to determine the maximum amount of human-induced sediment contributed by eroding banks on the mainstem Blackfoot River (Table F-2). These analyses attribute nearly 7,000 tons/year of the sediment to banks with moderate or high levels of human disturbance. Still, the proportion of this load that is due to human influences versus natural is unknown. In other words, these banks may have contributed some amount of sediment in the absence of human activities increasing bank erosion. In consultation with DEQ, we estimated between 50 and 75% of this sediment load is from controllable human activities based on best professional judgment. Therefore, we attributed up to 75% of the 7,000 tons (5,250 tons) of sediment per year to the Blackfoot River to controllable human activities increasing bank erosion.

Reaches of the Blackfoot River vary in sediment contributed from eroding banks associated with human disturbance. The reach below the Landers Fork influenced section contributes the largest amount of maximum human-induced sediment load from eroding banks, 5,764 tons/year (Table F-2). Tables F-3 and F-4 show the relative impacts for the several types of human activities noted. Human activities associated with potential bank erosion; however, livestock grazing and encroachment by roads are the predominate influences. Some of these activities, such as livestock grazing, are likely more controllable via BMPs than other, potentially more permanent impacts such as encroachment by roads. Another important factor than can influence erosion processes in rivers is the influence of sediment from upstream sources. Sediment deposited from upstream sources increase bank pressure along downstream reaches, which in turn, contributes to further bank erosion. Some of these upstream sources are due to controllable human activities, although it is difficult to quantify the impact that these upstream human sources have on downstream bank erosion. Allocations in Section 5 and recommended mitigation measures described in Section 6 of this document address reducing upstream sediment sources as well as reducing eroding banks in the impaired reach of the Blackfoot River.

Table F-2. Yearly Sediment Loads from Eroding Banks.

	Sediment Load from Eroding banks, mainstem Blackfoot River, using Rosgen (2000) lateral migration rates (tons/yr)		
	Upper Listed Reach (MT76F001_010) Headwaters to Landers Fork	Lower Listed Reach (MT76001_020b) Poorman Creek to Nevada Creek	Total
Human-induced (maximum)	284	6710	6,994
Natural	1085	26414	27,497
Sub Totals	1369	33124	34,492

Table F-3. Total Blackfoot River bank Lengths Affected by Human Sources by Reach; Percent Refers to the Percent of the Reach Affected by Each Type of Disturbance.

Human	**BR1**		**BR2**		**BR4**		**BR5**		**BR6**		**BR7**	
Influence	**Ft**	**%**	**Ft**	**%**	**Ft**	**%**	**Ft**	**%**	**Ft**	**%**	**Ft**	**%**
Revetment	319	0.6	173	0.5	726	2.2	1221	2	1844	2.4	1266	1.2
Buildings	0	0	0	0	1544	4.6	405	0.7	0	0	1505	1.4
Pavement	0	0	0	0	187	0.6	405	0.7	859	1.1	0	0
Road/Railroad	235	0.5	970	2.6	2249	6.7	5519	9.2	4253	5.5	2471	2.3
Pipes	0	0	0	0	0	0	0	0	351	0.5	325	0.3
Landfill/Trash	0	0	274	0.7	0	0	282	0.5	0	0	0	0
Park/Lawn	113	0.2	0	0	419	1.2	0	0	0	0	0	0
Grazing	85	0.2	0	0	1559	4.6	6465	10.8	16854	21.8	6617	6.3
Logging	0	0	0	0	997	3	3230	5.4	0	0	0	0
Mining	0	0	0	0	0	0	0	0	0	0	0	0
Total	752	1.5	1416	3.8	7681	22.8	17525	29.3	24161	31.2	12184	11.5

Table F-4. Total Combined Blackfoot River Bank Lengths Affected by Human Sources; Percent Refers to Relative Percentage of Each Type of Human Disturbance.

Human Influence	Total Eroding Bank Lengths	% of Total Eroding Banks; All Reaches
Revetment	5549	8.7
Buildings	3454	5.4
Pavement	1451	2.3
Road/Railroad	15697	24.6
Pipes	676	1.1
Landfill/Trash	556	0.9
Park/Lawn	532	0.8
Grazing	31580	49.6
Logging	4227	6.6
Mining	0	0
Total	63,722	100

APPENDIX G
USE OF SEDIMENT CORE DATA

A significant source of information on streambed composition in the Blackfoot Headwaters Planning Area is McNeil core samples (McNeil and Ahnell, 1960) collected by the US Forest Service. These data have several applications in making beneficial use support determinations and developing TMDL targets. Furthermore, core samples are a least-biased approach to assessing substrate composition (Young and Hubert, 1991). Another value of this particular dataset is the large number of replicates, spatial coverage, and temporal coverage. Monitoring has been ongoing from the late 1980s to the present with data available from 23 streams. Furthermore, the gradations measured using this technique allow assessment of several aspects of salmonid spawning gravel quality (Kondolf, 2000). This involves assessing life history requirements needed for successful reproduction: excavation of redds, incubation of embryos, and successful emergence of fry. Finally, fisheries biologists frequently use McNeil cores to evaluate survival to emergence of two key species, westslope cutthroat trout, and bull trout (Weaver and Fraley, 1991). Given these strengths, we evaluated this dataset as a means to make impairment determinations and develop numeric targets for streams in the Blackfoot Headwaters Planning Area.

Methods

Focusing on McNeil core data collected on the mainstem Blackfoot and 303(d) listed tributaries, we assessed the suitability of substrate composition for spawning by salmonids based on a procedure presented by Kondolf (2000). The first step in this analysis was to generate a size distribution for sampled particles. Due to the large number of samples collected, we represent size class distribution as box and whiskers of key particle size classes (< 6.35 mm, and < 2.38 mm) across years for each site.

The next step was to evaluate the ability of a female to excavate particles by examining the weighted mean of particles sampled for each core sample. This is a surrogate for the d_{50}, a commonly used statistic. These weighted averages provided the basis to generate box and whisker plots of d_{50} across years for each site. A general rule of thumb is that a fish can move particles up to 10% of her body length. Salmonids in the Blackfoot Headwaters Planning Area range up to 19 inches or 480 mm (Hillman et al., 1996), while most fish are between 9 and 15 inches (225 and 380 mm). Therefore, the median particle size in spawning microhabitats should range within 22.5 and 38 mm. Because all sites evaluated met this criterion, we will not include additional descriptions of these results.

Suitability for incubation relates to the percentage of grain sizes passing through the smaller gradations – such as the 0.85 mm sieves (Kondolf, 2000). Kondolf (2000) suggests that the 0.85 size gradation be less than 12-14% based on field observations by McNeil and Ahnell (1964) and Cederholm and Salo (1979). The percent fines measures for streams in the Blackfoot Headwaters TMDL planning area appear to satisfy this condition. Therefore, we used the 2.38 mm size gradation, in comparison to reference reaches, as an indicator of incubation success and as an additional indicator of successful fry emergence, discussed below.

In assessing whether fine sediment has the potential to block emergence of fry from redds, Kondolf (2000) recommended calculation of percentages finer than 3, 6, or 10 mm. Then, compare these percentages with values from laboratory and field studies. We selected the gradations less than 2.38 mm and 6.35 mm for analysis. The 6.35 mm was selected in order to make comparisons with survival-to-emergence studies conducted by Weaver and Fraley (1991) for westslope cutthroat trout and bull trout. These investigators found a strong linear relationship between survival-to-emergence and the proportion of fines less than 6.35 mm (Figure G-1 and Figure G-2). These relationships are used here justify the use of numeric endpoints by comparing impaired reaches to reference reaches to develop numeric targets for desired survival-to-emergence based on percent fines.

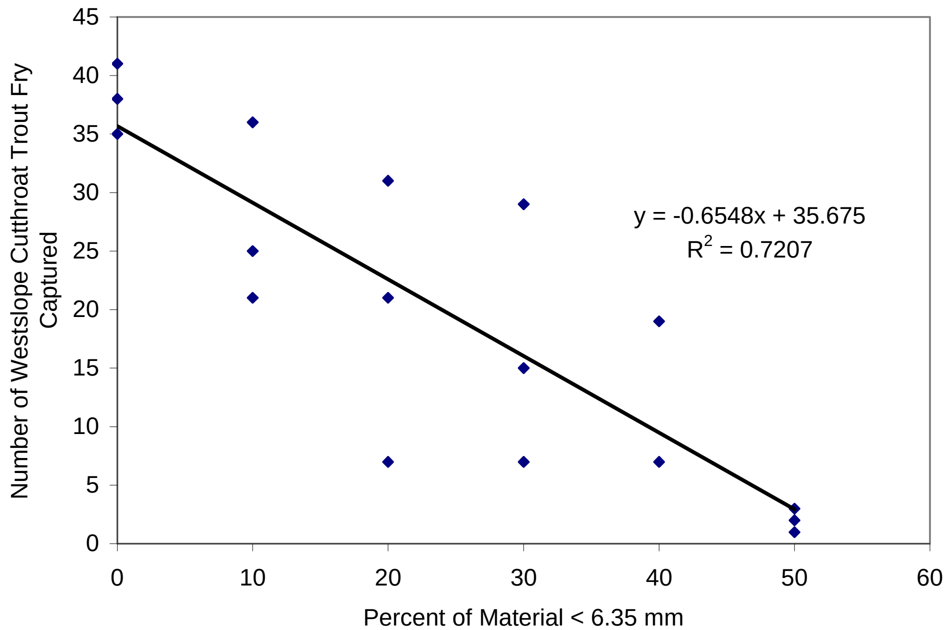

Figure G-1. Relationship Between Numbers of Westslope Cutthroat Trout Fry Successfully Emerging from Replicates of Six Gravel Mixtures and the Percentage of Material Smaller Than 6.35 mm in Each Mixture (Weaver and Fraley, 1991).

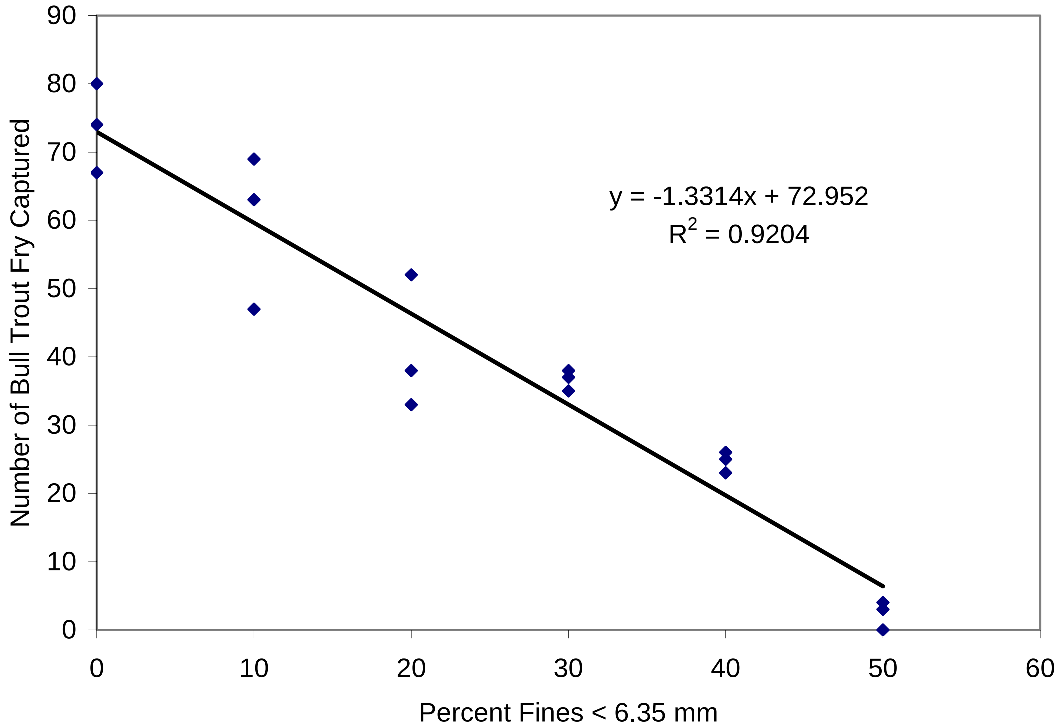

Figure G-2. Relationship Between Number of Bull Trout Fry Successfully Emerging from Replicates of Six Gravel Mixtures and the Percentage of Material Smaller Than 6.35 mm in Each Mixture (Weaver and Fraley, 1991).

The nature of the available data precluded assessment of other considerations in evaluating spawning gravel quality recommended by Kondolf (2000). These considerations include accounting for cleaning of gravels during redd excavation, accounting for accumulation of fine sediments during incubation, and effects of hydrologic events on bed composition. We assumed these would not result in a net change in substrate composition from excavation to emergence, and if there were any changes, they would be consistent between streams being evaluated and reference streams. Another recommendation was to assess intra-gravel flow within a pool tail. This requires detailed information on flow level, channel bed geometry and may be influenced by large-scale groundwater circulation patterns. The lack of data to assess fully these conditions precluded assessing this consideration as well, although this is partly addressed by the assessment of fines less than 0.85 and 2.38 mm.

A final step was development of targets for percent fines. To develop numeric criteria for TMDL targets we evaluated fine sediment levels from all available core samples of tributary streams in the Blackfoot Headwaters Planning Area and nearby drainages provided by the Helena National Forest. Then, we ranked each stream based on median values of the < 6.35 mm gradation. The five streams with the lowest median values were designated as least impaired streams to be used for reference conditions and became the basis of targets for tributaries in the Blackfoot Headwaters Planning Area (reference Section 1.4).

Results and Discussion

Reference Conditions

Generation of distribution statistics for percent fines < 6.35 mm in tributary streams in the Blackfoot Headwaters Planning Area and nearby drainages indicates high variability in proportions of fine particles among streams (Figure G-3). Percent fines < 2.38 mm showed similar trends to the percent fines < 6.35 mm for most streams (Figure G-4). The exception was Poorman Creek, which had proportionally less particles in the 2.38 mm gradation than the 6.35 mm. This suggests that fine sediment may not present a constraint on incubation of eggs in Poorman Creek; entombment of fry is a potential impairment.

