Montana Department of
ENVIRONMENTAL QUALITY

Addendum to Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs and Framework for Water Quality Restoration

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ACRONYM LIST

Acronym	Definition
AML	Abandoned Mine Lands
ARM	Administrative Rules of Montana
BLM	Bureau of Land Management (Federal)
BMP	Best Management Practice
BEHI	Bank Erosion Hazard Index
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DNRC	Department of Natural Resources & Conservation (Montana)
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Initiatives Program
FWP	Fish, Wildlife & Parks (Montana)
GIS	Geographic Information System
LA	Load Allocation
MBMG	Montana Bureau of Mines and Geology
MOS	Margin of Safety
NRCS	Natural Resources Conservation Service
NRDP	Natural Resource Damage Program (Montana Dept. of Justice)
PIBO	PACFISH/INFISH Biological Opinion
RDG	Reclamation and Development Grants
RIT	Resource Indemnity Trust
RM	River Mile
SWAT	Soil & Water Assessment Tool
TMDL	Total Maximum Daily Load
TPA	TMDL Planning Area
USFS	United States Forest Service
WLA	Wasteload Allocation
WRC	Watershed Restoration Coalition
WRP	Watershed Restoration Plan

DOCUMENT SUMMARY

This document presents a Total Maximum Daily Load (TMDL) and framework water quality improvement plan for three impaired tributaries to the Clark Fork River: Browns Gulch, the upper segment of Warm Springs Creek near Phosphate, Montana, and the lower segment of Lost Creek (**Figure 1-1**). This document is presented as an addendum to the 2010 TMDL document *Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs and Framework for Water Quality Restoration* (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, 2010). The parent document will hereto forward be referenced as "DEQ, 2010". This addendum contains three TMDLs addressing sediment and metals impairments not addressed in the parent document (DEQ, 2010).

The Montana Department of Environmental Quality (DEQ) develops TMDLs and submits them to the U.S. Environmental Protection Agency (EPA) for approval. The Montana Water Quality Act requires DEQ to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. TMDLs provide an approach to improve water quality so that streams and lakes can support and maintain their state-designated beneficial uses.

The Upper Clark Fork TMDL Planning Area (TPA) is located in Granite, Silver Bow, and Deer Lodge counties and includes the Clark Fork River and its tributaries from Butte to the Flint Creek confluence near Drummond. The TPA is bounded by the Boulder Mountains to the east, the Highland and Anaconda Ranges to the south, the Flint Creek Range to the west, and the Garnet Range to the north. The total area is 955,622 acres, or approximately 1,493 square miles, with land ownership consisting of federal, state, and private lands. The Clark Fork River is a separate TPA that includes all of the Clark Fork River upstream of the Flathead River confluence.

DEQ is currently developing TMDLs for the Clark Fork River and numerous tributaries. Much of the outreach for these TMDLs is overlapping but they are being organized into separate documents: (1) sediment and metals TMDLs for three Upper Clark Fork tributaries (i.e., this addendum to the parent document (DEQ, 2010); (2) sediment TMDLs for the Clark Fork River and Silver Bow Creek, as well as nutrient TMDLs for eight Upper Clark Fork tributaries (i.e., Upper Clark Fork Phase 2 document); (3) metals TMDLs for the Clark Fork River and Silver Bow Creek (i.e., Clark Fork River-Silver Bow Creek Metals document); and (4) sediment, nutrient, and temperature impairments for 12 tributaries in the Central Clark Fork Tributaries TMDL Project Area, which is adjacent to the Upper Clark Fork TPA and extends to the confluence with the Flathead River near Paradise/Plains (i.e., Central Clark Fork Tributaries document).

The scope of this addendum is limited to Upper Clark Fork tributary sediment and metals related impairments because it relies on much of the information presented in the parent document (DEQ, 2010). Two of the TMDLs address problems with sediment/siltation and one TMDL addresses metals-related impairment associated with sulfates (**Table DS-1**). As discussed above, other remaining impairments in the Upper Clark Fork TPA are being addressed by TMDLs in separate documents.

Table DS-1. List of Impaired Waterbodies and Their Impaired Uses in the Upper Clark Fork TPA with Completed Sediment and Metals TMDLs Contained in this Document

Waterbody and Location Description	TMDL Prepared	TMDL Pollutant Category	Impaired Use
Browns Gulch, from headwaters to mouth (Silver Bow Creek)	Sediment	Sediment	Aquatic Life
Warm Springs Creek, from headwaters to line between R9W and R10W (near Phosphate)	Sediment	Sediment	Aquatic Life
Lost Creek, the south State Park boundary to the mouth (Clark Fork River)	Sulfate	Metals	Aquatic Life

Sediment

Sediment was identified as impairing aquatic life in Browns Gulch and the upper segment of Warm Springs Creek near Phosphate, Montana. Sediment is affecting designated uses in these streams by altering aquatic insect communities, reducing fish spawning success, and increasing turbidity. Water quality restoration goals for sediment were established on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available instream habitat as it related to the effects of sediment, and the stability of streambanks. DEQ believes that once these water quality goals are met, all water uses currently affected by sediment will be restored.

Sediment loads are quantified for natural background conditions and for the following sources: bank erosion, hillslope erosion, and roads. The sediment TMDLs in this addendum for the upper portion of Warms Springs Creek and Browns Gulch indicate that reductions in sediment loads ranging from 34–51% will satisfy the water quality restoration goals.

Recommended strategies for achieving the sediment reduction goals are also presented in this plan. They include Best Management Practices (BMPs) for building and maintaining roads, for harvesting timber. In addition, they includes BMPs for expanding riparian buffer areas and using other land, soil, and water conservation practices that improve stream channel conditions and associated riparian vegetation.

Metals

One sulfate TMDL is provided for the lower segment of Lost Creek. Although sulfate is not a metal, it is frequently associated with metals and mining sources and considered a metals-related cause of impairment. The parent document (DEQ, 2010) contains arsenic, copper, and lead TMDLs for lower Lost Creek, but at the time those TMDLs were prepared, the most recent available data were from 1993 and were all less than the target value. Based on the age of the data and lack of target exceedances, no TMDL was prepared at that time but additional monitoring was recommended. Data collected in 2010 verified the 303(d) listing for sulfates on Lost Creek.

The water quality restoration goal for sulfate is a translation of Montana’s narrative standard, as developed in the parent document (DEQ, 2010), and is based on reference data and literature values. DEQ believes that once the water quality goal is met, all beneficial uses will be restored.

Metals loads are quantified for natural background conditions and mining sources using sampling data. Necessary reductions in sulfate loads range from 0% to 13% and mostly rely on addressing elevated loads in groundwater associated with historic mining activities. State and federal programs, as well as potential funding resources, to address metals sources are summarized in **Section 9.0** of the parent document.

Water Quality Improvement Measures

Implementation of most water quality improvement measures described in this plan is based on voluntary actions of watershed stakeholders. Ideally, local watershed groups and/or other watershed stakeholders will use this TMDL document, and associated information, as a tool to guide local water quality improvement activities.

A flexible approach to most nonpoint source TMDL implementation activities may be necessary as more knowledge is gained through implementation and future monitoring. The plan includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals and to help refine the plan during its implementation.

1.0 PROJECT OVERVIEW

This document is an addendum to the 2010 TMDL document *Upper Clark Fork Tributaries Sediment, Metals and Temperature TMDLs and Framework for Water Quality Restoration* (DEQ, 2010). This addendum addresses two sediment impairments and one metals-related impairment in three tributaries to the Clark Fork River (**Figure 1-1**). An analysis of water quality information and establishment of TMDLs for sulfate in the lower segment of Lost Creek and sediment in Browns Gulch and the upper segment of Warm Springs Creek near Phosphate, Montana, are presented herein. This document also presents a general framework for resolving these problems.