Dry Creek, Buffalo Creek, the Blackfoot River above the Landers Fork, Copper Creek, and Humbug Creek ranked as the streams with lowest median fines less than 6.35 mm. These five streams were therefore used to represent least impaired or reference conditions for other streams. The 25^{th} percentile for these five streams was 19.3%, the median 24.5%, and the 75^{th} percentile was 29% (Figure G-5). The TMDL target based on this assessment is median values will not exceed the 75^{th} percentile of the reference streams, or 29%. The use of the 75^{th} percentile instead of the lower median value is in recognition of the natural variability around percent fines measures and target conditions. Based on distribution statistics for particles < 2.38 mm, the 75^{th} percentile for the reference streams is 15% (Figure G-6). Similarly, for particles less than 2.38 mm in diameter, median values should not exceed the 75^{th} percentile of the reference streams, or 15%.

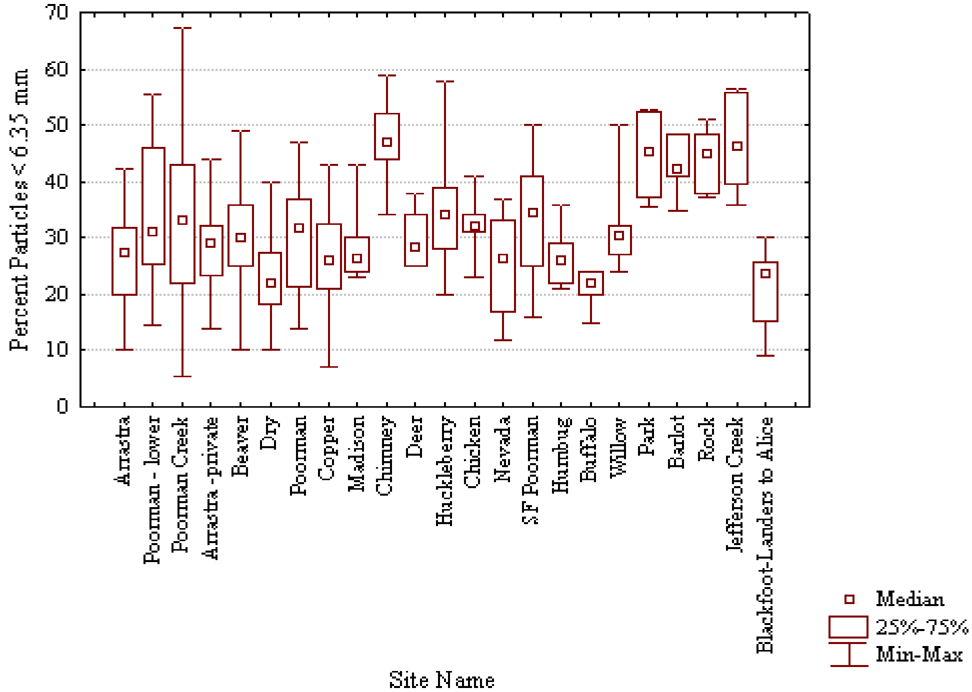

Figure G-3. Distribution Statistics for Percent Fines < 6.35 mm Measured on Tributary Streams in the Blackfoot River Drainage (Unpublished Data). Note that the Willow Creek in this Dataset is not the 303(d) Listed Stream.

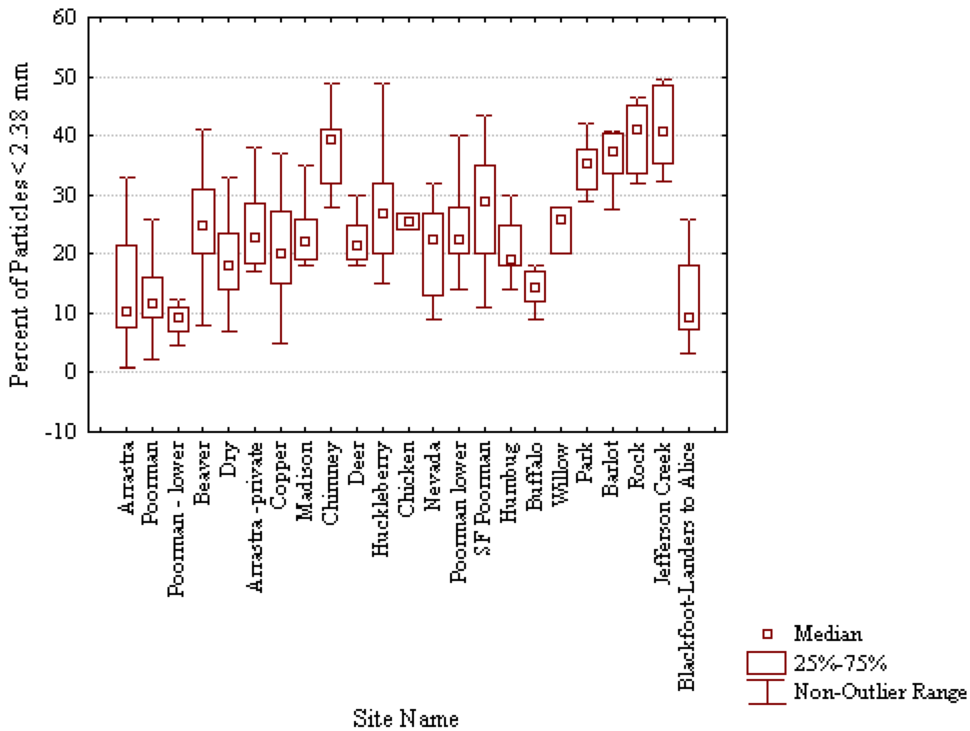

Figure G-4. Distribution Statistics for Percent Fines < 2.38 mm Measured on Tributary Streams in the Blackfoot River Drainage (Unpublished Data). Note that the Willow Creek in this Dataset is not the 303(d) Listed Stream.

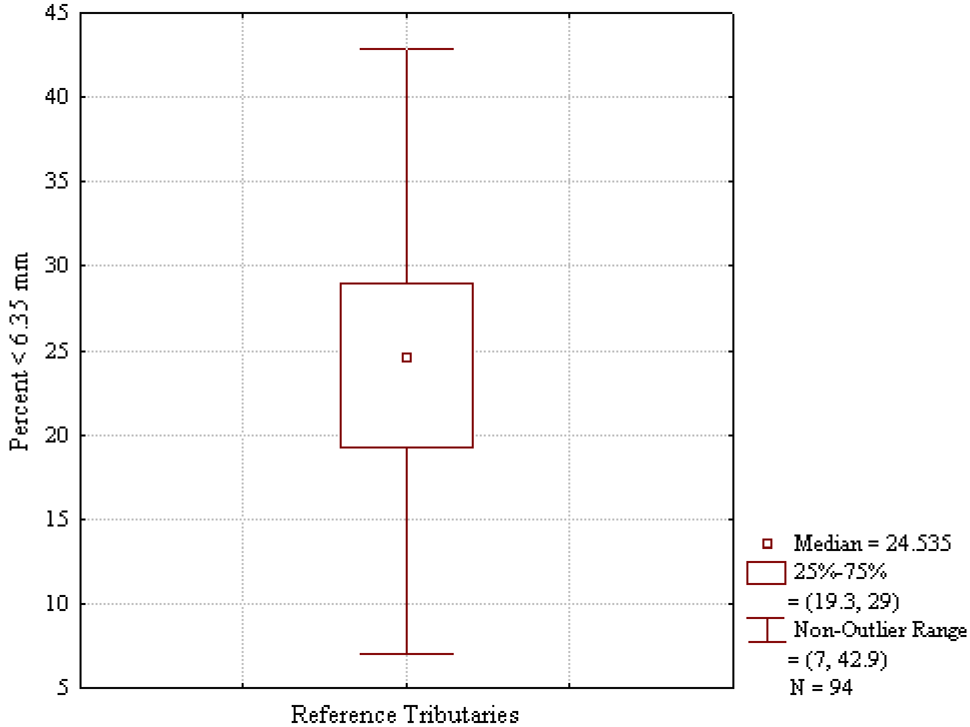

Figure G-5. Distribution Statistics for Percent Particles < 6.35 mm in Reference Streams in the Blackfoot River Drainage.

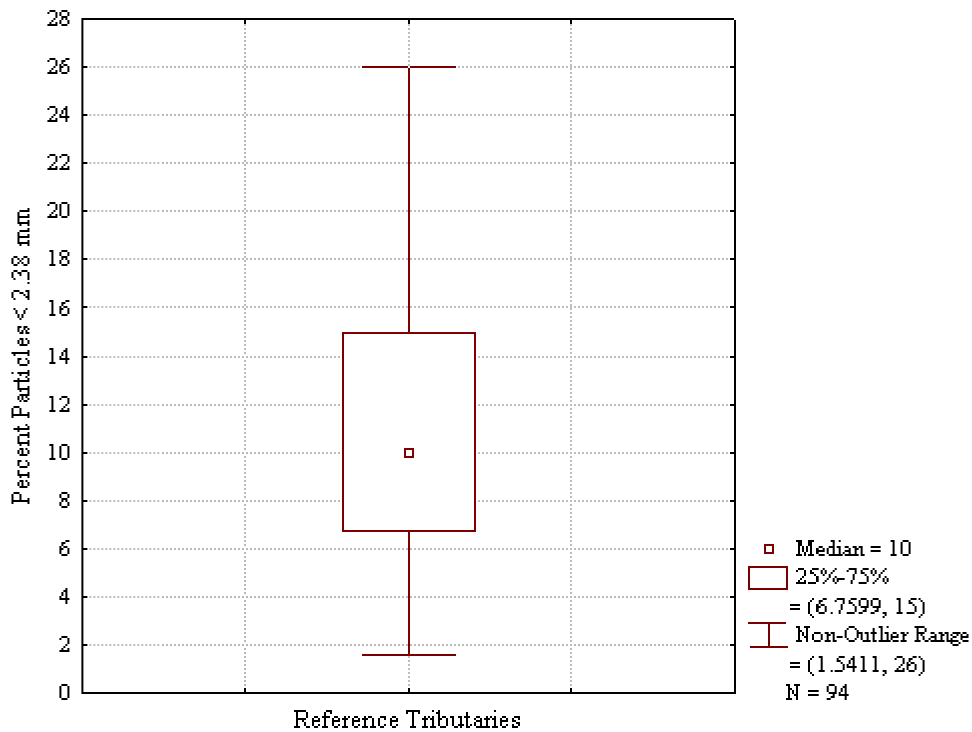

Figure G-6. Distribution Statistics for Percent Particles < 2.38 mm in Tributary Streams in the Helena National Forest.

Blackfoot River (Above Landers Fork)

Core samples collected on this reach of the Blackfoot River indicate relatively low levels of fine sediment in the most recent samples (Figure G-7 and Figure G-8). For the 6.35 mm gradation, the median was less than the 75th of the reference streams in all years. In fact, this segment of the Blackfoot River was used as a reference stream, suggesting that fine sediment does not impair beneficial uses in this portion of the Blackfoot River. For the 2.38 mm gradation, the median was substantially less than the 75th percentile of reference streams in the most recent two sampling events indicating full support. In 1986, this gradation exceeded the target considerably. It is difficult to determine the reason for these relatively high numbers; however, it may relate to the tailings dam failure in 1976. The lower values may reflect flushing and recovery from this event.

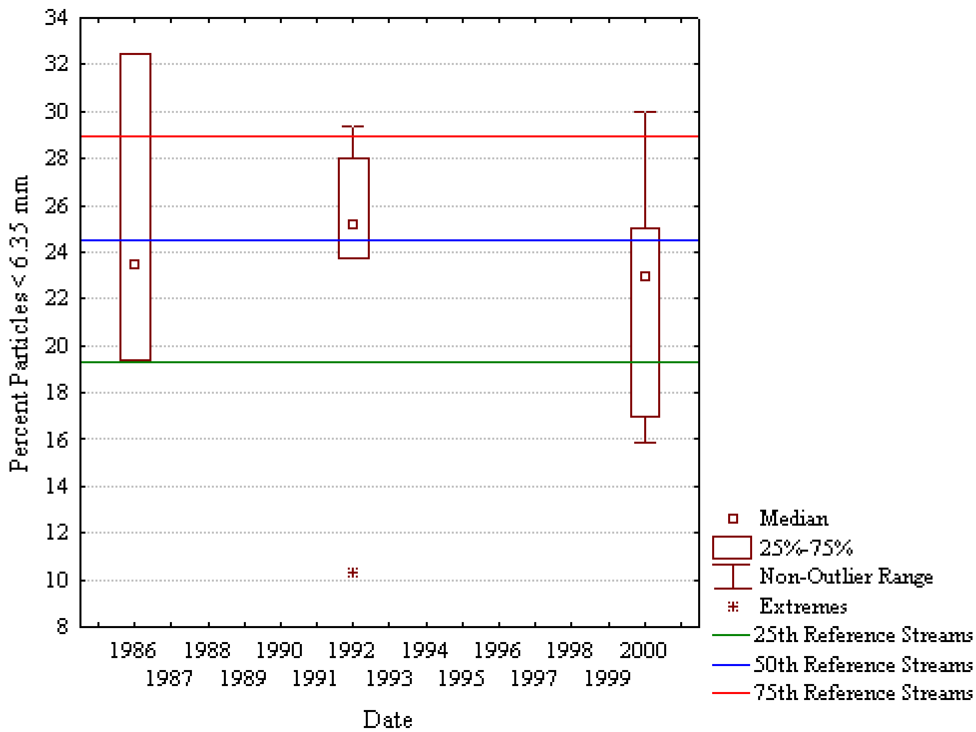

Figure G-7. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 6.35 mm Measured on the Blackfoot River Above Landers Fork.

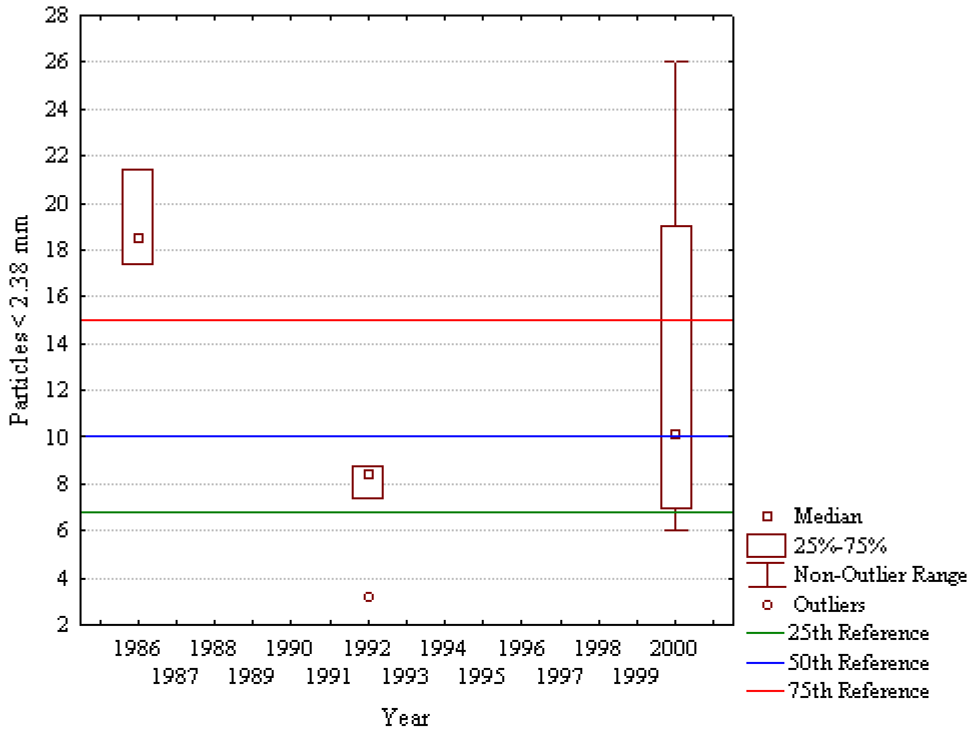

Figure G-8. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 2.38 mm Measured on the Blackfoot River above Landers Fork.

Blackfoot River (Landers Fork to Nevada Creek)

USFS personnel have collected core samples at three locations on the Blackfoot River in the Landers Fork to Nevada Creek reach. Sampling occurred from the mid-1980s to 2000 with over 200 samples collected. Box and whisker plots generated from these data indicate that proportions of fine sediment in this reach of the Blackfoot River are at levels below the target conditions indicating harmful conditions to incubating eggs and embryos (Figure G-9 and Figure G-10). Moreover, there is an apparent trend of increased levels of sedimentation starting in the mid-1990s and persisting to 2000. The proportions of particles < 2.38 mm are highest at the Nevada/Ogden reach reflecting the high proportions of fine sediment observed during field investigations.

Criteria developed for tributary streams in this analysis should be applied to mainstem reaches with caution. These reaches tend to have finer bank materials and therefore naturally entrain a greater proportion of fine sediment. However, because mainstem sites demonstrated levels comparable to proposed targets for tributary streams, in some years, these targets are probably attainable for the mainstem of the Blackfoot River. Therefore, the targets established in tributary streams are applied to all stream segments in the Blackfoot Headwaters Planning Area.

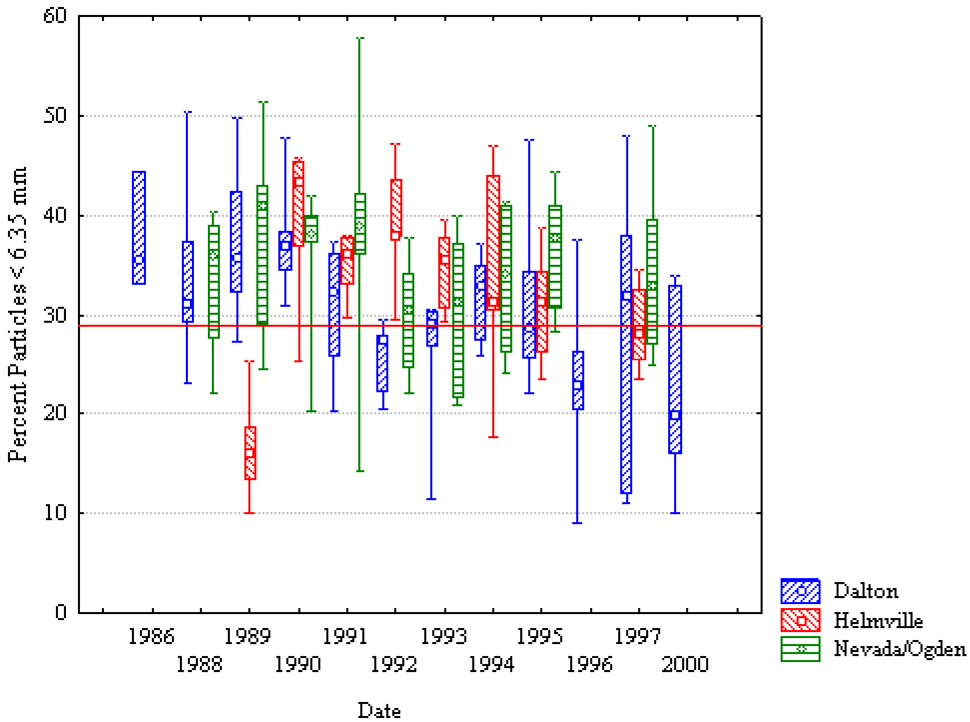

Figure G-9. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 6.35 mm Measured on the Blackfoot River (Landers Fork to Nevada Creek Reach).

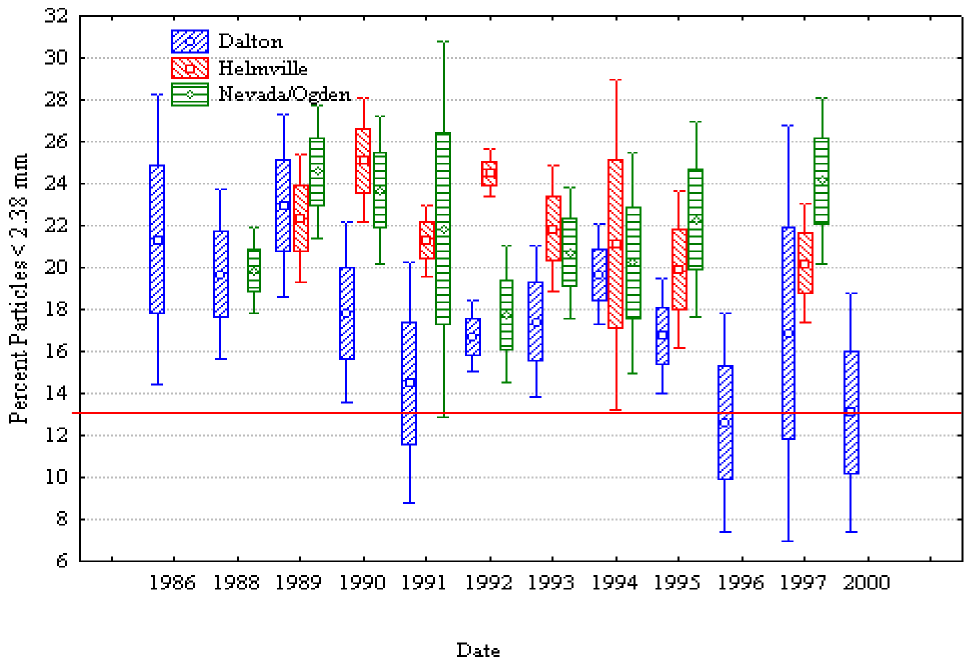

Figure G-10. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 2.38 mm Measured on the Blackfoot River (Landers Fork to Nevada Creek Reach).

Arrastra Creek

Comparison of percent fines in the two gradations indicates percent fines exceed the target levels in some years at two locations in Arrastra Creek. For the 6.35 gradation, the median exceeded the target of 29% at both sampling locations for several years (Figure G-11). Despite an apparent improving trend for this size class, the target was exceeded at the lower sampling site in the most recent sampling year, 2001. For the 2.38 mm gradation (Figure G-12), the target was exceeded twice in eight years of sampling. These data suggest that fine sediment results just barely justify an impairment of beneficial uses based on these target conditions.

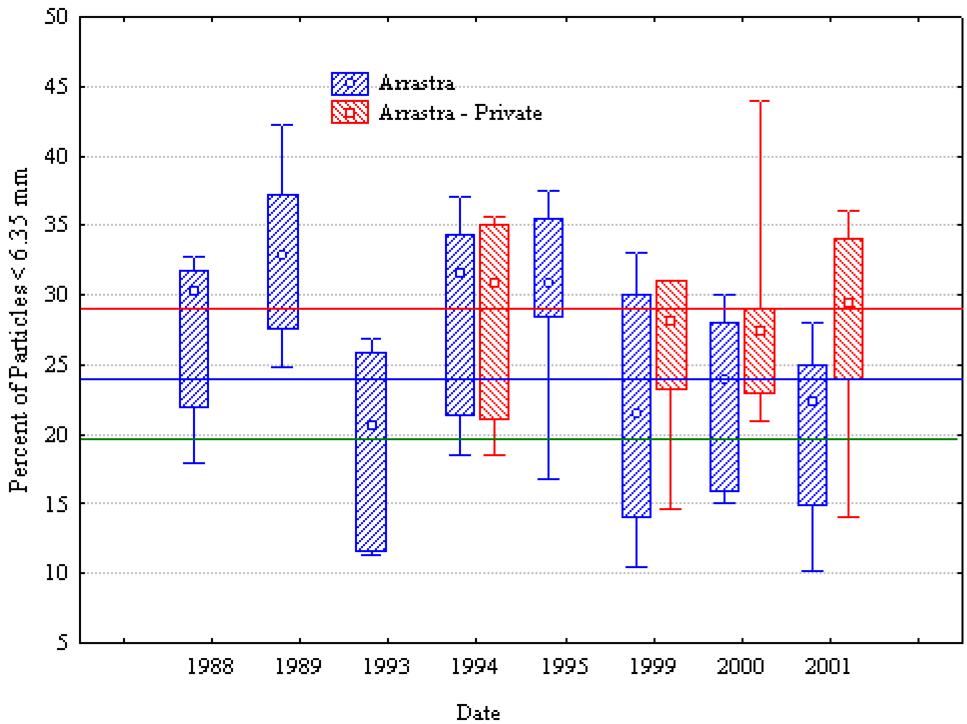

Figure G-11. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 6.35 mm Measured on Arrastra Creek.

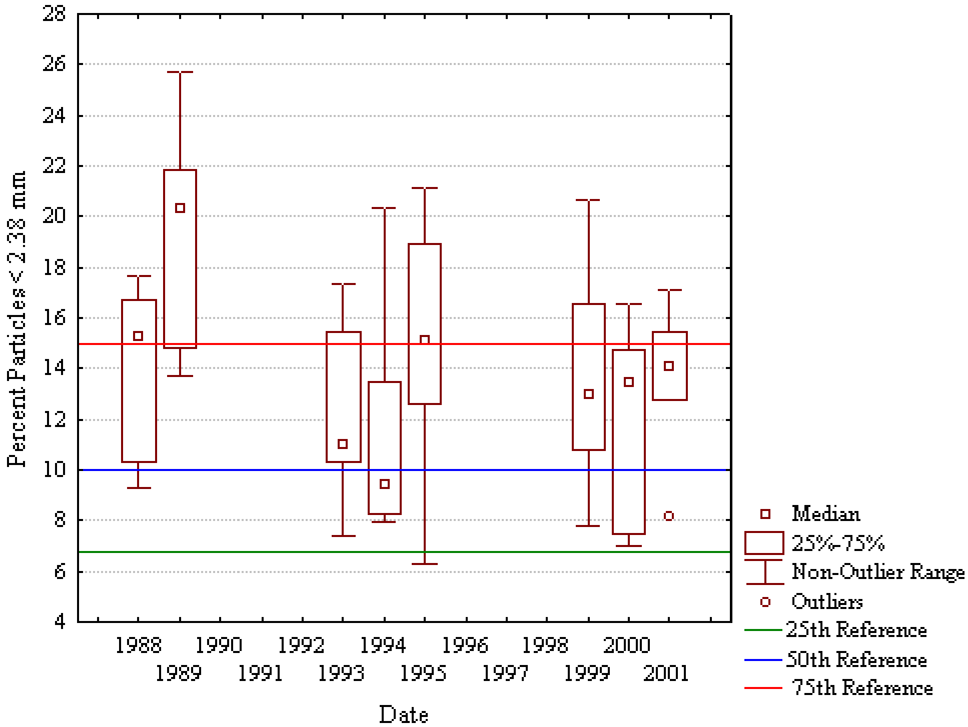

Figure G-12. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less than 2.38 mm Measured on Arrastra Creek.

Poorman Creek

Sediment monitoring in the Poorman Creek watershed includes collection of over 180 samples (Figure G-13). Analyses of these data indicate that fine sediment limits propagation of cold-water fish by substantially decreasing survival-to-emergence through entombment of fry when compared to reference conditions. Proportions of particles less than 6.35 mm were above criteria in most years and at several sampling stations in the basin. In contrast, the 2.38 mm gradation has frequently been within the criteria, especially over the last few years (Figure G-14). Nevertheless, these results corroborate an impairment determination for Poorman Creek for the propagation of salmonids, a designated beneficial use.