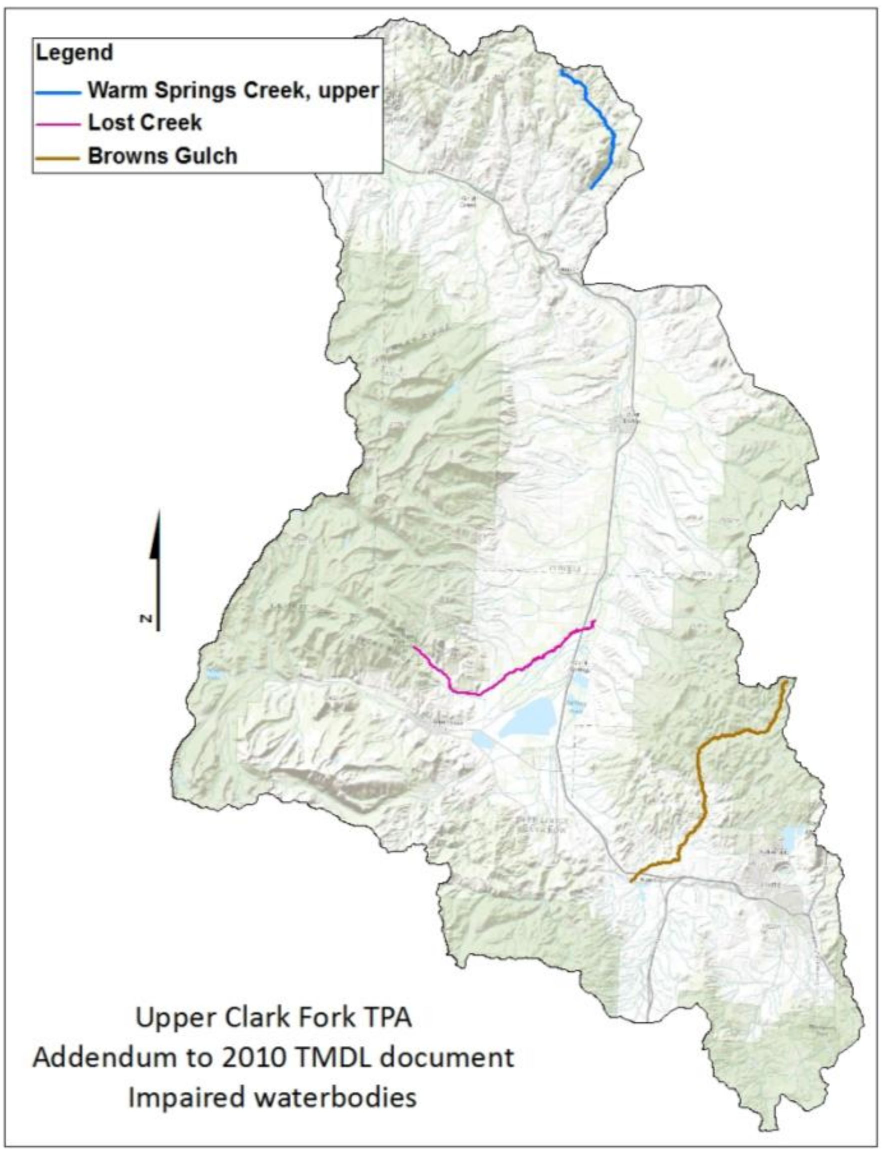

Figure 1-1. Impaired Waterbodies in the Upper Clark Fork TPA Addressed in this Addendum

1.1 Water Quality Impairments and TMDLs Addressed by this Document

Table 1-1 below lists all of the impairment causes from the "2012 Water Quality Integrated Report" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012a) that are addressed in this document.

New data assessed during this project identified a new sediment impairment cause for one waterbody (i.e., Browns Gulch). The impairment cause is identified in **Table 1-1** and noted as not being on the 2012 303(d) List (within the integrated report). Instead, the new impairment cause will be documented within DEQ assessment files and incorporated into the 2014 integrated report.

TMDLs are completed for each waterbody – pollutant combination, and this document contains three TMDLs (**Table 1-1**). There is one non-pollutant type of impairment that is also addressed in this document. TMDLs are not required for non-pollutants, although in many situations the solution to one or more pollutant problems will be consistent with, or equivalent to, the solution for one or more non-pollutant problems. The overlap between the pollutant TMDLs and non-pollutant impairment causes is discussed in **Section 6**. **Section 6** also provides some basic water quality solutions to address those non-pollutant causes not specifically addressed by TMDLs in this document.

Although DEQ recognizes that there are other pollutant listings for this TPA without completed TMDLs (**Table A-1** in **Appendix A** of parent document (DEQ, 2010)) this addendum only addresses those identified in **Table 1-1**. This is because DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or a couple of specific pollutant types. Sediment, metals and temperature TMDLs were previously completed for this Upper Clark Fork TPA in 2010 (DEQ, 2010). As described above in the document summary, additional TMDLs for the Upper Clark Fork River and its tributaries will be addressed in separate documents.

Table 1-1. Water Quality Impairment Causes for the Upper Clark Fork TPA Addressed within this Document

Waterbody and Location Description[a]	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status	Included in 2012 Integrated Report[b]
Browns Gulch, from headwaters to mouth (Silver Bow Creek)	MT76G003_040	Sedimentation / Siltation	Sediment	Sediment TMDL completed	No
Warm Springs Creek, from headwaters to line between R9W and R10W (near Phosphate)	MT76G005_111	Sedimentation / Siltation	Sediment	Sediment TMDL completed	Yes
		Alteration in streamside or littoral vegetative covers	Not Applicable; Non-Pollutant	Addressed by sediment TMDL	Yes
Lost Creek, the south State Park boundary to the mouth (Clark Fork River)	MT76G002_072	Sulfates	Metals	Sulfate TMDL completed	Yes

[a] All waterbody segments within Montana's Water Quality Integrated Report are indexed to the National Hydrography Dataset
[b] Impairment causes not in the "2012Water Quality Integrated Report" were recently identified and will be included in the 2014 Integrated Report

1.2 What this Document Contains

This document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy. The TMDL components are summarized within the main body of the document. Additional technical details are contained in the appendices. In addition to this introductory section, this document includes:

Section 2.0 Upper Clark Fork Watershed Description:
Describes the physical characteristics and social profile of the watershed.

Section 3.0 Montana Water Quality Standards:
Discusses the water quality standards that apply to the Upper Clark Fork River watershed.

Section 4.0 Defining TMDLs and Their Components:
Defines the components of TMDLs and how each is developed.

Sections 5.0 and 6.0 Sediment and Metals TMDL Components (sequentially):
This section includes (a) a discussion of the affected waterbodies and the pollutant's effect on designated beneficial uses, (b) the information sources and assessment methods used to evaluate stream health and pollutant source contributions, (c) water quality targets and existing water quality conditions, (d) the quantified pollutant loading from the identified sources, (e) the determined TMDL for each waterbody, (f) the allocations of the allowable pollutant load to the identified sources.

Section 7.0 Other Identified Issues or Concerns:
Describes other problems that could potentially be contributing to water quality impairment and how the TMDLs in the plan might address some of these concerns. This section also provides recommendations for combating these problems.

Section 8.0 Water Quality Improvement Plan:
Discusses water quality restoration objectives and a strategy to meet the identified objectives and TMDLs.

Section 9.0 Monitoring for Effectiveness:
Describes a water quality monitoring plan for evaluating the long-term effectiveness of Addendum to Upper Clark Fork Tributaries Sediment, Metals, and Temperature TMDLs and Framework for Water Quality Restoration.

Section 10.0 Public Participation & Public Comments:
Describes other agencies and stakeholder groups who were involved with the development of this plan and the public participation process used to review the draft document. Addresses comments received during the public review period.

2.0 Upper Clark Fork Watershed Description

This addendum to the Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs and Framework for Water Quality Restoration document (DEQ, 2010) addresses sediment impairments in Browns Gulch and the upper segment of Warm Springs Creek near Phosphate, Montana, and sulfate impairment in the lower segment of Lost Creek.

As of January 21, 2014, there are no active Montana Pollutant Discharge Elimination System permits that discharge to Browns Gulch, Lost Creek, or the upper segment of Warm Springs Creek near Phosphate, Montana.

Please refer to the watershed description in the parent document for an overview of physical, biological, and social characteristics of the Upper Clark Fork TPA (DEQ, 2010).

3.0 MONTANA WATER QUALITY STANDARDS

The federal Clean Water Act (CWA) provides for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's surface waters so that they support all designated uses. Water quality standards are used to determine impairment, establish water quality targets, and to formulate the TMDLs and allocations.

Montana's water quality standards and water quality standards in general include three main parts:

1. Stream classifications and designated uses
2. Numeric and narrative water quality criteria designed to protect designated uses
3. Nondegradation provisions for existing high-quality waters

Montana's water quality standards also incorporate prohibitions against water quality degradation as well as point source permitting and other water quality protection requirements.

Nondegradation provisions are not applicable to the TMDLs developed within this document because of the impaired nature of the streams addressed. Those water quality standards that apply to this document are reviewed briefly below. More detailed descriptions of Montana's water quality standards may be found in the Montana Water Quality Act (75-5-301,302 Montana Code Annotated), and Montana's Surface Water Quality Standards and Procedures (Administrative Rules of Montana (ARM) 17.30.601-670).

3.1 STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Waterbodies are classified based on their designated uses. All Montana waters are classified for multiple uses. The upper segment of Warms Springs Creek near Phosphate, Montana, and Browns Gulch are both classified as B-1 streams. For a B-1 classification, the 'B' denotes the specific level of protection applied to uses and the '1' denotes the suitability for growth and propagation of salmonid fishes and associated aquatic life. Waters classified as 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
- Agriculture and industrial water supply

While some of the waterbodies might not actually be used for a designated use (e.g., drinking water supply), their water quality still must be maintained suitable for that designated use. DEQ's water quality assessment methods are designed to evaluate the most sensitive uses for each pollutant group addressed within this document, thus ensuring protection of all designated uses. For streams in western Montana, the most sensitive use assessed for sediment and sulfate is aquatic life. DEQ determined that two waterbody segments are impaired for sediment and one waterbody segment is impaired for sulfate in the Upper Clark Fork TPA (**Table 3-1**).