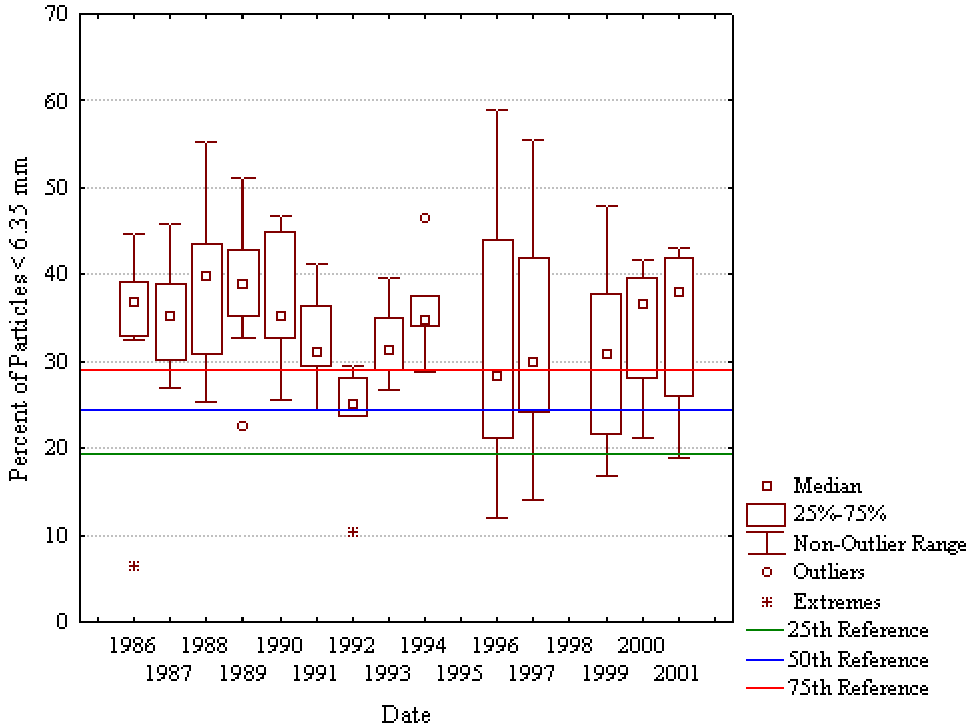

Figure G-13. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 6.35 mm Measured on Poorman Creek.

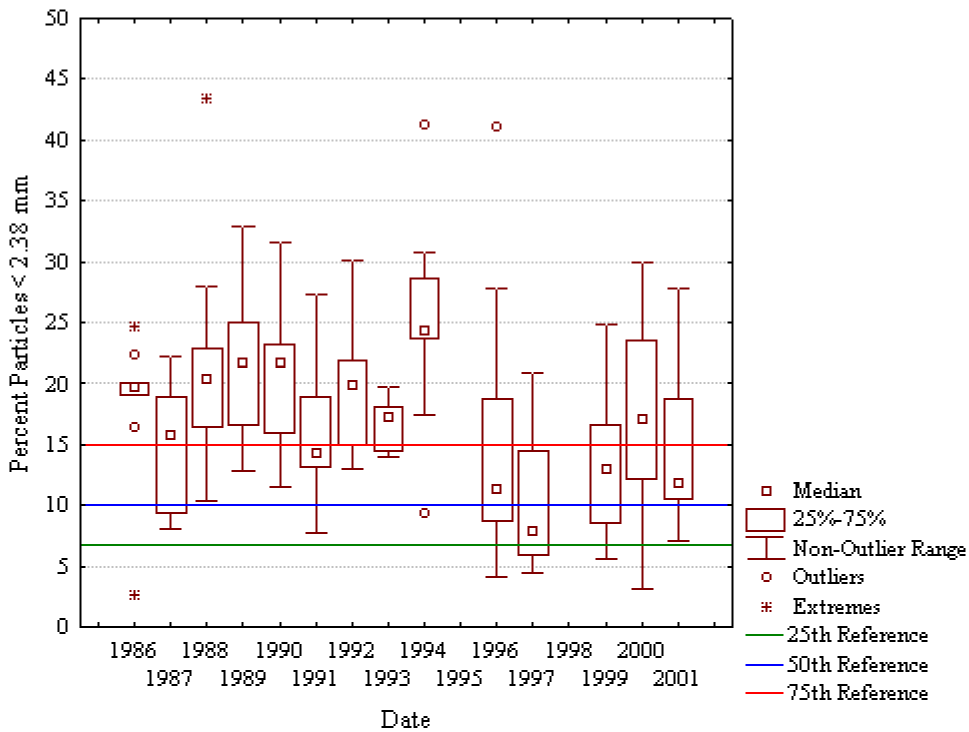

Figure G-14. Distribution Statistics and Criteria Based on Reference Stream Dataset for Particles Less Than 2.38 mm Measured on Poorman Creek.

APPENDIX H
RESULTS OF FISH HABITAT ASSESSMENTS CONDUCTED ON ARRASTRA CREEK

Existing assessments of physical habitat conditions in Arrastra Creek (USFS, unpublished data) provided a quantitative basis for assessing stream conditions and establishing targets. USFS field crews (Helena Ranger District) conducted a fish habitat assessment following protocols described by Hankin and Reeves (1988) on three reaches of Arrastra Creek in 1996. These reaches extended from the confluence with the Blackfoot River upstream approximately 5 miles. Reach 1 began at the confluence with the Blackfoot River, reach 2 began upstream at the confluence with an historic abandoned channel of the Blackfoot, and reach 4 begins at the upstream end of Frenchy's Pond. These data provide a surrogate for the modified EMAP assessments conducted during Phase II field assessments.

Reach 1 was a sedge/rush dominated section with a limited presence of riparian or upland trees. Reach 2 showed an increase in riparian shrubs and upland trees, and Reach 4 exhibited the lowest amount of bare ground and the highest percentage of riparian shrubs, riparian trees, and over story trees (Figure H-1). The presence of riparian trees was small to absent in all reaches, however the riparian shrub community was well developed in both Reach 2 and 4. It is important to emphasize that these data are from a 1996 survey, riparian and upland vegetation conditions are likely to have changed since that time.

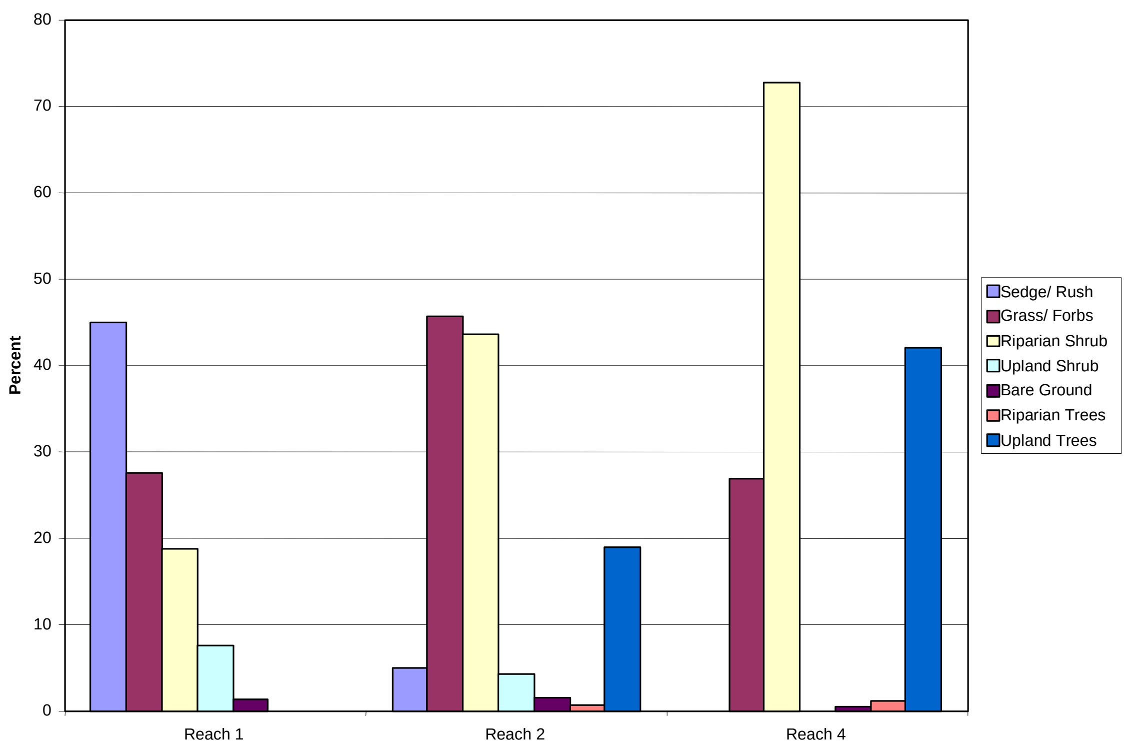

Figure H-1. Riparian and Upland Vegetation Along 3 Reaches of Arrastra Creek.

The banks in Arrastra Creek became progressively more unstable farther downstream. In Reach 4, nearly 100% of the banks were stable and well vegetated (Figure H-2). In contrast, only 50% of the banks in Reach 1 were vegetated and stable, while close to 40% were vegetated but unstable. Each reach exhibited a relatively high proportion of undercut banks, an important attribute for assessing available fish habitat.

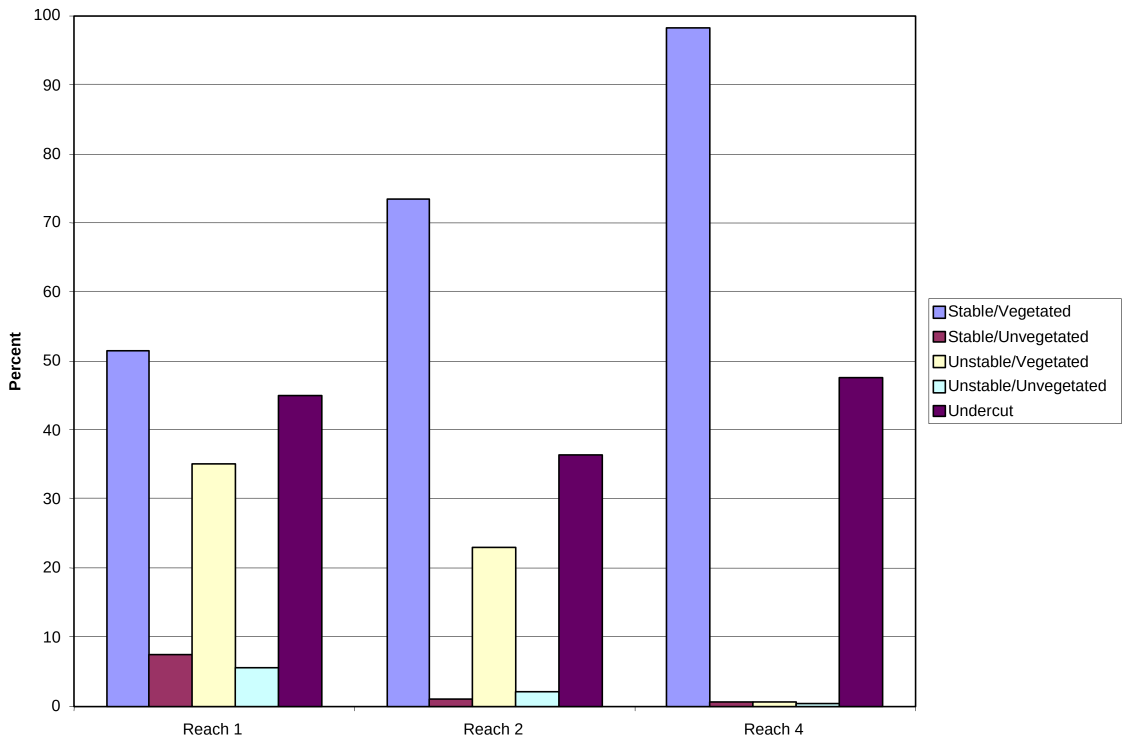

Figure H-2. Bank Stability Conditions (Stable/Vegetated, Stable/Unvegetated, Unstable/Vegetated, Unstable/Unvegetated, Undercut) in 3 Reaches of Arrastra Creek.

Gravel dominated streambed particles in Arrastra Creek, particularly in Reach 2 (Figure H-3). However, Reach 1 exhibited a high percentage of fine material based on pebble counts. Silt and sand accounted for 35% of particles. Upstream, fine material was present only in small quantities. Larger substrate material (rubble, cobble, and boulders) began to appear in Reach 2 and comprised a relatively high percentage in Reach 4.

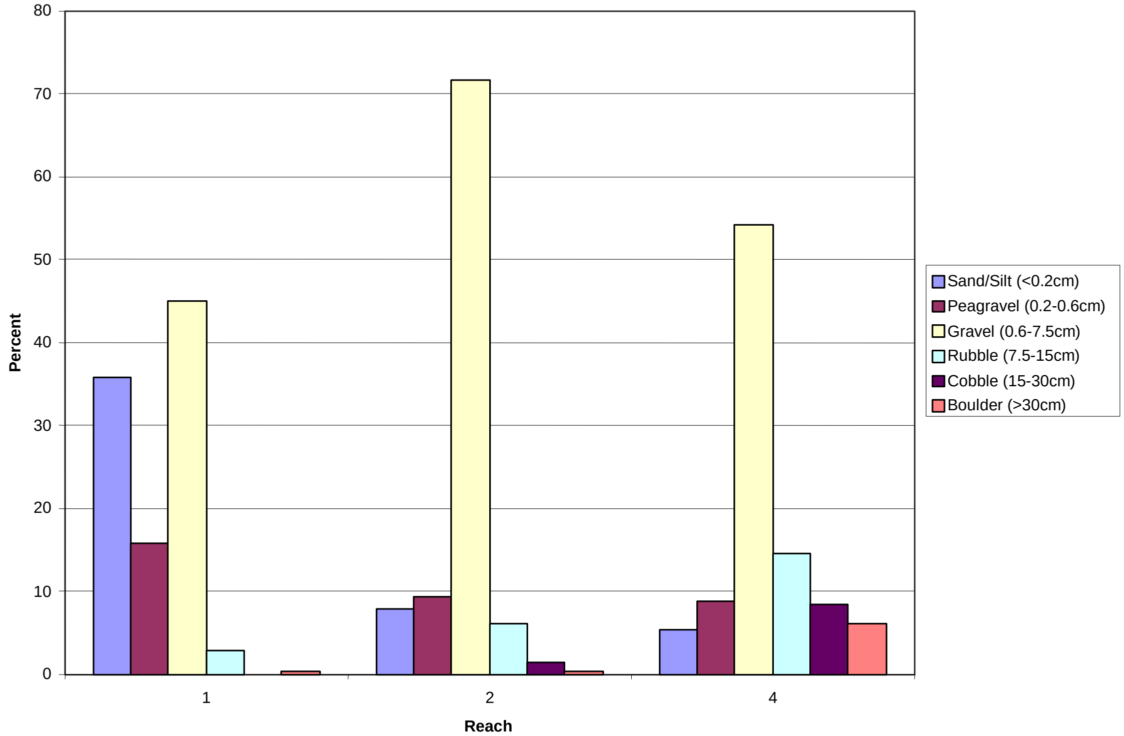

Figure H-3. Substrate Composition Within 3 Reaches of Arrastra Creek.