Table 3-1. Impaired Waterbodies and Their Impaired Designated Uses in the Upper Clark Fork TPA

Waterbody and Location Description	Waterbody ID	Impairment Cause[a]	Impaired Use(s)
Browns Gulch, from headwaters to mouth (Silver Bow Creek)	MT76G003_040	Sediment / Siltation	Aquatic Life
Warm Springs Creek, from headwaters to line between R9W and R10W (near Phosphate)	MT76G005_111	Sediment / Siltation	Aquatic Life
Lost Creek, the south State Park boundary to the mouth (Clark Fork River)	MT76G002_072	Sulfates	Aquatic Life

[a] Only includes those pollutant impairments addressed by TMDLs in this document

3.2 Numeric and Narrative Water Quality Standards

Section 3.3.2 of the parent document (DEQ, 2010) provides a summary of Montana's numeric and narrative water quality standards. Only narrative standards are applicable for sediment and sulfate TMDL development covered by this document. The narrative standards applicable to sediment are also discussed in **Section 3.3.2** and presented within **Table 3-3** of the parent document. The metals discussion in the parent document does not specifically discuss the narrative standards applicable to sulfates, but they are contained in **Table 3-3**. They are found in ARM 17.30.637 and are commonly referred to as "free from" standards because they specify that "state surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life."

4.0 Defining TMDLs and Their Components

4.1 General Description of TMDLs and Their Components

Section 4.0 in the parent document provides in introductory description of the TMDL components followed by **Sections 4.1** through **4.4** where TMDL components are described. The following Section provides additional detail regarding TMDL implementation.

4.2 Implementing TMDL Allocations

Nonpoint source reductions linked to Load Allocations (LAs) are not required by the CWA or Montana statute, and are primarily implemented through voluntary measures. This document contains several key components to assist stakeholders in implementing nonpoint source controls. **Section 7.0** discusses a restoration and implementation strategy by pollutant group and source category, and provides recommended BMPs per source category (e.g., grazing, cropland, urban, etc.). **Section 7.5** discusses potential funding sources that stakeholders can use to implement BMPs for nonpoint sources. Other site-specific pollutant sources are discussed throughout the document, and can be used to target implementation activities. DEQ's Watershed Protection Section helps to coordinate nonpoint implementation throughout the state and provides resources to stakeholders to assist in nonpoint source BMPs. Montana's Nonpoint Source Management Plan further discusses nonpoint source implementation strategies at the state level (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012b).

DEQ uses an adaptive management approach to implementing TMDLs to ensure that water quality standards are met over time (outlined in **Section 8.0** of the parent document (DEQ, 2010). This includes a monitoring strategy and an implementation review that is required by Montana statute (see **Section 8.2** of the parent document (DEQ, 2010). TMDLs may be refined as new data become available, land uses change, or as new sources are identified.

5.0 Sediment TMDL Components

This section of the addendum to the parent document (DEQ, 2010) focuses on sediment as a cause of water quality impairment in the Upper Clark Fork TPA for two tributaries to the Clark Fork River. It describes: (1) the mechanisms by which sediment impair beneficial uses of those streams, (2) the specific stream segments of concern, (3) the presently available data pertaining to sediment impairments in the watershed, (4) the various contributing sources of sediment based on recent data and studies, and (5) the sediment TMDLs and allocations.

The term sediment is used in this document to refer collectively to several closely-related factors associated with the sediment pollutant, including suspended sediment, stream channel geometry that can affect sediment delivery and transport, and sediment deposition on the stream bottom.

5.1 Mechanisms of Effects of Excess Sediment to Beneficial Uses

Section 5.1 of the parent document provides a summary how sediment can affect beneficial uses.

5.2 Stream Segments of Concern

Table 5-1 presents stream assessment units that have been listed for sediment impairment on the 2012 303(d) List that were not addressed by sediment TMDLs in the parent document (DEQ, 2010).

Table 5-1. Waterbody Segments in the Upper Clark Fork TPA with Sediment Related Pollutant and Non-Pollutants on the 2012 303(d) List Addressed in this Document

Waterbody ID	Stream Segment	2012 Probable Causes of Impairment[a]
MT76G005_111	**WARM SPRINGS CREEK**, headwaters to line between R9W and R10W (near Phosphate)	**Sedimentation/siltation**, *Alteration in streamside or littoral vegetative covers*

[a] Non-pollutant impairment cause is presented in *italics*

Browns Gulch in the Silver Bow Creek drainage has not been formally assessed by DEQ. However, extensive sampling and source assessment efforts by the Watershed Restoration Coalition (WRC); the Mile High Conservation District; Natural Resources Conservation Service (NRCS); Montana Fish, Wildlife & Parks (FWP); and the United States Forest Service (USFS) have identified potential sediment impairments to beneficial uses in Browns Gulch. A formal data compilation and sediment impairment assessment was completed by DEQ in December 2013 (**Appendix J**). Based on these previous data collection efforts and comparison to sediment targets in the mainstem, Browns Gulch will be included for TMDL development (**Table 5-2**).

Table 5-2. Additional Waterbody Segments in the Upper Clark Fork TPA included for TMDL Development

Waterbody ID	Stream Segment	Probable Causes of Impairment
MT76G003_040	**BROWNS GULCH,** headwaters to the mouth (Silver Bow Creek)	**Sedimentation/siltation**

5.3 Information Sources and Assessment Methods

Existing data specifically related to sediment conditions for listed tributaries was collected in 2007 from impaired tributaries as part of TMDL development for DEQ (DEQ, 2010). The two main information sources used to assess sediment and habitat conditions for the Clark Fork tributaries of interest are from the DEQ 2007 field effort, and 2007 and 2008 reports produced by the Montana Natural Resource Damage Program (NRDP) and FWP. Additional fieldwork was completed on the upper segment of Warm Springs Creek near Phosphate in August 2011. Also, where available and applicable, data from land management agencies such as the USFS, NRCS, Deer Lodge Conservation District, and various reports related to the upper Clark Fork and its tributaries, along with field notes, "windshield surveys" from DEQ personnel, and information contained within DEQ Sufficient Credible Data/Beneficial Use Determination files were used to supplement the two main sources of data.

5.3.1 DEQ Longitudinal Field Method for Sediment and Habitat Impairment

In the summer of 2007, 25 sites on listed and non-listed streams throughout the Upper Clark Fork TPA were selected for sediment and habitat data collection (**Appendix A**, **Figure A-20** in the parent document (DEQ, 2010). Initially, all streams of interest underwent an aerial assessment procedure by which reaches were characterized by four main attributes: stream order, valley gradient, valley confinement, and ecoregion. These four categories represent the main factors that are not influenced by the presence of human activity, and thereby allow for comparisons among those reaches of the same characteristics. However, land management practices as a result of the presence of humans may have an impact on the way a stream responds. Reaches were stratified further based on anthropogenic influence to allow for the observance of natural versus anthropogenic effects. Reaches were then chosen for assessment to allow for a representation of various reach characteristics and anthropogenic influence. These data were used to develop sediment targets for low and high gradient reaches on impaired tributaries in the Upper Clark Fork watershed.

In August 2011, one site was assessed on the upper segment of Warm Springs Creek using the same methodology outlined above. These data were used as a comparison to sediment targets developed in the parent document and to assess sediment sources in the assessment unit. As the Warms Springs Creek data were not used for target development or sediment load estimation, they are not included in **Appendix D** of the parent document (DEQ, 2010) with data collected by DEQ on Upper Clark Fork tributaries in 2007.

Sediment and habitat related information that was collected includes: width/depth ratio, entrenchment ratio, riffle cross section, riffle pebble count, riffle grid toss, grid toss in pool tails, pool frequency, residual pool depth, riparian green line, and eroding bank analysis. Detailed methodology and procedure for field methods can be found in the DEQ assessment methods (Montana Department of Environmental Quality, 2009) and data from the field effort is presented in **Appendix D** of the parent document (DEQ, 2010).

As of spring 2013, DEQ has not conducted fieldwork in the Browns Gulch drainage. However, in August 2011 contractors of the WRC and the Mile High Conservation District conducted sediment and habitat fieldwork following DEQ protocols on 10 sites on the Browns Gulch mainstem in the Silver Bow Creek drainage. Data collected included riffle pebble counts (100 count), width/depth ratio, entrenchment ratio, riffle cross section, and Bank Erosion Hazard Index (BEHI) (Pioneer Technical Services, Inc. et al., 2011).

5.3.2 Montana Fish, Wildlife & Parks/Natural Resource Damage Program: An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin

Section 5.3.2 of the parent document (DEQ, 2010) provides a summary of this information source.

5.4 Water Quality Targets

5.4.1 Targets

In order to ascertain the relative impact of sediment on a stream and its beneficial uses, comparison of stream conditions to a suite of numeric water quality targets is used. In this case, a single water quality target is not sufficient for determining the condition of a stream, however, when viewed in combination measures of instream siltation, morphological characteristics that contribute to loading, storage, and transport of sediment or that demonstrate those effects, and biological response to increased sediment provide a good representation of the current condition as it relates to sediment.

In developing these targets, consideration must be made to account for natural variation throughout the river continuum. Specifically, some reaches will have a natural tendency for storage of sediment and others will be more efficient at sediment transport. Therefore, targets follow stratifications employed in the data analysis, such that they can be applied appropriately.

The water quality targets presented in this section (**Table 5-3**) are based on the best available science and information available at the time the parent document was developed. Furthermore, the exceedance of one or more target values does not definitively equate to a state of impairment. The degree to which one or more targets are exceeded should be taken into account, and the combination of target analysis, qualitative observations, and sound, scientific professional judgment is crucial when assessing stream condition. A brief description and justification of the target parameters used in the analysis is included in the sections that follow, and rationale and development of target values is included in **Appendix B** of the parent document (DEQ, 2010).

Table 5-3. Upper Clark Fork TPA Sediment and Habitat Targets

Sediment and Habitat Water Quality Target Measures	High Gradient Reaches (>2% slope)	Low Gradient Reaches (<2% slope)
Morphology		
Width/Depth Ratio	≤15	≥12 - ≤22
Entrenchment	1.4 - 2.2	≥2.2
Substrate Composition		
Pebble Count, % <2mm	≤7	≤10
Pebble Count, % <6mm	≤18	≤23
Browns Gulch, Pebble Count, % <2mm	≤18	≤18
Browns Gulch, Pebble Count, % <6mm	≤31	≤31
Pool Habitat		
Residual Pool Depth (feet)	≥0.8	≥1.0
Pool Frequency (per 1,000 feet of stream)	≥15	≥12

Morphology and pool habitat targets were kept the same for Browns Gulch, but pebble count targets were changed to reflect the highly erosive soils in the Elkhorn Mountains-Boulder Batholith level IV ecoregion, which includes much of the Browns Gulch drainage. These revised targets were developed by compiling pebble count statistics for other sediment-impaired streams that drain from the Elkhorn Mountains-Boulder Batholith level IV ecoregion. These sediment-impaired streams are located in the Big Hole and Jefferson River drainages as well as the Little Blackfoot River and Boulder River watersheds. The 25th percentile of these data was used to identify the target for both high gradient and low gradient stream reaches in Browns Gulch. All sediment and habitat targets were kept the same for Warm Springs Creek (near Phosphate). **Section 5.4.1.1** through **Section 5.4.1.3** of the parent document provide a description of the morphology, substrate composition and pool habitat target parameters (DEQ, 2010).

In addition, **Section 5.4.2** of the parent document provides discussion on water quality parameters used as supplemental target values (DEQ, 2010). Although not a direct measure of sediment, they provide insight into the condition of the stream and streambanks or of the overall riparian quality which often is associated with factors that may be leading to increased sediment loads and the habitat degradation. The supplemental target values are based on the greenline assessment process and include a goal of 70% or greater shrub cover and 5% or less bare ground.

5.4.2 Comparison of Listed Waters to Targets (by Stream Segment)

5.4.2.1 Browns Gulch, Headwaters to the Mouth (MT76G003_040)

Browns Gulch was not included in the DEQ 2007 or 2011 field data collection efforts, but was assessed in multiple projects by the WRC, the Mile High Conservation District, and the NRCS and their contractors. FWP also conducted monitoring and stream health fieldwork in 2009 and PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring of the USFS has monitoring sites in the upper watershed.

Data collection efforts by the WRC, the Mile High Conservation District and PIBO included metrics used by DEQ to assess stream health. In **Table 5-4**, data relevant to DEQ's assessment method has been compiled.

Comparing the compiled data in **Table 5-4** with the Upper Clark Fork TPA sediment and habitat targets for low gradient streams, none of the measured width/depth ratios or entrenchment ratios met the targets. Pebble counts (<2mm, <6mm) were also all above targets. The single residual pool depth measurement was above the target and the single pool frequency measurement also met the target. For high gradient streams, targets were met for width/depth ratio, entrenchment ratio and pool frequency.

Table 5-4. Compilation of Sediment and Habitat Field Study – Selected Data for Browns Gulch (Values in Bold Exceed the Target)

Site Information					Morphology		Substrate Composition[b]		Pool Habitat	
DEQ Reach	**Data Source[a]**	**Collection Date**	**Site ID**	**Gradient Category**	**W/D Ratio**	**Entrnch. Ratio**	**<2mm (%)**	**<6mm (%)**	**Residual Pool Depth (ft)**	**Pool Frequency (per 1,000')**
BRWN 09	WRC	2011	BG01	Low	**10.6**	**1.4**	**96.0**	**84.0**	*NR*	*NR*
BRWN 09	WRC	2011	BG03	Low	**11.5**	**1.5**	**80.0**	**74.0**	*NR*	*NR*
BRWN 06	WRC	2011	BG06	Low	**7.7**	**1.1**	**69.0**	**59.0**	*NR*	*NR*
BRWN 05	WRC	2011	BGDM	Low	**3.0**	**1.5**	**52.0**	32.0	*NR*	*NR*
BRWN 04	WRC	2011	BG12	Low	**6.7**	**1.8**	**47.0**	**43.0**	*NR*	*NR*
BRWN 04	PIBO	2008	237	Low	**26.1**	*NR*	*NA*	*NA*	1.18	24.20
BRWN 03	WRC	2011	BG16	High	10.5	1.5	*NA*	*NA*	*NR*	*NR*
BRWN 03	PIBO	2008	2635	High	8.85	*NR*	*NA*	*NA*	**0.49**	49.56

[a] Greenline information comparable to DEQ methods was not collected by others; [b] WRC – 100 pebbles from 1 transect at a riffle; PIBO – 100 pebbles from 20 transects (5 per transect) from all stream features (*NA* = not applicable); *NR* = not recorded

Results of the 2009 FWP stream assessments at six locations on Browns Gulch found that 4 sites were 'At Risk' (50–80 rating), 1 was 'Not Sustainable' (<50) and only 1 was 'Sustainable' (>80–100) (**Table 5-5**) (Lindstrom, 2011).

Table 5-5. 2009 FWP Stream Assessment Results for Browns Gulch

Site Descr.	DEQ Reach	Gradient Category	W/D Ratio	Geomorph Rating	Veg Rating	Fish Rating	All Considerations
RM 2.6	BRWN 09	Low	N/A	37	24	30	69
RM 5.3	BRWN 09	Low	N/A	37	55	30	43
RM 8.8	BRWN 05	Low	N/A	57	52	70	57
RM 11.6	BRWN 05	Low	N/A	77	57	70	67
RM 13.9	BRWN 04	High	N/A	90	87	100	90
RM 16.5	BRWN 02	High	N/A	90	64	43	74

There is evidence of erosion and deposition of fine sediment occurring in Browns Gulch and is most evident downstream of the Telegraph Gulch confluence. Low flows and channel alteration is well documented in the lower segment of the stream corridor. Browns Gulch may have a high natural sediment load compared with other basins but, conversely, may simply be at a higher risk of erosion.

Recent studies have documented some issues including road and cattle impacts on Browns Gulch but these studies have also established that Browns Gulch is not a significant source of bedload or suspended sediment to Silver Bow Creek. However, this may be more a function of dewatering in the lower reaches than physical attributes of the drainage. The FWP report (Lindstrom, 2011) indicated fair to good fish habitat in many areas but did identify fine sediment accumulation as a condition limiting fish habitat at several locations in the lower segment of the Browns Gulch assessment unit. A full assessment and comparison to targets is available in **Appendix J**.

Although Browns Gulch lacks morphology and pool habitat data, the high percent fines in riffles coupled with marginal riparian conditions, particularly in the middle and lower sections of the stream identify Browns Gulch as impaired for sediment. A TMDL will be developed for Browns Gulch.

5.4.2.2 Warm Springs Creek (near Phosphate), Headwaters to Line between R9W and R10W (MT76G005_111)

The upper segment of Warm Springs Creek near Phosphate was not included in the DEQ 2007 field data collection effort, but was assessed in August 2011 as part of fieldwork in the Upper Clark Fork watershed.

Comparison of results from the 2011 field data collection show high percent fines for <2mm but are within the target for <6mm substrate size. Width/depth ratio meets the target although the stream appears slightly entrenched. Pool habitat characteristics are within the target range. Percent shrub cover is below what would be expected for this stream and percent bare ground meets the target of ≤5% (**Table 5-6**).

Table 5-6. 2011 DEQ Sediment and Habitat Field Study – Selected Data for Warm Springs Creek

Site	Gradient Category	Morphology		Substrate Composition		Pool Habitat		Greenline	
		W/D Ratio	Entrnch. Ratio	<2mm	<6mm	Residual Pool Depth	Pool Frequency (per 1,000')	Percent Shrub Cover	Percent Bare Ground
WSP-16	High	7.8	2.4	12	16	0.85	24	17	5

Results of the FWP stream assessments on the upper segment of Warm Springs Creek near Phosphate determined that site to be 'At Risk' (50–80 rating) (**Table 5-7**).

Table 5-7. 2009 FWP Stream Assessment Results for Upper Warm Springs Creek

Site Description	DEQ Reach	Gradient Category	W/D Ratio	Geomorph Rating	Veg Rating	Fish Rating	All Considerations
RM 11.5	WSP-8	High	NA	83	73	70	77

In the upper segment of Warm Springs Creek, ownership is divided between private property (65%) and public lands (35%). The Bureau of Land Management (BLM) and the State of Montana manage several sections and smaller parcels in the upper watershed. The principal land uses in the upper drainage are livestock grazing and active timber harvest. Past mining activity, including associated road networks and building infrastructure, is also observable throughout the lower portions of the upper segment of Warm Springs Creek. A sizeable waterfall (approximately a 50-foot drop) is located on Warm Springs Creek near River Mile (RM) 5.3 just downstream of the lower boundary of the upper Warms Springs Creek assessment unit.