Fast and slow water habitat types were present throughout the length of the project reach (Figure H-4). The number of fast water habitat types, which included riffles, rapids, and runs were more prevalent in each reach. Slow water habitat types, such as pools, comprised a smaller proportion of the overall habitats in Arrastra Creek.

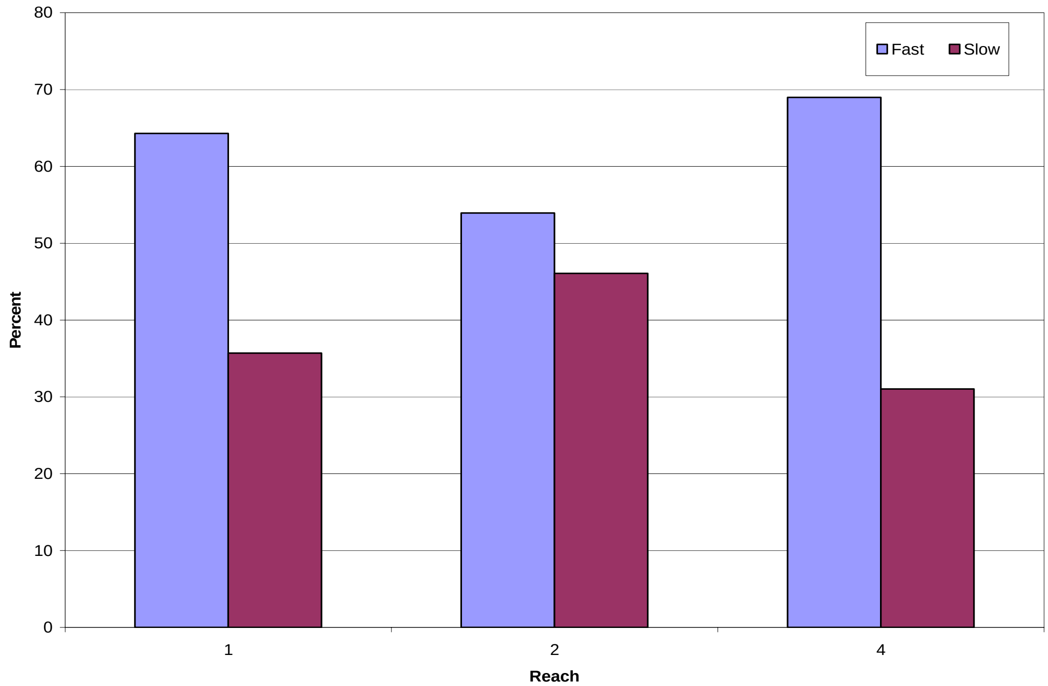

Figure H-4. Number of Fast and Slow Water Habitat Types in 3 Reaches of Arrastra Creek.

Conclusions

In conclusion, increasing the riparian over story component, thereby increasing the overall riparian structural diversity, particularly in Reach 2, will address the unstable and unvegetated bank conditions. Increasing the structural diversity will also increase the stability of those areas with unstable but vegetated banks. Reach 2 and 4 are dominated with high gravel substrate and an excessive bed load. Reach 1 also exhibits high fine sediment substrate, which may be a result of deposition from upstream sources. Improving upstream bank stability will also decrease the amount of sediment available for deposition.

APPENDIX I
LANDERS FORK INVESTIGATIONS

While not a 303(d) listed stream, TMDL planning efforts in the Blackfoot Headwaters Planning Area focused considerable effort to evaluate the role of the Landers Fork in influencing both geomorphology and water quality in the Blackfoot River. Geologic and hydrologic conditions unique to the Landers Fork prompted these investigations. Field observations indicated that the Landers Fork sub-watershed, approximately 131 square miles in area, is a significant contributor of sediment and flow to the Blackfoot River. The geology of the Landers Fork drainage basin includes highly erodible glacial deposits that commonly comprise the valley margin. Landers Fork investigations included field reconnaissance activities and an analysis of sediment transport capabilities.

Estimation of Sediment Transport Capacity of the Landers Fork

To estimate the relative sediment inputs from human and natural sources on the mainstem Blackfoot River, we assessed the sediment transport capacity of the Landers Fork at three locations. The selected sites consisted of one channel segment located just upstream of the Copper Creek confluence, and two locations downstream of the Highway 200 bridge, near the mouth of the channel. A number of activities provided data to support this analysis. The first step was the development of representative hydrology for the sites. Next, we surveyed channel cross-sections and longitudinal profiles at the three locations. We conducted pebble counts at these locations to describe sediment gradations. These data allowed calculations to estimate the average annual sediment transport capacities through each reach.

Daily stream flow data from USGS Gage 12335000 (Blackfoot River near Helmville MT) provided the basis for development a mean annual hydrograph for the sites. This gage, located near the Highway 141 Bridge, was operational from October 1940 to October 1953 and provided a 13-year record of mean daily flows. To scale the gage data to the sites on the Landers Fork, we employed regional regression equations (Omang, 1992) to estimate the 2-yr, 50-yr, and 100-yr peak flows at each site, with the daily flows proportioned based on those discharges. These discharges provided a basis of proportioning daily flows rather than simply drainage area, as the discharge calculations incorporate both precipitation and drainage area.

The estimated peak discharge events are shown in Table I-1. At the mouth of the Landers Fork, estimated peak flows ranged from 38% (2-yr) to 43% (100-yr) of those calculated at the Helmville gage. Just upstream of Copper Creek, the peaks range from 25% (2-yr) to 31% (100-yr) of those at the gage. The maximum-recorded mean daily discharge recorded for the period of record at the Helmville gauge was 5890 cfs in 1943. The estimated 2-year discharge of 3,926 cfs was exceeded a total of 4 days during that 13-yr time period. As such, the mean daily flows were proportioned according to the 2-yr flow relationship.

Table I-1. Flow Estimates Derived from Regional Regression Relationships.

Flow Event	Estimated Discharge (cfs)		
	Helmville Gage	Mouth Landers Fork (% of Gage)	Upstream Copper Cr Confluence (% of Gage)
2-yr	3926	1476 (38%)	993 (25%)
50-yr	15875	6274 (40%)	4450 (28%)
100-yr	20442	8700 (43%)	6345 (31%)

Mean annual hydrographs calculated for cross sections on the Landers Fork. The mean annual hydrographs determined for the cross section locations are shown in Figure I-1. The plot shows the mean daily discharges derived from the 13-year period of record, and proportioned to each site. These estimated mean daily flow values were then utilized to estimate the average annual sediment transport capacity at each cross section.

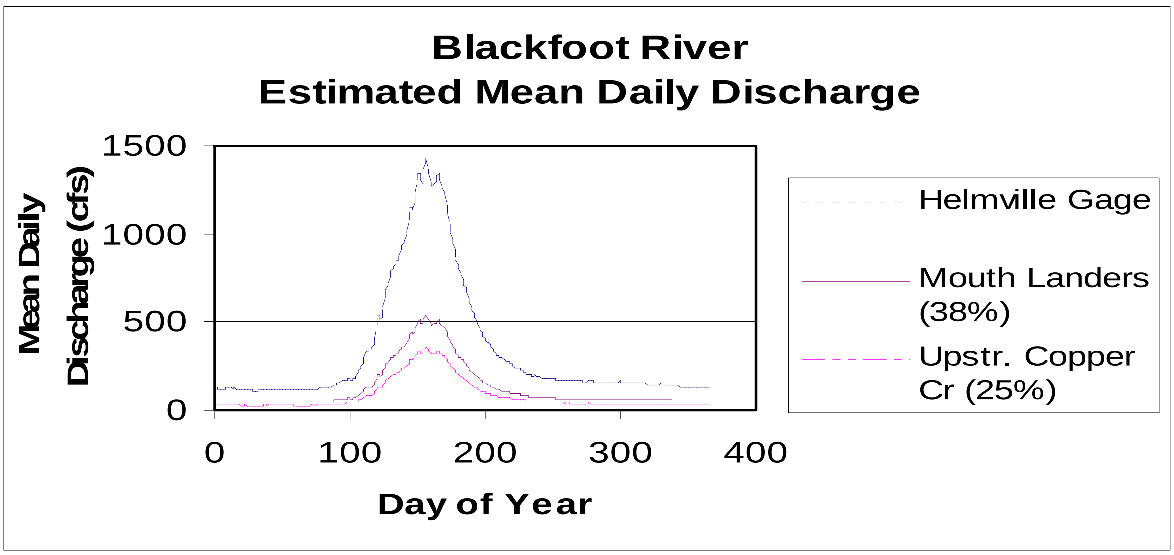

Figure I-1. Estimated Mean Annual Hydrographs for Cross Section Sites Based on Proportioned Helmville Gage Data.

In order to estimate the sediment transport capacity of each site, we utilized an at-a-station hydraulics software package, WinXSPRO, to determine hydraulic and sediment transport energy associated with each cross section/profile configuration. Next, we developed a sediment discharge rating curve (sediment transport rate vs. discharge) using the Meyer-Peter-Mueller transport function and bulk sediment gradation measurements. The annual flow hydrographs were then utilized to calculate daily transport volumes, and those cumulative daily transport volumes generated an average annual transport capacity estimate. See Table I-2 for results of the sediment transport capacity analysis.

Table I-2. Estimated Annual Sediment Transport Capacities, Landers Fork Cross Sections 1-3.

Cross Section	Location	DA (sq mi)	DA (acres)	Slope	D84 (bed) (mm)	D50 (bar) (mm)	Sed trans capacity (tons/yr)	Comments
1	Upstream of Copper Creek	84	53505	1.7%	90	16	1180227	Steep/Supply limited
2	Downstrea m Highway 200	131	83722	0.5%	100	16	173032	Transport Reach
3	Downstrea m Highway 200	131	83722	1.0%	100	9	1367844	Steep/Supply limited

The results of the assessment of sediment transport capacity include a range of transport volumes of approximately 173,000 to 1.4 million tons per year. These volumes reflect the capacity of the channel to convey sediment, but do not directly address the volume of sediment delivered. Finally, the results indicate that if large volumes of sediment are delivered to the Landers Fork channel there is sufficient transport energy available in the Landers Fork to convey that sediment to the Blackfoot River.

Field Reconnaissance

Field reconnaissance of the Landers Fork occurred concomitant with the 2002 field assessments. Activities included an erosion inventory supplemented with visual estimates of riparian cover and human influence. Field personnel used methodologies similar to those used for the modified EMAP assessments, with reduced rigor due to the extensive reach length. The assessed reach included the whole portion of the Landers Fork from the mouth to about ¼ mile above the Forest Service boundary at Forest Service Trail #438. The observers also recorded extensive field notes including observations of identifiable impairments and potential remedies. To further aid in interpreting field conditions, they viewed historic aerial photos that captured the impacts of a large flood event occurring sometime between 1937 and 1996, possibly in 1964. The objective of these investigations was to determine the relative roles of human activities, natural disturbance, or other natural factors in influencing the sediment load contributed to the Blackfoot River from the Landers Fork. If human activities were a significant factor in influencing sediment loading, this would have implications for impairment determinations and the ability to improve habitat conditions in both the Blackfoot River and the Landers Fork.

Comparison of the historic aerial photos suggests that a large flow event occurring in the mid-1960s resulted in significant alteration in geomorphology and floodplain vegetation. Note that several drainages in the region, such as the Teton River, experienced a 500-year event in 1964 that resulted in extensive alteration of channel morphology. On the Landers Fork, the photos from 1937 showed a relatively narrow active channel with bars well vegetated with trees for an upstream section near the current wilderness boundary. By 1966, the channel and vegetation characteristics changed dramatically. The active channel became considerably wider with bare, depositional bars along most of its length. Significantly, these alterations occurred in areas where human activities were negligible suggesting that many of the conditions that persist to this day were the result of natural disturbance in the basin. Nevertheless, the photos did indicate that some riparian harvest had taken place historically in some sections located further downstream.

Bank erosion is a significant source of sediment loading in the Landers Fork and was therefore a focus of the 2002 field assessment. The observers encountered 12 very large eroding banks mostly in the upper assessed reaches on the Landers Fork with each rating as severely eroding. Furthermore, review of aerial photos indicated that these types of eroding banks were common features in the upper reaches of the Landers Fork above the reach assessed in 2002. Fine sediment comprised between ¼ and ¾ of the particles contributed from the 12 banks, while cobbles and gravels were stored in aggradational areas. The observers rated each of these banks as major contributors of fine sediment. However, since these banks occurred where the stream abutted deposits of glacial till and were typically not associated with causative human activities, their sediment contributions were likely natural.

In addition to terrace banks comprised of highly erodible glacial till, field observers mapped and extensive number of additional eroding banks along the assessed reach and noted human influences in proximity of these banks. While human activities, notably livestock grazing, were likely causing increased bank erosion in some locations, the overall obvious contributions from human activities were likely nominal compared to the eroding terraces. Still, implementation of BMPs as part of the overall plan for the watershed should address the relatively minor contributions from eroding banks and help reduce overall loading to the Blackfoot River.