Fish habitat at RM 11.5 was rated as good (score: 7 points out of a potential of 10), but was less than its potential (Liermann et al., 2009). While there were several good pools and undercut banks in the survey reach, the riparian area included only sparse woody shrubs and trees with little overhead cover and shade. Additionally, there was a lack of woody debris in the channel in the survey reach. Extensive past timber harvest activities was noted upstream of RM 11.5 in the upper portions of the watershed. The stream goes dry during summer at approximately RM 6.1. The extent of this condition was not determined by FWP (Liermann et al., 2009), although the channel remains dry upstream of RM 6.1 for over a mile (**Figure 5-1**).

Figure 5-1. Dry Section of Warm Springs Creek in Canyon Upstream of the Anderson Mine Facility

Groundwater seeping through a member of the Kootenai Formation and Ellis Group (KJke), which contains limestone, dissolves calcium carbonate and forms travertine deposits when it resurfaces (Sears et al., 2000). This unit is the reason the creek goes dry through this section during certain parts of the year such as late summer. The waterfall appears to occur at the boundary of Kootenai Formation and Ellis Group member.

Upper Warms Springs Creek morphology and pool habitat do not appear to be far from the desired condition; however high percent of fines <2 mm in riffles coupled with marginal riparian conditions, particularly in the middle sections of the stream identify Warm Springs Creek as in need of continued improvement in order to maintain support for fisheries and aquatic life. Disturbance-induced grasses were common throughout the riparian zone, and livestock use adjacent to the stream was notable at the 2009 FWP site (RM 11.5) and within the 500-foot DEQ sample reach (WSP-16) surveyed in August 2011. A TMDL will be developed for the upper segment of Warm Springs Creek.

5.4.3 TMDL Development Summary

Based on the results of **Sections 5.4.5**, the following streams and stream segments will be included for TMDL development for sediment (**Table 5-8**). Sediment sources and estimates of sediment loads from those sources are investigated in **Section 5.5**, and the TMDLs and allocations of sediment load are presented in **Section 5.6**.

Table 5-8. Upper Clark Fork TPA Waterbodies included in Sediment TMDL Development

Waterbody ID	Stream Segment	2012 Probable Causes of Impairment[a]
MT76G003_040	**BROWNS GULCH,** headwaters to the mouth (Silver Bow Creek)	**Sedimentation/siltation**
MT76G005_111	**WARM SPRINGS CREEK**, headwaters to line between R9W and R10W (near Phosphate)	**Sedimentation/siltation**, *Alteration in streamside or littoral vegetative covers*

[a] Browns Gulch was formally assessed by DEQ in May 2013 and will be included on the 2014 303(d) List

5.5 Source Quantification

Three major source categories of sediment have been identified in the Upper Clark Fork TPA. When developing TMDLs, sediment loads must be quantified for each of the significant source categories, and where appropriate, strategies for reducing those loads from human caused sources must be developed such that streams meet all applicable water quality standards. This section describes the methodology, rationale, and assumptions in sediment load quantification and load reduction that is used as the basis for the Warm Springs Creek and Brown's Gulch sediment TMDLs.

5.5.1 Bank Erosion

Section 5.5.1 of the parent document provides an introduction to bank erosion as a source of sediment loading. This includes **Sections 5.5.1.1** through **5.5.1.2** where the bank erosion assessment process also applied to Warm Springs Creek is described in detail. As stated previously, bank erosion fieldwork was conducted by DEQ on Warm Springs Creek in 2011 and by the WRC and Mile High Conservation District on Browns Gulch in 2011.

5.5.1.1 Bank Erosion Sediment Loading Results for Warm Springs Creek and Browns Gulch

Using the information related to percent influence contributing to the bank erosion, all reaches were then segregated into two categories: Reaches dominated by "natural" influences on bank erosion, which includes all reaches that have 75% or more of the percent influence attributed to natural causes, and reaches dominated by anthropogenically influenced bank erosion which includes all reaches that have less than 75% of the eroding bank influence attributed to natural causes. The average total load was then derived for both of these categories using only the DEQ 2007 field data (**Table 5-9**). Data collected by DEQ on Warm Springs Creek (2011) and by the WRC/Mile High Conservation District on Browns Gulch (Pioneer Technical Services, Inc. et al., 2011) is not included in **Table 5-9**. This was the method applied for BEHI on the upper Warm Springs Creek sediment.

Table 5-9. Sediment Load Attributed to Natural and Anthropogenic Influenced Banks

Average Bank Erosion Load (tons/year) per 1,000' in Upper Clark Fork TPA		
	Natural	**Anthropogenic**
	n=7	n=17
Actively/Visually Eroding Banks	3.6	9.4
Slowly Eroding/Vegetated Banks	2.1	2.8
All Banks	4.9	11.4

A different approach was used for Browns Gulch from that used for the upper segment of Warm Springs Creek. BEHI fieldwork was conducted on ten 500-foot reaches on the mainstem of Browns Gulch in mid-August 2011 from the Flume Gulch confluence to mouth (Pioneer Technical Services, Inc. et al., 2011). Contractors from Pioneer Technical Services, Inc. and Applied Geomorphology, Inc. in the service of WRC and the Mile High Conservation District applied the Rosgen (Rosgen, 2006) method that DEQ uses for its assessments. For Browns Gulch, the reaches were dived into anthropogenic versus naturally influenced as described above. However, given the extensive fieldwork on Browns Gulch, 2011 BEHI data was applied to the each stream reach in the Browns Gulch assessment unit based on stream order, gradient, and/or confinement and did not use the dataset compiled for other Upper Clark Fork tributaries in **Table 5-9** (Pioneer Technical Services, Inc. et al., 2011).

5.5.1.2 Establishing the Total Allowable Load for Bank Erosion

As the result of the aerial assessment and Geographic Information System (GIS) reach stratification process, each identified reach includes information that attributes likely percent influence contributing to bank erosion. These determinations are based on best professional judgment, watershed reconnaissance, and visible land use/land cover as evidenced in the aerial photos and remote imagery.

Every reach on every stream of interest is then defined either as anthropogenically influenced or naturally influenced (based on the criteria above), and the average load as determined from the field investigation is applied accordingly, and normalized to the length of the reach. The sum of the attributed loads to each reach on a stream is then calculated to determine the total sediment load from bank erosion for each stream. This sum per stream is referred to as the "existing" load.

To determine the total allowable load from bank erosion for each stream, the average total load from the "natural" influenced reach category is applied to the entire length of stream, for each of the streams of interest.

Upper Warm Springs Creek, near Phosphate

The upper segment of Warm Springs Creek near Phosphate is presented in **Table 5-10** following the methodology used in the parent document using bank erosion data collected in 2007 by DEQ in the Upper Clark Fork TPA (DEQ, 2010).

Table 5-10. Upper Warm Springs Creek (near Phosphate) Bank Erosion Stream Load Derivation

	Stream Length (ft)	Existing Load (tons/year)		Allowable Load (tons/year)		Reduction (tons/year)
Natural Influence	0	(*4.9/1,000')	0	(Length*4.9/1,000')	0	
Anthro Influence	50,396	(*11.4/1,000')	574.5	(Length*4.9/1,000')	246.9	
Total	50,396		574.5		246.9	327.6

Browns Gulch

Given the extensive bank erosion data collected by Pioneer Technical Services, Inc. et al. (Pioneer Technical Services, Inc. et al., 2011) in Browns Gulch and the presence of highly erosive soils in the Elkhorn Mountains-Boulder Batholith level IV ecoregion, bank erosion loads for Browns Gulch were calculated using only the drainage-specific data from this watershed.

The sediment load for bank erosion on Browns Gulch was determined using the BEHI load data collected by Pioneer Technical Services, Inc. et al. (Pioneer Technical Services, Inc. et al., 2011) from 10 sites on the mainstem of Browns Gulch. From the DEQ stratification of Browns Gulch, there are seven reach types that comprise the 18.1 miles of the assessment unit and all reach types are anthropogenically influenced. Pioneer Technical Services, Inc. et al. collected BEHI data from 10 sites on Browns Gulch which represent four reach types in the middle and lower sections of the drainage which is also the most impaired areas (Pioneer Technical Services, Inc. et al., 2011). The three most upstream reach types, which were not sampled in 2011, occur almost entirely within USFS managed properties in the headwaters of Browns Gulch.

To calculate the bank erosion load, the average loads were used for reach types where data had been collected. For instance, for reach type MR-0-3-U (0–2% gradient, Strahler stream order three, unconfined), the mean load from bank erosion was 60.35 tons/mile/year (**Table 5-11**). There are 4.1 miles classified as MR-0-3-U so the total bank erosion load attributed to this reach type is 248.1 tons/year. Where only a single site was sampled in a given reach, the value was applied to the entire length (e.g., MR-0-4-C). For reach types MR-10-1-C and MR-4-1-C, no bank erosion loads were calculated. These are small order, high gradient, confined systems which most likely contribute very small loads from bank erosion. Given the strong data available for the most impaired reaches in the middle and lower sections of Browns Gulch, the decision was made to ignore potential loading from eroding banks in these headwater reaches. Fish and riparian data from FWP (Lindstrom, 2011) identified the MR-2-2-C section of the stream as having very slowly eroding banks and good riparian communities. For this reason, a conservative estimate of ½ of the observed load from MR-0-3-U was used to calculate the sediment load from banks for MR-2-2-C (**Table 5-11**).