An overall conclusion of reconnaissance investigations on the Landers Fork was that the stream channel lacked woody debris and complex habitat features for fish. There were few deep pools and cover in the form of overhanging banks, riparian vegetation, and/or large woody debris was lacking. The exception was the reach of the Landers Fork downstream from the confluence of Copper Creek and upstream from the Highway 200 Bridge, which appeared to have some of the best pool habitat and a greater concentration of large woody debris. Other impacts identified by the 2002 reconnaissance team included impacts from three bridges and presence of noxious weeds, primarily knapweed.

Activities following floods during the mid-1960s and beyond may have had impacts on channel morphology, sediment transport, and fish habitat. Long time residents report that following these flood events, the Army Corps of Engineers commissioned removal of woody debris and dozing in both the Landers Fork and the aggraded reach of Blackfoot River to facilitate sediment transport in these streams (Ron Pierce, MFWP, personal communication). Note that during this period, fish habitat concerns were not a major consideration in river management. The long-term impacts from these channel alterations on channel form and function is unknown. Review of the bridge design and investigation of management practices to maintain these bridges (i.e. dredging with heavy equipment) are recommended actions to better assess the impacts of bridges. Furthermore, these investigations may shed light on the impact of channel dozing and woody debris removal conducted following the flood of 1964.

Due to the importance of the Landers Fork as a migration corridor for bull trout spawning in Copper Creek, a number of additional assessments and management activities are warranted. For example, monitoring of flow characteristics is recommended to provide information on connectivity for fish passage. Furthermore, the aggradational nature of this stream requires additional investigation. The extent that current aggradational processes can be attributed to the large flood event as well as the above-mentioned management practices is still uncertain, although these aggradational processes apparently contribute to subsurface flows. Coincidentally, a review of historical records indicates that flow conditions today are better than they were in the 1970s (Hagan, 1976). These increased flows are perhaps an indication of recovery from the heavy-handed "maintenance" from earlier years.

Another significant concern regarding human related impacts and/or threats on the Landers is associated with the dynamic nature of this laterally mobile channel. Comparison of field conditions in 2002 with the 1995 aerial photos indicated significant lateral movement at numerous locations in recent years. In some locations, the stream was moving toward clear-cut areas within the floodplain, which would result in less bank stability and a prolonged period of higher sediment loading for these reaches. As noted previously, aerial photos indicated some historical riparian harvest as well as significant logging activities within the stream corridor. This suggests that the existing streamside management zone requirements for a highly meandering system such as the Landers Fork do not provide adequate protection over the long term. Finally, noxious weed control was also recommended remedy to promote the overall health of the system.

Conclusions

The Landers Fork has considerable effect on the nature of the Blackfoot River below its confluence. From a water quality standards viewpoint, it is important to determine whether this influence is predominately "natural" or due to human-caused disturbance in the basin. A number of activities in the basin have the potential to increase sediment loading over natural including roads, bridges, timber harvest, and livestock grazing. However, these analyses support attributing geologic conditions and natural disturbance as the overwhelming influences on the Landers Fork. As a result, most of the load to the Blackfoot River from the Landers Fork is considered as natural, thus influencing fisheries habitat expectations in some of the Blackfoot reaches exhibiting significant negative impacts from Landers Fork. Also, sediment TMDL development is not required for the Landers Fork, consistent with the finding of full support of beneficial uses on the 2002 303(d) list. Still, there is potential for improvement or mitigation of existing and potential future human-related impacts through the provisions for water quality improvement included in this plan. These provisions include allocations developed in Section 5 and implementation measures in Section 6. Furthermore, as discussed in Section 8, impacts from bridges or other human activities should be closely scrutinized to evaluate and promote connectivity between the Blackfoot River and bull trout spawning grounds in Copper Creek, and to further verify the full support condition for Landers Fork.

APPENDIX J
ROAD SURFACE SEDIMENT ANALYSIS

The Helena National Forest and Plum Creek Timber Company conducted detailed analysis of sediment contributions from roads in a few select drainages in the upper Blackfoot River watershed (Helena National Forest and Plum Creek Timber Co., unpublished data, 2002). This analysis focused on surface erosion from roads including cut slopes, fill slopes and the roadbed. The analysis does not cover impacts from culvert failure, water routing/increased flows, or increased potential for mass wasting. Plum Creek and Helena National Forest personnel estimated loading from a subset of the analysis area on roads these entities controlled, and determined the average sediment delivery per mile of road. This average sediment delivery rate of 0.26 tons/mile of road was then applied to all roads within the portions of the study area where the majority of roads are unpaved forest roads. The actual sediment delivery rate may be underestimated in places since the Forest Service and Plum Creek already had a generally high level of BMP implementation, whereas the level of BMP implementation on small private and county roads was not evaluated for this assessment.

Table J-1 below lists results of road sediment delivered by sub-watershed. Based on this analysis, roads deliver a total of 302 tons/yr of sediment to tributary streams and ultimately to the Blackfoot River. Of this amount, 150 tons/yr are delivered to upstream reaches of the Blackfoot and 152 tons/yr are delivered directly to the lower reach from Poorman Creek to Nevada Creek, although all 302 tons have the potential to eventually reach this lower reach of the Blackfoot River.

Table J-1. Road Sediment Yields Listed by Sub-Watershed.

	Miles of Road	Road Density (length of road/mi2)	Sediment Delivery tons/yr
Arrastra Creek	73.73	3.10	19
Beaver Creek	40.42	2.25	11
Humbug Creek	65.42	2.50	17
Keep Cool Creek	72.50	5.10	19
Landers Fork	160.88	1.23	42
Lincoln Gulch	40.54	3.40	11
Mineral Hill	6.73	2.94	2
Moose Creek	20.65	1.76	5
Patterson Prairie	51.19	5.02	13
Poorman Creek	85.31	2.08	22
Sauerkraut Creek	58.92	4.12	15
Stonewall Creek	63.04	2.33	16
Upper Blackfoot	371.65	3.22	97
Willow Creek	71.12	3.84	18
Willow Creek 303(d) list	59.19	3.06	15

APPENDIX K
USFS ROAD INVESTIGATIONS IN POORMAN CREEK

Due to concerns regarding the potential of roads to contribute fine sediment to surface waters in the Poorman Creek drainage, the USFS conducted a number of investigations to guide remedial activities. These investigations occurred in the mid-1990s and involved identification of locations where roads deliver sediment to streams, locations of undersized culverts at risk of washing out, and prescriptions to rectify the observed conditions. This section summarizes several memos from the Helena National Forest fisheries biologist to the Lincoln District Ranger in July and November of 1996. Since this work was completed, concern for sediment delivery into Poorman Creek lead to a request for Federal Highways funding for paving at least a portion of the Poorman road. That effort is ongoing.

The first memo (July 31, 1996) described proposed road improvements for South Fork Poorman Creek. There were several problems identified on this tributary including delivery of sediment from road fords and road drainage as well as barriers to fish passage at culverts. The impetus for these investigations was a large-scale proposal to treat vegetation within the entire Poorman Creek drainage. Analyses associated with this project indicated the South Fork of Poorman Creek was important in conservation of both westslope cutthroat trout and bull trout. This memo described specific road improvements proposed to address sediment loading and fish barrier issues. See Table K-1 for a description of these improvements and their status as of December 2003.

Table K-1. Road Improvements Proposed for the South Fork of Poorman Creek Watershed and Update of Status (Laura Burns, Fisheries Biologist, USFS).

Location (Mileage from intersection of South Fork Road with Stemple Road)	Identified Problem	Delivered Sediment tons/year	Proposed Action	Status as of December 2003
0.001 (site #33)	Undersized culvert on Poorman Creek and partial fish passage barrier	0.01	Replace per INFISH	Culvert was replaced with a bridge in late summer of 2003
0.1 (site #34)	Undersized culvert and fish passage barrier	0.34	No action as barrier was desirable for prevention of colonization of brook trout	Culvert is no longer a barrier and should be replace per INFISH1 Culvert was replaced with a bridge in late summer of 2003

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Table K-1. Road Improvements Proposed for the South Fork of Poorman Creek Watershed and Update of Status (Laura Burns, Fisheries Biologist, USFS).

Location (Mileage from intersection of South Fork Road with Stemple Road)	Identified Problem	Delivered Sediment tons/year	Proposed Action	Status as of December 2003
1.7 (site #41)	Undersized culvert and fish passage barrier	0.02	Installation of larger pipe with baffles	Completed
2.5 (site #42)	Undersized culvert and fish passage barrier	0.007	Install 36 to 42 inch arch pipe, filling of existing road ruts	Completed
2. (site #43)	Unreinforced ford		Install adequately sized culvert with baffles	Completed
2.5 – 2.7 (site #43)	Heavily rutted road		Erosion control to divert water off road	Completed
2.8 (site #43)	Poorly drained road	0.78	Provide road drainage to eliminate water delivering sediment to road crossing at mile 2.7	Completed

The next memos, dated November 14 and November 18, 1996, provide details of a similar investigation on Poorman Creek (Table K-2). These memos detail estimated sediment load from roads, culverts at risk of wash out during high flows, and culverts that present barriers to fish movement. The first table is a list of sediment delivery sites located along roads in the Poorman drainage. The amount of sediment predicted for delivery as each site was calculated using a field-applied model from The Guide for Predicting Sediment Yields from Forested Watersheds (Cline et al., 1981). The second table is an investigation of the culverts in the Poorman drainage including culvert capacity and ability to provide fish passage. Based on this investigation, the surveyed roads contribute over 7.6 tons of sediment per year to the Poorman Creek watershed. Note that completed remedies have decreased that amount in some places.

Table K-2. Sources, Estimated Sediment Loads, and Proposed Remedies to Decrease Sediment Loading to Poorman Creek from Roads.

Site Number	Mile	Identified Problem	Fish Barrier?	Delivered Sediment (tons/year)	Proposed Remedy	Status
1	Start at Helena Forest sign.1 mile from section 7 and 8 boundary T 13N R 8W 0.0	Stream abuts road fill	yes[2]	0.05	Use larger riprap material, ensure road grading does not disturb soil	
2	0.2	Road close to stream, blading practices		0.02	Install road delineators, improve blading practices	
22	0.3	Road borders stream, blading practices		0.02	Install road delineator, avoid grading material where it can wash into stream	
3	0.8	Stream close to road under old harvest unit, blading concerns		0.02	Install road delineators, improve grading practices, install silt fence	
4	1.2	Culvert, blading		0.18		
5	2.0	McClellan culvert, blading		0.06	Install road delineators, improve grading practices	
6	2.6	Bottomless culvert, soil disturbance, beaver/ water table problems, blading, culvert at risk of washout	No	0.03	Remove existing beaver dam	
6a		Improve blading practices				
7	5.1	Road crossing, blading		0.05		
8	5.1	Ditch drainage		0.34		
9		Road drainage at Little Davis culvert		0.33		

2 This fish barrier is desirable to prevent encroachment of brook trout.

Table K-2. Sources, Estimated Sediment Loads, and Proposed Remedies to Decrease Sediment Loading to Poorman Creek from Roads.

Site Number	Mile	Identified Problem	Fish Barrier?	Delivered Sediment (tons/year)	Proposed Remedy	Status
10	6.3	Multiple culvert crossing, blading practices, road drainage		0.32	Install road delineators, improve blading practices	
10a	6.7	Intermittent side drainage and cross drain, hillside erosion, road ditch drainage		0	Install silt fence below culvert outlet	
11	7.6	Culvert needs repair, blading practices, road drainage		0.03	Install road delineator at crossing, improve blading practices	
12	8.0	Road slope drains to stream, blading practices		0.06	Install road delineators, improve blading practices	
13	8.25	Road drainage to stream, blading practices		0.09		
14	8.35	Undersized culvert, road drainage		0.03		Culvert removed, road closed
15	8.5	Road drainage, blading practices		0.15		
16	8.55	Direct blading of material into stream, encroachment on channel		0.03		
17	8.6	Road crossing, erosion from old road fill		0.01		
18	8.7	Road drainage into wetland		0.09		
19	8.8	Culvert crossing, blading practices, culvert too short		0.01	Replace of repair culvert	

Table K-2. Sources, Estimated Sediment Loads, and Proposed Remedies to Decrease Sediment Loading to Poorman Creek from Roads.

Site Number	Mile	Identified Problem	Fish Barrier?	Delivered Sediment (tons/year)	Proposed Remedy	Status
20	9.1	Culvert crossing, extreme sediment delivery site from ditch and road drainage, blading practices, culvert too short		1.51		Culvert replaced with passage
21	9.6	Culvert crossing tributary, blading practices, road drainage, erosion from FS side of road		0.40		Cross drain culverts were installed
23		Fields Gulch culvert crossing		0.02		
23a		Ford on side tributary to Fields Gulch		0.		
24		Erosion at Baldy Culvert Crossing		0.16		
25		Culvert crossing		0.005		
26		Erosion from Silver Bell Mine Road		0.003		
27		Erosion from Silver Bell Mine Road		0.01		
28		Davis Gulch Road Fill exposed adjacent to stream		0.03		
29		Road drainage to tributary		0.08		
30		Seep wasting above road flows over road to stream		0.06		
31		Road drainage to stream		0.02		

Table K-2. Sources, Estimated Sediment Loads, and Proposed Remedies to Decrease Sediment Loading to Poorman Creek from Roads.

Site Number	Mile	Identified Problem	Fish Barrier?	Delivered Sediment (tons/year)	Proposed Remedy	Status
32		Road drainage and undersized culvert		0.02		
35		Erosion from two track road directly to stream		0.07		
36		Erosion entering at culvert crossing		0.04		
37		Erosion at existing ford on tributary		0.15		
38		Erosion at existing ford on South Fork Poorman Creek		0.18		
39		Erosion from road delivers to stream at ford crossing		0.30		
40		Erosion at existing ford		0.08		
44		Road erosion enters at existing ford		0.08		
45		Road erosion		0.08	Cross drains installed	Completed
46		Erosion and delivery at creek crossing		0.14		
47		Sediment delivery at pipe crossing		0.03		
48		Erosion entering at pipe crossing		0.14		
49		Sediment delivery from water running over road		0.20		
50		New seep site, water down road and delivery to stream		0.13		

Table K-2. Sources, Estimated Sediment Loads, and Proposed Remedies to Decrease Sediment Loading to Poorman Creek from Roads.