Table 5-11. Browns Gulch Bank Erosion Calculation

DEQ Reach Type	Pioneer Technical Services, Inc. et al. (2011) Reaches	Load (tons/mile/year)	Total Length per Reach Type (mi)	Load (tons/year)
MR-10-1-C	0	0.00	0.5	0.0
MR-4-1-C	0	0.00	1.1	0.0
MR-2-2-C	0	6.05	1.7	5.7
MR-0-3-C	1	6.60	3.1	20.4
MR-0-3-U	4	60.35	4.1	248.1
MR-0-4-C	1	12.10	1.2	14.4
MR-0-4-U	4	173.45	6.4	1,118.5
Total	10			1,407.1

The same reduction used for other sediment impaired tributaries in the Upper Clark Fork TPA is used for Browns Gulch; existing load minus (natural load/anthropogenic load) (100% – (4.9/11.4) = 57% reduction) (**Table 5-12**).

Table 5-12. Browns Gulch Bank Erosion Stream Load Derivation

	Existing Load (tons/year)	Allowable Load (tons/year)	Reduction (tons/year)
Natural Influence	0.0	0.0	
Anthro Influence	1,407.1	605.1	
Total	1,407.1	605.1	802.0

The total allowable load from bank erosion is added to the total allowable load from the other significant sources in the watershed to derive the TMDL for sediment for each stream of interest.

5.5.1.3 Determining Bank Erosion Allocations Based on Percent Reduction

The difference between the existing load and the total allowable load is the reduction from bank erosion necessary to achieve the TMDL. This reduction is distributed among the anthropogenic influences present throughout the watershed. In order to distribute the anthropogenically influenced bank erosion load among the sources, information from the stream reach stratification is reviewed. For every reach, the length of reach is divided among the associated influencing categories as were identified in the aerial assessment and stratification process. The lengths associated with each influence category are then totaled for the stream of interest, and the percentages of influence are determined and used to distribute the sediment load. Upper Warm Springs Creek near Phosphate is presented in **Table 5-13** and **Figure 5-2** and Browns Gulch is shown in in **Table 5-14** and **Figure 5-3**.

It is acknowledged that the developed sediment loads and the method by which to attribute anthropogenic influence are estimates based on aerial photography, best professional judgment, and limited access to each stream reach. The assignment of bank erosion loads to the various causes is not definitive however it does provide helpful guides for directing focus and efforts at reducing the loads from those causes which are likely having the biggest impacts on the investigated streams.

Table 5-13. Upper Warm Springs Creek Distribution Influence on Bank Erosion

Reach ID	Reach Length (ft)	Transportation (%)	Grazing (%)	Mining (%)	Forest (%)	Natural (%)
WSP-01	1,802.61	10	10	0	10	70
WSP-02	993.66	40	10	0	40	10
WSP-03	2,091.28	10	10	0	70	0
WSP-04	2,323.17	0	10	0	80	10
WSP-05	1,552.31	0	0	0	0	100
WSP-06	1,229.51	0	0	0	0	100
WSP-07	862.68	10	30	0	10	50
WSP-08	1,034.95	20	0	0	80	0
WSP-09	3,648.01	0	0	0	100	0
WSP-10	1,478.39	20	0	0	80	0
WSP-11	658.24	0	0	0	50	50
WSP-12	5,747.54	40	0	0	60	0
WSP-13	617.25	40	20	0	40	0
WSP-14	1,438.30	50	30	0	20	0
WSP-15	1,300.15	50	30	0	0	20
WSP-16	647.39	20	0	80	0	0
WSP-17	506.94	50	0	30	20	0
WSP-18	3,089.87	50	0	0	50	0
WSP-19	457.23	50	0	0	50	0
WSP-20	5,309.96	50	0	0	50	0
WSP-21	2,370.01	60	0	0	40	0
WSP-22	1,112.89	50	0	0	30	20
WSP-23	5,650.80	50	0	0	20	30
WSP-24	1,356.41	40	0	40	0	20
WSP-25	3,101.39	50	0	50	0	0
Total Length		17,000	1,925	2,763	20,899	7,585
% of Total Length		34	4	6	41	15

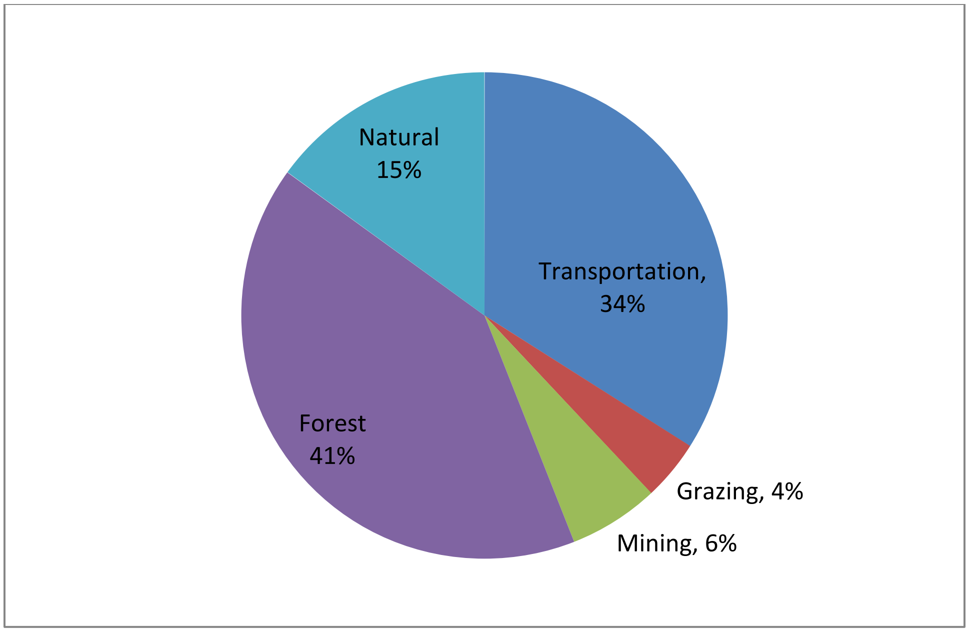

Figure 5-2. Distribution of Influencing Factors on Bank Erosion for Upper Warm Springs Creek near Phosphate

Table 5-14. Browns Gulch Distribution Influence on Bank Erosion

Reach ID	Reach Length (ft)	Transportation (%)	Grazing (%)	Cropland (%)	Forest (%)	Irrigation (%)	Other (%)	Natural (%)
BRWN 01-01	2,475.16	0	0	0	0	0	50	50
BRWN 02-01	5,852.02	0	0	0	0	0	50	50
BRWN 03-01	3,072.40	10	10	0	50	0	0	30
BRWN 03-02	3,393.71	40	50	0	0	0	0	10
BRWN 03-03	2,702.51	0	90	0	0	0	0	10
BRWN 04-01	7,318.54	50	0	0	40	0	0	10
BRWN 04-02	8,978.37	30	60	0	10	0	0	0
BRWN 05-01	21,710.5	20	70	0	0	0	0	10
BRWN 06-01	3,715.59	30	70	0	0	0	0	0
BRWN 07-01	2,771.35	0	100	0	0	0	0	0
BRWN 08-01	6,264.63	0	90	0	0	0	0	10
BRWN 09-01	16,976.2	0	80	0	0	10	0	10
BRWN 09-02	6,285.80	0	30	30	0	0	30	10
BRWN 09-03	4,300.05	40	60	0	0	0	0	0
Total Length		15,194	54,078	1,886	5,361	1,698	6,049	11,550
% of Total Length		16	56	2	6	2	6	12

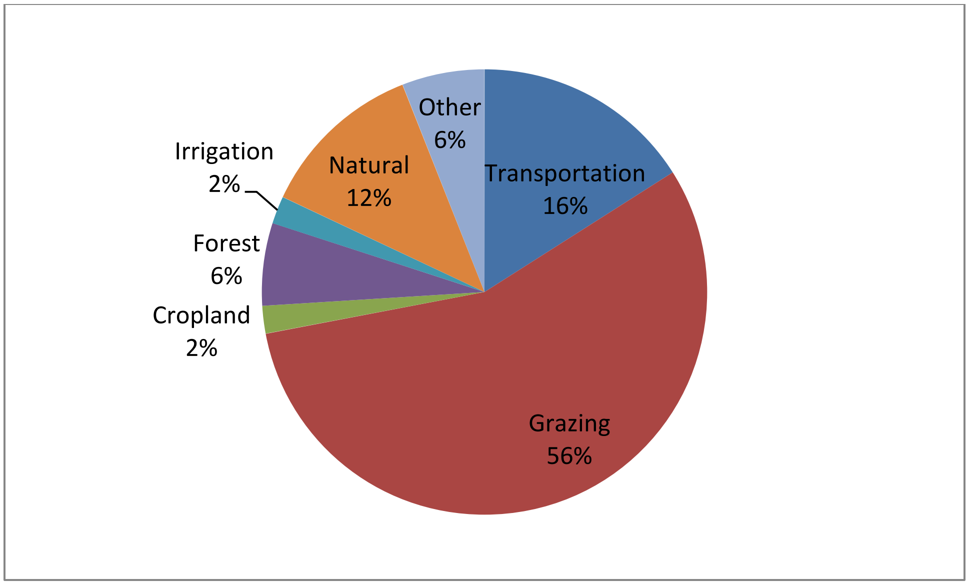

Figure 5-3. Distribution of Influencing Factors on Bank Erosion for Browns Gulch

Upper Warm Springs Creek is dominated by forest and transportation influences while Browns Gulch has myriad sources but grazing is likely the most significant.