Site Number	Mile	Identified Problem	Fish Barrier?	Delivered Sediment (tons/year)	Proposed Remedy	Status
51		Ditch drainage at culvert		0.10	Install sediment fence at crossing, line ditch with rock, change shape of road prism to prevent diversion of water to ditch	
52		Road material grading into stream below forest boundary		0.10	Install delineators and change blading practices	
53		Road material graded into Poorman Creek, ditch drainage from county road below forest boundary		0.10	Install delineators and change blading practices	
54		Road material graded into Poorman Creek at culvert crossing, road drainage ditch delivering sediment		0.20	Install delineators, change blading practices, line ditch with rock, eliminate ditch, alter road prism	

Table K-3. Poorman Drainage Culvert Investigation (Only Crossings which Need to be Addressed are Listed in the Table).

Crossing Number	Mile	Identified Problem	Fish Barrier?	Priority	Status
1	0.0 (County road crossing of Poorman road in T14 N 8W section 36	Undersized culvert and partial barrier	Yes	Moderate – undersized	
2	0.4	Crossing providing access to private home has undersized culvert and presents a barrier to spring spawning salmonids	Yes	Moderate -undersized	
3	0.6	Culvert at county road crossing is undersized and presents fish barrier, risk of damage and extensive sediment delivery with a 10 year flood event	Yes	Very High – undersized	
5	On Fields Gulch Road	Culvert crossing Fields Gulch in section 18 is at risk of wash out with 50 year flood, fish barrier during spring and summer but this may be desirable to prevent brook trout encroachment	Yes	Low	
6	2.6	Undersized Culvert	No	High - undersized	
7	3.45	McClellan culvert, do not provide for fish passage due to likelihood of brook trout invasion	Yes	Moderate – undersized	
10	3.62	A road crossing providing access to a private home is susceptible to wash out during 10-year flow events. May be a barrier to spring spawning salmonids	Yes	Moderate – undersized	

Table K-3. Poorman Drainage Culvert Investigation (Only Crossings which Need to be Addressed are Listed in the Table).

Crossing Number	Mile	Identified Problem	Fish Barrier?	Priority	Status
18	5.7	Culvert with moderate risk of damage during a 50-year event, is probably a passage barrier for spring spawning salmonids	Yes	Moderate - Evaluate for passage capability in spring	
19	6.0	Culvert with high risk of damage during a 25 year event, likely passage barriers for cutthroat trout	Yes	High - Replace with pipe providing higher flows	
20	6.3	Bottomless concrete culvert crossing	No	Moderate	
21	6.3	Ford providing access to a private cabin. Not a preferred crossing for fisheries health	No	Moderate - Improve ford or replace with small bridge	
23	7.45	High risk of failure during a 10 year event	Yes	High - Replace with higher capacity culvert	
24	7.65	Velocity barriers to fish, high risk of flooding during 10 year flows	Yes	Very High - Install structure supporting 100 year events, provide fish passage	
25	8.1	Moderate risk of failure during 50 year flows, possible fish barrier		Assess fish passage in spring	Completed – Replaced with a bridge
26	8.2	Possible cutthroat velocity barrier, moderate risk of failure during 50 year flows		High - Replace with culvert capable of sustaining 100 year flows	Completed – Replaced with a bridge
36	8.7	High risk of failure during 10 year flows		High - Replace with bridge or larger culvert	

Table K-3. Poorman Drainage Culvert Investigation (Only Crossings which Need to be Addressed are Listed in the Table).

Crossing Number	Mile	Identified Problem	Fish Barrier?	Priority	Status
37	8.9	Velocity and vertical migration barrier for salmonids, however do not provide fish passage as there are no brook trout in the drainage. High risk of failure during ten year flows	Yes	Very High	Completed
38	9.55 Forest road crossing of Davis Gulch	High risk of failure during 10 year flows		High - Close road and reclaim	Completed
39A	9.75	Culvert crossing tributary		High- due to risk of washout	
40	10.0	Culvert crossing tributary		Moderate – no fish passage necessary	
41	10.5	High risk of failure during 25 year events		High - Replace with pipe able to sustain 100 year floods, provide for fish passage	Completed
42	11.1	High risk of failure during 25 year events reduce bedload above pipe	No	Moderate -Replace with pipe able to sustain 100 year floods, no fish passage as above distribution	
43	11.3	Undersized culvert crossing tributary	Yes	Moderate to High	Completed
44	Davis Gulch sec 17	Culvert crossing which provides fish passage. Moderate risk of washout during 50-year event	No	Low to Moderate	
47	Long Gulch crossing fs road #1838	Undersized culvert for the 25 year event	No	Moderate	

APPENDIX L
SEDIMENT CONTRIBUTED FROM ROAD TRACTION SANDING

Road traction sanding during winter months provides a potential source of sediment loading to streams. In the Blackfoot Headwaters Planning Area, this risk applies to stream segments adjacent to two state highways. Montana State Highway 200 parallels the main stem of the Blackfoot River for much of its 36-mile length. Highway 279 over Flesher Pass (8.3 miles) is also a major road in the watershed. Montana Department of Transportation (MDT) regularly sands these roads during winter months. Analysis of Highways 200 and 279 indicates these highways encroach within 200-feet of the Blackfoot River for 3.37 miles and 0.59 miles respectively (Table L-1).

Table L-1. Proximity of Sanded Highways to Streams in the Blackfoot Headwaters Planning Area.

Road	Length Within 100’ of Blackfoot River or Willow Creek	Length Within 200’ of Blackfoot River or Willow Creek	Total Length Within the Watershed
Highway 200	0.93 miles	3.37 miles	36 miles
Highway 279	0.15 miles	0.59 miles	8.3 miles

MDT personnel provided information on the amount of sand spread on the highways in question. The area receives sanding services from two separate MDT locations, one that covers Highway 200 from the junction of Highway 279 to Rogers Pass and Highway 279 from the junction with Highway 200 to Flesher Pass. The other covers Highway 200 from the junction of Highway 279 to all points west. Average traction sand application rates for the two areas are 73 tons/mile/year and 36 tons/mile/yr respectively. Using these application rates, the following table lists the amount of road sand applied on roads close to the Blackfoot River and Willow Creek (Table L-2).

Table L-2. Traction Sand Applied to Highways Near 303(d) Listed Streams.

Stream	Traction Sand Applied to Roads within 100’ of stream	Traction Sand Applied to Roads within 200’ of stream
Blackfoot River	35 tons/yr	128 tons/yr
Willow Creek	11 tons/yr	43 tons/yr

Assuming a conservatively high estimate of 10% delivery of traction sand from roads within 100 feet of the streams, and 5% delivery for roads within 100 to 200 feet of the stream, total sediment loads from road sanding are 3.3 tons/yr delivered to Willow Creek and 9.9 tons/yr delivered to the Blackfoot River, for a combined total load of about 12.2 tons/yr. Of the 3.96 miles of Highways 200 and 279 within 200 feet of the Blackfoot River or tributaries, 2.58 miles (65%) deliver sediment from traction sand directly to the impaired reach from Poorman Creek to Nevada Creek and 1.38 miles (35%) deliver sediment from traction sand directly to Willow Creek.

Several observations helped develop the 200-foot area of influence and the 5% and 10% delivery rates. Examination of highway segments within 200 feet of the Blackfoot River and Willow Creek reveals that in most places the roadbed has a low gradient. This suggests that 50% of traction sand side cast from the road surface will end up in the cut slope ditch. Since this ditch is also low gradient, little of this material will be transported along the ditch to culverts that reach the fill slope (streamside) of the highway. In addition, in all but two areas, side slopes adjacent to the highway are low gradient and would not likely deliver sediment downhill to a stream. Also, the two stretches of Highway 200 that are within 200 feet of the Blackfoot River are on steep side slopes with riprap placed along the riverbank to prevent channel migration. The coarse nature (1-3 ft. diameter boulders) of the riprap suggests it would trap most of the sediment coming from uphill sources before delivery to the Blackfoot River.

Comparison of these results with a study done on Vail Pass in Colorado (Lorch, 1998) suggests that the 10% value for sand application within 100 feet may be a low estimate. This study found that as much as 30% of traction sand was delivered into the nearby stream channel. On the other hand, the relatively low sanding rates and mitigating factors discussed above make the 10% value a reasonable estimate for this relatively low sediment load within this portion of the Blackfoot River watershed.

APPENDIX M
SEDIMENT CONTRIBUTED FROM UPLAND SOURCES

Hillslope erosion from upland sources is another potential source of sediment loading to streams in the Blackfoot Headwaters Planning Area. This typically occurs where erodible soils occupy sufficiently steep slopes that lack adequate protection by vegetation. Erosion of upland soils is a natural phenomenon in watersheds, however, human activities such as timber harvest, road construction, and livestock grazing, particularly in the absence of best management practices, can intensify sediment production. Similarly, natural disturbance such as wildfire may have a comparable impact. Another contributing factor is the increase in water yield from vegetation removal in a watershed. Essentially, a reduction in vegetative cover in a watershed decreases interception and evapotranspiration of precipitation resulting in greater water yield. A redistribution of snow into cleared openings also adds to increased water yield. Moreover, associated land disturbance can compact soils or remove protective organic or duff layers. The resultant increase in overland flow over altered soils promotes erosion of soil, which can ultimately enter streams. Furthermore, the increase in water yield can be linked to increased peak flows, which can place more stress on stream banks, thereby increasing bank erosion and in-stream sediment production.

To evaluate the significance of sediment production and delivery from hillslope erosion in the upper Blackfoot watershed, we developed a GIS based Sediment Source and Delivery Model (SSDM). The model involved three separate analyses: evaluation of the relative potential for the landscape to both produce and deliver sediment to streams, quantification of the change in high vegetation cover types over a seven year period (1992-1999), and a prediction of the increased water yield and associated peak flow that would result from any change in vegetation from 1992-1999.

The first SSDM model component of the model evaluates the impacts of vegetative cover, slope, precipitation, and soil erodibility with respect to sediment production. The model then evaluates the connectivity of areas with high sediment production potential to streams via steeply sloped, low cover areas. Using this model in development of numerical sediment loads requires calibration with empirical field data. This calibration is a goal of the monitoring plan. In the interim, the model was used to identify areas more likely to produce and deliver sediment to tributary streams and is used in developing restoration strategies discussed in Section 6.0.

The second SSDM model component evaluated vegetation change from 1992-1999 through analysis of 1999 imagery and spatial data on historic timber harvests. A two class vegetation data set was created by conducting a supervised classification of 1999 IRS (Indian Remote Sensing Satellite) imagery provided by the Helena National Forest. The two classes are high cover types (trees, riparian zones) and low cover types (grasses, rangeland, agricultural land, bare ground, recently timbered areas). The interpretation was conducted using the Feature Analyst software (www.vls-inc.com) running within ArcGIS 8.2. Percent high cover results are presented in Table M-1, Column C below. Reported timber harvests on USFS land (1992-1999), Plum Creek Timber Co. land (1997-1999), and Montana State land (1992-1995) were then added to the high cover land class. Recently harvested areas on other private lands and State lands not in the 1992-1995 dataset were visually interpreted from the imagery and added to the high cover land class as well. The resultant new high cover data then represents 1999 conditions with the prior seven years of harvest added back; in essence, 1992 high cover. The change in high cover land class is reported in the table as the recent vegetation change (Column D), with negative values representing reduced cover between 1992 and 1999 likely due to timber harvest. Table M-1 also lists the sub-watershed 1999 vegetation data (high and low cover) results in predicted areas more likely to produce and deliver sediment to streams (Columns E & F), along with the percent vegetative change in these areas due to harvest between 1992 and 1999 (Column G).

Finally, change in water yield was estimated by calculating the amount of precipitation that would no longer be intercepted by the reduced vegetation cover. Reductions in vegetative cover due to riparian degradation or silviculture activities have been shown to result in an increase in mean annual water yield due to increased accumulation of snowpack in open areas, as well as reduction in evapotranspiration and interception (EPA, 1980; Troendle et al., 2001; Zeimer, 2000). Depending on watershed conditions, the increased water yield can affect sediment production and delivery (Rice et al., 2000). An average annual runoff analysis was conducted within the project GIS using a flow accumulation algorithm. We evaluated two scenarios, one with 1999 vegetation conditions, and a second using interpreted pre-recent logging vegetation conditions (see description of vegetation interpretation in the section immediately above). We assigned vegetation a 25% interception rate such that 25% of the average annual precipitation was intercepted by areas with the high cover land cover class and was not allowed to run off in the calculation. The calculated increase in water yield is simply the amount of average annual precipitation not intercepted by the reduced high cover vegetation. Column H in Table M-1 identifies the modeled increase in water yield for sub-watersheds within the study area. This increased water yield can be linked to the potential increase in peak flow (Jones et al., 1996).

An example of how to interpret the results in Table M-1 is as follows: The Arrastra Creek sub-watershed is 15,218 in size, and is 66.8% covered by high cover vegetation types (tree canopy, riparian). High cover vegetation types were reduced by 1.9% from 1992-1999. A fairly large amount of area has a predicted elevated potential to produce and deliver sediment to streams, of which, 16.9% has high cover vegetation types, 3.9% has low vegetation cover types (grass, bare areas), and 0.5% has been harvested between 1992-1999. From the 1.9% change in high cover vegetation, a 1.2% increase in water yield is predicted.