5.5.1.4 Assumptions and Considerations

Section 5.5.1.6 of the parent document provides a summary list of assumptions and considerations relative to bank erosion source assessment (DEQ, 2010). For Browns Gulch, it is assumed that site selection and selected field measurements by Pioneer Technical Services, Inc. et al. (2011) represent existing sediment conditions in the Browns Gulch drainage.

5.5.2 Sediment from Roads

Section 5.5.2 of the parent document provides a summary description of roads as a source of sediment (DEQ, 2010).

5.5.2.1 Quantifying Sediment from Roads

Sections 5.5.2.1 of the parent document provides discussion on general road assessment methodologies and Upper Clark Fork TPA road statistics obtained via aerial assessment (DEQ, 2010). A similar aerial assessment was conducted for Warm Springs Creek near Phosphate and Browns Gulch. In each watershed, relevant statistics related to miles of road, road type, road ownership, numbers of crossings, and road/stream proximity were calculated. This includes those stream segments identified as intermittent. A few significant statistics are provided in **Table 5-15**. These types of information are often used in road sediment-source assessment methodology and provide the basis of comparison to estimate sediment loads from roads.

Table 5-15. Road Statistics for Browns Gulch and Upper Warm Springs Creek

Watershed	Watershed Area (sq mi)	Road Density (mi/sq mi)	Number of Crossings	Road Miles	Within 100' of the Stream
Browns Gulch[a]	84.5	2.6	183	216.4	31.8 (14.7%)
Upper Warm Springs Creek near Phosphate[a]	23.1	6.2	49	142.6	14.8 (10.4%)

[a] Road statistics determined using approach in DEQ (2010) document

5.5.2.2 Sediment from Road Crossings

Section 5.5.2.2 of the parent document summarizes road crossing assessment results from previous DEQ studies (DEQ, 2010). The average sediment load per sub-watershed for 21 sub-watersheds studied equals 1.38 tons/year/crossing (refer to **Table 5-32** of the parent document).

5.5.2.3 Sediment from Parallel Segments

Section 5.5.2.3 of the parent document provides discussion on sediment from parallel road segments and previous TMDL assessment work on parallel road segments (DEQ, 2010). Sediment loads from parallel road segments were not derived for Upper Clark Fork Tributaries TMDL work based on previous TMDL examples and the guidelines from the Washington Road Surface Erosion Model.

It is important to note however, that even though a sediment load is not being quantified for parallel segments, it does not preclude the entire road system for management improvements when addressing sediment load reductions and developing strategies for achieving the TMDL as sections of parallel road segments are inherently included within the approaches to the road/stream intersections that are quantified as part of the road crossing loads.

5.5.2.4 Establishing the Total Allowable Load for Road Crossings

Section 5.5.2.4 of the parent document (DEQ, 2010) describes how a 55% reduction in sediment loading from road crossings was derived and subsequently used to determine allowable sediment loading values. The reductions are based on application of standard road crossing BMPs. This same 55% sediment load reduction is applied to both Browns Gulch and upper Warm Springs Creek. Resultant estimated allowable loads are shown in **Table 5-16**.

Table 5-16. Road Sediment Calculations for Browns Gulch and Upper Warm Springs Creek

Sub-Watershed	Number of Crossings	Estimated Existing Sediment Load (tons/year)	Estimated Total Allowable Load (55% reduction)
Browns Gulch	219	302.2	136.0
Warm Springs (_111)	49	67.6	30.4

5.5.2.5 Determining Allocations

For each listed tributary in the Upper Clark Fork, road networks were identified and segregated by ownership. Because the road sediment load in the upper Clark Fork is estimated, and not based on data specific to each sub-watershed, the most appropriate method for allocating the total allowable load is to distribute that load among those responsible for management of the roads. The total allowable load is simply partitioned among the ownership categories based on the percentage of road crossings identified within each category. **Table 5-17** provides the road ownership and load distribution information for the upper segment of Warm Springs Creek near Phosphate, Montana. The same data summary for Browns Gulch may be found in **Table 5-18**.

It is recognized that in reality, in some cases the majority of the sediment load may come from only a few discrete locations within a watershed, or some ownership classes may currently have some or all of their roads addressed with appropriate BMPs and the allocations may already have been met. It is expected however, that the derived sediment load and expected reductions in this document serve as a starting point for road management investigations, and a guideline for where to begin additional studies to improve and refine these estimates.

Table 5-17. Upper Warm Springs Creek Road Ownership and Load Distribution

Road Ownership	Road Miles	Road Crossings	Existing Load (tons/year)	Allowable Load (tons/year)
Private/County	125.2	40	55.2	24.8
Bureau of Land Management	14.6	7	9.7	4.3
State of Montana	2.8	2	2.8	1.2
Total	142.6	49	67.6	30.4

Table 5-18. Browns Gulch Road Ownership and Load Distribution

Road Ownership	Road Miles	Road Crossings	Existing Load (tons/year)	Allowable Load (tons/year)
Private/County	123.1	95	131.1	59.0
United States Forest Service	85.5	110	151.8	68.3
State of Montana	6.9	9	12.4	5.6
Unknown	0.9	5	6.9	3.1
Total	216.4	219	302.2	136.0

5.5.2.6 Assumptions and Considerations

Section 5.5.2.6 of the parent document provides a summary list of assumptions and considerations relative to road erosion source assessment (DEQ, 2010).

5.5.3 Upland Sediment

Section 5.5.3 of the parent document provides introductory language regarding upland sediment loading and application of a model to assess this sediment source (DEQ, 2010). The same approach and overall process was applied to Warm Springs Creek and Browns Gulch.

5.5.3.1 Quantifying Sediment from Upland Sources Using the Soil and Water Assessment Tool

Section 5.5.3.1 of the parent document provides a summary description of the Soil & Water Assessment Tool (SWAT) model and overall approach used to quantify upland sediment loading (DEQ, 2010).

5.5.3.2 Establishing the Total Allowable Load for Upland Sediment

From the model output, an average annual sediment load delivered to the stream is determined for each sub-watershed, (or listed stream watershed) (**Tables 5-19** and **5-20**). The average annual upland sediment load is the sum of the average annual loads from each land cover/land use type (Hydrologic Response Units category). This sediment load represents the best estimation of current conditions resulting in sediment from upland sources. **Table 5-21** below presents the modeled existing sediment load, with additional information to provide comparisons in severity of sediment loading between upper Warm Springs Creek and Browns Gulch.

The initial model outputs represent an estimate of current conditions and practices that result in the upland sediment load. To determine the total allowable load from upland sources, land use/land cover categories where management practices could be improved are modified to represent those changes on the landscape, and the SWAT model is run again to simulate the resultant sediment loads that exist when all reasonable land, soil, and water conservation practices are employed.

For the purposes of this assessment, only a few land use categories were modified. These include barnyard, range brush and range grass. It is assumed that in the Upper Clark TPA, these land use categories have real potential for improvement and are often not meeting all applicable land, soil, and water conservation practices. The sediment contributions from the other land uses in the Upper Clark Fork TPA are presumed to be either negligible in its contribution, or with little potential for altering the current management to reduce sediment contribution from the existing load.

Three scenarios were run in the model. The baseline scenario represents the existing conditions and subsequent sediment loads for most watersheds in the Upper Clark Fork TPA. The improved condition scenario represents the changes that would occur with improved land management practices, including restoration of the riparian buffers to filter sediment from the landscape. Lastly, a “severe baseline” scenario was run. The severe baseline sediment loads were used as the existing condition in those watersheds where grazing was observed to be of a significantly higher impact than in other watersheds. In developing TMDLs, the severe baseline sediment loads were only used for Antelope Creek and Dempsey Creek. Additional detail regarding the assumptions used in the development of the current conditions and improvement scenario is presented in **Appendix F** of the parent document (DEQ, 2010).