The impact of increased water yield on sediment transport depends on both the sediment availability as well as the temporal distribution of the additional water on the flow hydrograph. Data derived from closely monitored, harvested watersheds characterized by spring snowmelt runoff have shown that the flow augmentation tends to be concentrated on the rising limb and peak of that spring snowmelt runoff event (Troendle et al., 2001). An increase in stream flow during the snowmelt period can result in a significant increase in sediment transport capacity, as spring runoff conditions commonly constitute the channel forming discharge, characterized by active sediment transport and channel adjustment (Andrews and Nankervis, 1995).

The potential effect of the increased water yield on sediment transport was evaluated for the mouth of the Landers Fork, as a baseline annual hydrograph and sediment transport condition have been developed for that location (Appendix I). In the Landers Fork drainage area, the estimated 1.4% reduction in vegetative cover has resulted in an increased annual water yield of approximately 1.3%. This increased yield would result in an increased sediment transport capacity of approximately 4.1%.

If upland-derived sediment is conveyed to the stream channels, the increased sediment transport capacity will result in an increased delivery of sediment to the Blackfoot River. Alternatively, if upland sediment is not available for transport, increased transport energy will result in sediment sourcing downstream from the channel perimeter due to bank and bed scour (Troendle et al., 2001). Therefore, the most effective means of preventing increased water yield and associated sediment delivery is to increase or maintain vegetative cover.

Table M-1. Vegetation Change, Elevated Potential Sediment Delivery, Increased Water Yield.

Column A	Column B	Column C	Column D	Column E	Column F	Column G	Column H
Sub-watershed Name	Area (acres)	Percent High Cover (1999)	Percent High Cover Change, 1992 to 1999	Percent of Area with Elevated Potential Sediment Yield and High Cover (1999)	Percent of Area with Elevated Potential Sediment Yield and Low Cover (1999)	Percent of Area with Elevated Potential Sediment Yield and Recent Harvest	Calculated % Change in Water Yield, 1992 to 1999
Arrastra Creek	15218	66.8	-1.9	16.9	3.9	0.5	1.2
Beaver Creek	11509	75.6	-1.3	6.9	2.7	0.0	0.8
Copper Creek	26663	83.2	-0.6	9.0	4.2	0.0	NA
Humbug Creek Area	16720	76.2	-3.3	2.9	0.4	0.0	1.0
Keep Cool Creek	9103	77.4	-5.5	1.5	0.1	0.0	1.6
Landers Fork	83722	73.4	-1.4	4.9	1.5	0.0	1.3
Lincoln Gulch	7628	79.9	-3.5	9.3	0.8	0.2	1.0
Mineral Hill	1464	28.6	0.0	0.4	2.5	0.0	0.3
Moose Creek Area	7497	84.1	-9.0	3.6	0.9	0.4	3.0
Patterson Prairie	6524	54.6	-5.0	7.2	4.5	1.2	1.4
Poorman Creek	26294	90.7	-1.4	15.5	0.8	0.0	0.6
Sauerkraut Creek	9150	74.6	-18.5	0.6	0.1	0.0	5.9
Stonewall Creek	17349	73.4	-1.3	12.8	1.8	0.0	0.4
Upper Blackfoot	73786	79.8	-1.1	9.8	1.5	0.0	0.5
Willow Creek	11854	77.5	-5.3	0.3	0.0	0.0	1.7
Willow Creek listed	12381	88.2	0.0	11.6	1.5	0.0	0.1

APPENDIX N
PUBLIC COMMENTS AND DEQ RESPONSE TO PUBLIC COMMENTS

Comment 1: While bank erosion rates along the Blackfoot River were estimated and included in the load allocation, there is no allocation for sediment coming from the Landers Fork. All we know is that the loads are likely to be quite large and mostly natural (see Appendix I). Based on the loading information we have, natural bank erosion along the Blackfoot is estimated to average about 27500 tons/yr. Human sources identified in the load allocation are estimated to contribute a total of 7700 tons/yr (6994 tons/yr from bank erosion along Blackfoot and 700 tons/yr from roads). As such, the human load allocation is estimated to be about 28% over the background load. However, the unquantified natural load from the Landers Fork is not included in the allocation. If it were, the human loading component (as a percentage of the total) could be trivially small, and sediment TMDL may have been found to be unnecessary. Additionally, it is critical to accurately account for the full background load, because if the instream targets for fine sediment in the mainstem Blackfoot are not met in the future, it is more than likely that this is due to natural sources. We recommend that the load allocation table (Table 5-2) have a line inserted that lists the Landers Fork as an identified natural source of pollutants that is presently unquantified. In the monitoring section of the document, we recommend that an investigation be undertaken to determine what the Landers Fork allocation is, and that the TMDL be revised as soon as possible afterward to reflect this new information. We believe this recognizes the "phased" nature of this TMDL.

> **DEQ Response to Comment 1**: As defined in Sections 5.1.2 and 5.1.3, the TMDL and allocations are based on a percent reduction in loading. The bank erosion allocation of Section 5.1.3.1 is specifically applied to accelerated stream bank erosion from human impacts along the Blackfoot River. The natural background bank erosion loads are not part of the allocation, which is consistent with the approach of only allocating load reductions to controllable sources. Because the Landers Fork load was determined to be predominately natural, no allocation is applied to the Landers Fork load. Therefore, it would not be appropriate to include a monitoring investigation or make any immediate commitments to modify the TMDL as suggested.
>
> Furthermore, the Blackfoot River targets (Section 5.1.1) are based on a fine sediment concern. The eroding banks along the Blackfoot River and erosion from roads within the watershed are both significant sources of fine sediment. Loading from the Landers Fork consists of both fine to very large size sediment. This significant portion of larger sediment makes much of the sediment load from the Landers Fork irrelevant for the purpose of this sediment TMDL and for comparison to background fine sediment loading conditions.
>
> Nevertheless, the Landers Fork does contribute a significant load of fine sediment, which is specifically noted in the last paragraph of the Section 5.1.1. This contribution is a consideration that must be taken into account when considering target achievability within the framework of adaptive management as discussed in Section 5.1.1 and Section 7.0. It is worth noting that the apparent reducing trends of percent fines in spawning gravels in the Blackfoot River and possibly other streams (Appendix G, Figures G-9

through G-14) imply that further reductions from improved management of fine sediment sources associated with human activities may indeed be achievable.

Based on the above response, no changes were made to the document to address this comment. The approach used for the TMDL and allocations does not require the requested changes. The target achievability concerns are already incorporated within the document and the existing adaptive management approach sufficiently addresses the uncertainty and phased nature of the TMDL.

Comment 2: The allocation related to the culvert in Arrastra Creek is inappropriate. Culverts are not pollutants. While this county road culvert sounds like it should be addressed in the watershed restoration (implementation) plan, it does not belong in the TMDL load allocation.

DEQ Response to Comment 2: A TMDL is required where a pollutant (e.g. sediment) is causing an impairment to an established beneficial use. Allocations, however, are established to reduce sources of sediment consistent with the TMDL. The culverts along the mainstem of Arrastra Creek have been repeatedly identified as a source of undesirable sediment accumulation and impairment to aquatic life. It is, therefore, appropriate to include these culverts within the sediment load allocations

Nevertheless, the allocation language within Section 5.2.3.1 and Table 5-5 has been modified to provide a clearer linkage between culverts, as well as other sources, and the desired pollutant loading reductions defined by the Arrastra Creek sediment TMDL. The culverts are now specifically included within a combined source category that includes sources that either contribute to eroding banks and/or the loss of sediment transport capabilities. The new sediment allocation language applied to this combined source category is a “30% reduction in sediment loading to the stream and sediment deposition within the channel.”

Comment 3: (DEQ Responses are embedded within the subcomments): Because of the lack of justification, the sections of the document related to “Land Use Indicators” for hillslope erosion and water yield should be removed from the load allocation section of the document. We recommend that hillslope erosion and water yield would be much better addressed as follows:

3a. Reinforce in Section 3 (source assessment section) that hillslope erosion and water yield are not presently believed to be an issue based on the available information and analysis (see Appendix M).

DEQ Response to Comment 3a: As suggested, wording has been added to Sections 3.1.3, 3.2.3, 3.3.3, 3.4.3, and 3.5.3 to reinforce the determination that hillslope erosion is not considered a significant source of sediment to the watersheds of concern. This is based on the assumption that timber harvest in these areas has been pursued at a high rate of BMP compliance consistent with forest practice audits. Water yield values are also considered low enough to not cause significant concerns at this time for the majority of the drainages.

3b. Add text to Section 8 (Monitoring) stating that these processes (hillslope erosion and water yield) will be re-evaluated by DEQ at the 5-year review to determine if their inclusion in the TMDL is warranted.

DEQ Response to Comment 3b: The inclusion of these land use indicators within the allocations section is warranted. As discussed in Section 5.1.3.2, hillslope erosion and water yield increases could represent significant sources of sediment if BMPs and/or reasonable land, soil and water conservation practices are not applied. These land uses are not specifically included in the TMDL via load reduction allocations, but should be evaluated through time to validate the assumption that they are not significant sediment sources, specifically under conditions where the identified indicator levels are exceeded.

The 5-year review identified in Section 8.0 is focused on evaluating whether or not targets are met. If targets are not met, the evaluation of hillslope erosion, water yield increases, and other land uses including those where allocations are applied can be a valuable tool to help understand whether or not water quality protection practices are in place and to help evaluate overall target achievability. As part of this 5-year review, DEQ can evaluate new information and determine if modifications are warranted for land use indicators, TMDLs, allocations and/or targets as they apply to hillslope erosion, water yield, or any aspect of the document.

3c. In Section 6 (Restoration Plan), amend text to state that the Blackfoot Challenge Cooperative Forest Stewardship Program will provide educational materials to landowners that will show where the higher-risk erosion areas are located in the watershed so landowners can factor this information to their land management planning.

DEQ Response to Comment 3c: In consultation with the Blackfoot Challenge, the recommended language has been added to Section 6.1.1

3d. Remove all text related to the land use indicator "trigger values" related to the percentage of high risk areas with vegetation removal and for water yield. We believe the trigger value for land clearing is arbitrary and relates little to watershed impact. The trigger value for water yield is meaningless because changes in mean annual flow do not relate to shear stress on eroding banks. Removing the reference to the trigger values will also address the current problem that no particular party is assigned responsibly for tracking the trigger values (maybe DEQ was planning on tracking the trigger values on a quarterly basis?).

DEQ Response to Comment 3d: The text will not be removed as suggested. As implied above, failure to implement BMPs and reasonable land, soil and water conservation practices can lead to significant erosion and sediment delivery in the high risk areas defined in Appendix M. The 10% trigger value is consistent with the highest levels of harvest in high risk areas over the past few decades as described in Section 5.1.3.2.1, and presumably represents a level of harvest where major hillslope erosion or mass wasting sediment loading issues have not been identified in a given watershed. Ideally, there would be no trigger and landowners would consistently evaluate all activities in these high risk areas to ensure water quality protection via application of forestry BMPs and compliance with the SMZ law.

As identified within Appendix M and elsewhere, the water yield is used as a modeled indicator of potential increased peak flows that can contribute to increased shear stress on eroding banks. Sufficient description and references are provided within Appendix M to establish this relationship.

The State's nonpoint source program is focused primarily on voluntary implementation of BMPs and water protection practices. For the most part, the DEQ will not be tracking the land use trigger values, nor will DEQ be tracking the application of road BMPs to meet the road reduction allocation or efforts to implement grazing management practices along the Blackfoot River to reduce bank erosion. Limited resources are available to pursue these efforts, although some evaluation may be done consistent with the 5-year review and Section 8.0.

Comment #4: We would recommend dropping the water quality target for clinger taxa richness since a broader metric for macroinvertebrates is already included as a target. Taxa richness would seem to be too dependent on the intensity of the survey and lab sampling approach used. For example, doing a full identification of a given sample will yield a higher clinger taxa richness than doing taxanomic identifications on a sub-sample, since your probability of identifying new taxa is increased.

DEQ Response to Comment #4: While the broader metric evaluates overall stream condition with respect to aquatic life support, clinger taxa richness is an indicator of fine sediment deposition. It is possible that clinger taxa richness targets may be met without meeting the broader metric target, suggesting that impairment other than fine sediment deposition may affect aquatic biology and should be investigated. Using the two targets helps ensure that beneficial uses are supported prior to any findings of full support conditions.

Taxa richness can be dependent upon sampling methodology as identified in the comment. The sampling and analysis methodology must be consistent with DEQ's standard operating procedures (SOPs) as identified within Section 8.0 (Table 8-1) of the public comment draft. DEQ's SOP is designed to minimize both spatial and temporal sample bias (Bukantis, 1998), via a traveling kick net method. Similarly, sub-sampling protocols in the lab involve a random, grid-based approach. DEQ evaluated the variance associated with using the traveling kick net and lab sub-sampling protocols and found these to be statistically sound methods to evaluate benthic macroinvertebrate communities. In response to the above comments, additional language has been added to the targets section (Section 5.1.1) as well as the monitoring section (Section 8.0) to clarify the use of this DEQ SOP.

Comment #5: Lastly, we believe that the monitoring section needs to be improved to more clearly define expectations of who is going to do what. In the absence of any defined "responsible party" I can only assume that DEQ is taking the lead. And if not DEQ, then the Blackfoot Challenge?

> **<u>DEQ Response to Comment #5</u>:** Section 8.0 of the public review draft identifies responsible parties for most monitoring activities, particularly monitoring associated with target compliance and evaluating the status of allocations. In general, where DEQ is not the lead, then the Blackfoot Challenge will pursue most or all monitoring depending on resource availability and overall priorities. We have added some additional clarification to Section 8.0 in response to this comment.

<u>Comments Noted (no response necessary):</u>

<u>Comment:</u> In general, we believe that the TMDL allocation for sediment from roads (30% reduction from current) is defensible, and reasonable with implementation of Best Management Practices (BMPs).

<u>Comment:</u> The document does an adequate job of documenting uncertainty with regard to attainability of water quality targets (e.g., instream fine sediment targets). This is nicely improved from the stakeholder draft.

<u>Comment:</u> We believe the Implementation Plan is well done and have no specific recommended changes.