Table 5-19. Upper Warm Springs Creek – SWAT Land Use Sediment Loads

	Alfalfa	Barnyard	Forest	Lawn	Range-Brush	Range-Grass	Urban	TOTAL
Existing	27.4	0.1	3.0	0.0	546.0	752.1	21.4	1,349.9
BMPs	27.4	0.0	3.0	0.0	478.7	664.7	21.4	1,195.2
Severe	27.4	0.1	3.0	0.0	612.5	1,166.4	21.4	1,830.8

Table 5-20. Browns Gulch – SWAT Land Use Sediment Loads (tons/year)

	Alfalfa	Barnyard	Forest	Lawn	Range-Brush	Range-Grass	Urban	TOTAL
Existing	1.2	1.6	7.1	0.0	238.3	350.8	270.9	870.0
BMPs	1.2	0.8	7.1	0.0	205.3	305.3	270.9	790.6
Severe	1.2	1.6	7.1	0.0	271.2	576.0	270.9	1,128.1

Table 5-21. Sediment Load from Upland Sources and Comparison between Watersheds

Subbasin	Watershed Area (square miles)	Delivered Sediment Load (tons/year)	Normalized to Tons per Square Mile
Browns Gulch	84.5	1,128.1	13.35
Upper Warm Springs Creek (near Phosphate)	23.1	1,830.8	79.25

5.5.3.3 Incorporating Improved Riparian Condition

Section 5.5.3.3 of the parent document describes how riparian conditions are incorporated into the SWAT model (DEQ, 2010). This same approach was applied to Warm Springs Creek and Browns Gulch and the results are available in **Tables 5-22** and **5-23**, respectively.

Table 5-22. Browns Gulch Riparian Buffer Load Reduction Estimate

Riparian Condition			Buffering Capacity	
Category	**Percent Stream Length**	**Upland Load Distribution**	**Reduction Potential**	**Estimated Load with Buffer Improvement**
Good	*19%*	*165.3*	0%	165.3
Fair	*76%*	*661.2*	25%	495.9
Poor	*5%*	*43.5*	50%	21.8
Upland Load From Model		870.0	Desired Load	494.7

Table 5-23. Upper Warm Springs Creek Riparian Buffer Load Reduction Estimate

Riparian Condition			Buffering Capacity	
Category	**Percent Stream Length**	**Upland Load Distribution**	**Reduction Potential**	**Estimated Load with Buffer Improvement**
Good	*9%*	*121.5*	0%	121.5
Fair	*91%*	*1,228.4*	25%	921.3
Poor	*0%*	*0*	50%	0
Upland Load From Model		1,349.9	Desired Load	1,042.8

5.5.3.4 Determining Allocations for Upland Erosion

The allocation approach described in **Section 5.5.3.4** of the parent document is also applied in the same manner for both Warm Springs Creek and Browns Gulch (DEQ, 2010).

5.5.3.5 Assumptions and Considerations for Upland Sediment

Section 5.5.3.5 of the parent document provides a description and list of applicable assumptions and considerations (DEQ, 2010).

5.6 TMDL and Allocations (by Stream)

The sediment TMDLs for all streams and stream segments presented below are expressed as a yearly load, and a percent reduction in the total yearly sediment loading achieved by applying the LA reductions identified in the associated tables. These reductions address both coarse and fine sediment loading to ensure full protection of beneficial uses. The allocations are based on information provided from the source assessment analyses used within this document, and a determination that these approximate source load reductions for each stream or segment of interest, and its contributing tributaries, will cumulatively account for the total percent reduction needed to meet the TMDL, and is achievable by addressing the major human caused sources described in this section. The sediment load in allocations and associated rationale behind the allocations are described in **Section 5.5** and **Appendix I** in the parent document (DEQ, 2010). Due to the uncertainty and assumptions associated with the methods used to determine sediment loads, the specific annual loads should not necessarily be recognized as an exact quantification. However the percent reductions presented offer a valuable and more conceivable goal for watershed restoration planning purposes and an accurate representation of the *degree* of sediment reduction that would result from the implementation of this plan. As required by

EPA, TMDLs must also be expressed as actual daily loads. Information on interpreting these values into "daily" sediment loads is presented in **Appendix C** in the parent document (DEQ, 2010).

Sediment from upland erosion in the following tables (**Tables 5-24** and **5-25**) is represented as the sum of upland sediment load from each of the land uses within that watershed. This category, by default, incorporates both sediment loads influenced by anthropogenic activities and natural loads. However, within the context of TMDL development and Montana state law, we can interpret the natural load to be the load that results when all reasonable land, soil, and water conservation practices are applied, which in this case, also equates to the Sediment LA.

A TMDL is determined by the sum of the Wasteload Allocation (WLA), LA, and Margin of Safety (MOS). WLAs are derived for specific point sources, often which require local, state, or federal permits that put limits on the amount of a particular pollutant that a nearby waterbody can receive. Neither Browns Gulch nor the upper segment of Warm Springs Creek near Phosphate has an associated WLA.

5.6.1 Browns Gulch (MT76G003_040)

The Browns Gulch sediment TMDL is outlined in **Table 5-24**. Eroding banks comprise the largest part of the estimated existing load followed by upland erosion. A 51% reduction in existing sediment loads is necessary to achieve the sediment TMDL for Browns Gulch.

Table 5-24. Browns Gulch Sediment TMDL

Sources		Current Estimated Load (tons/year)	Sediment Load Allocation (tons/year)	Sediment Load Allocation – Expressed as Percent Reduction
Roads		302.2	136.0	55%
Eroding Banks	Anthropogenically Influenced	1,407.1	605.1	57%
	Natural	0.0	0.0	
Upland Erosion	All Land Uses	870.0	530.7	39%
Total Sediment Load		2,579.3	1,271.8	51%

5.6.2 Upper Warm Springs Creek, near Phosphate (MT76G005_111)

The sediment TMDL for the upper segment of Warm Springs Creek is outlined in **Table 5-25**. Upland erosion comprises the largest part of the estimated existing load followed by eroding banks. A 34% reduction in existing sediment loads is necessary to achieve the sediment TMDL for Upper Warm Springs Creek.

Table 5-25. Upper Warm Springs Creek, near Phosphate Sediment TMDL

Sources		Current Estimated Load (tons/year)	Sediment Load Allocation (tons/year)	Sediment Load Allocation – Expressed as Percent Reduction
Roads		67.6	30.4	55%
Eroding Banks	Anthropogenically Influenced	574.5	246.9	57%
	Natural	0	0	
Upland Erosion	All Land Uses	1,349.9	1,042.8	23%
Total Sediment Load		1,992.0	1,320.1	34%

5.7 Seasonality and Margin of Safety

All TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and LAs. TMDL development must also incorporate an MOS into the LA process to account for uncertainties in pollutant sources and other watershed conditions, and to ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes seasonality and MOS in the Upper Clark Fork TPA tributary sediment TMDL development process.

5.7.1 Seasonality

Section 5.7.1 of the parent document defines seasonality as it also relates to Browns Gulch and upper Warm Springs Creek (DEQ, 2010).

5.7.2 Margin of Safety

Section 5.7.2 of the parent document defines MOS as it also relates to Browns Gulch and upper Warm Springs Creek (DEQ, 2010).

5.7.3 Uncertainty and Adaptive Management

Section 5.7.3 of the parent document defines uncertainty and adaptive management as it also relates to Browns Gulch and upper Warm Springs Creek (DEQ, 2010).

6.0 Metals TMDL Components

This section of the addendum to the DEQ (2010) document focuses on sulfates as a cause of water quality impairment in the Upper Clark Fork TPA for one tributary to the Clark Fork River. Since sulfates are considered a metals-related impairment, this section describes: (1) the mechanisms by which metals impair beneficial uses, (2) the specific stream segment of concern, (3) the presently available data pertaining to sulfate impairment in the watershed, (4) the various contributing sources of sulfate based on recent data and studies, and (5) the sulfate TMDLs and allocations.

6.1 Effects of Excess Metals on Beneficial Uses

Waterbodies with metals concentrations exceeding the aquatic life and/or human health standards can impair support of numerous beneficial uses including aquatic life, coldwater fisheries, drinking water, and agriculture. Within aquatic ecosystems, elevated concentrations of heavy metals can have a toxic, carcinogenic, or bio-concentrating effect on biota. Likewise, humans and wildlife can suffer acute and chronic effects from consuming water or fish with elevated metals concentrations. Because elevated metals concentrations can be toxic to plants and animals, high metals concentrations in irrigation or stock water may affect agricultural uses.

6.2 Stream Segments of Concern

There is only one waterbody segment and metals-related impairment cause identified on the 2012 Montana 303(d) List being addressed within this addendum: sulfates in the lower segment of Lost Creek, which extends from the Lost Creek State Park boundary to the mouth (**Figure 1-1**).

6.3 Water Quality Data and Information Sources

Information sources for evaluating the location and magnitude of sulfate sources in Lost Creek are the same as those used for metals in the parent document (DEQ, 2010). The primary sources used are GIS layers, available water quality data, and aerial photos. GIS data included the DEQ High Priority Abandoned Hardrock Mine sites, the DEQ Abandoned Hardrock Mines database, the DEQ Active Hardrock Mine sites, the Montana Bureau of Mines and Geology (MBMG) Abandoned and Inactive Mines database, and permitted point sources (i.e., Montana Pollutant Discharge Elimination System permits). As stated in **Section 2.0**, there are no permitted point sources in the Lost Creek watershed.

Because DEQ considers recent data to be that collected within the past 10 years, and at the time the parent document was written (DEQ, 2010), the only available sulfate data was from the Superfund Remedial Investigation in 1993, additional data were collected in 2010. Four sites were sampled along the lower segment of Lost Creek in July and September 2010 (**Figure 6-1**).

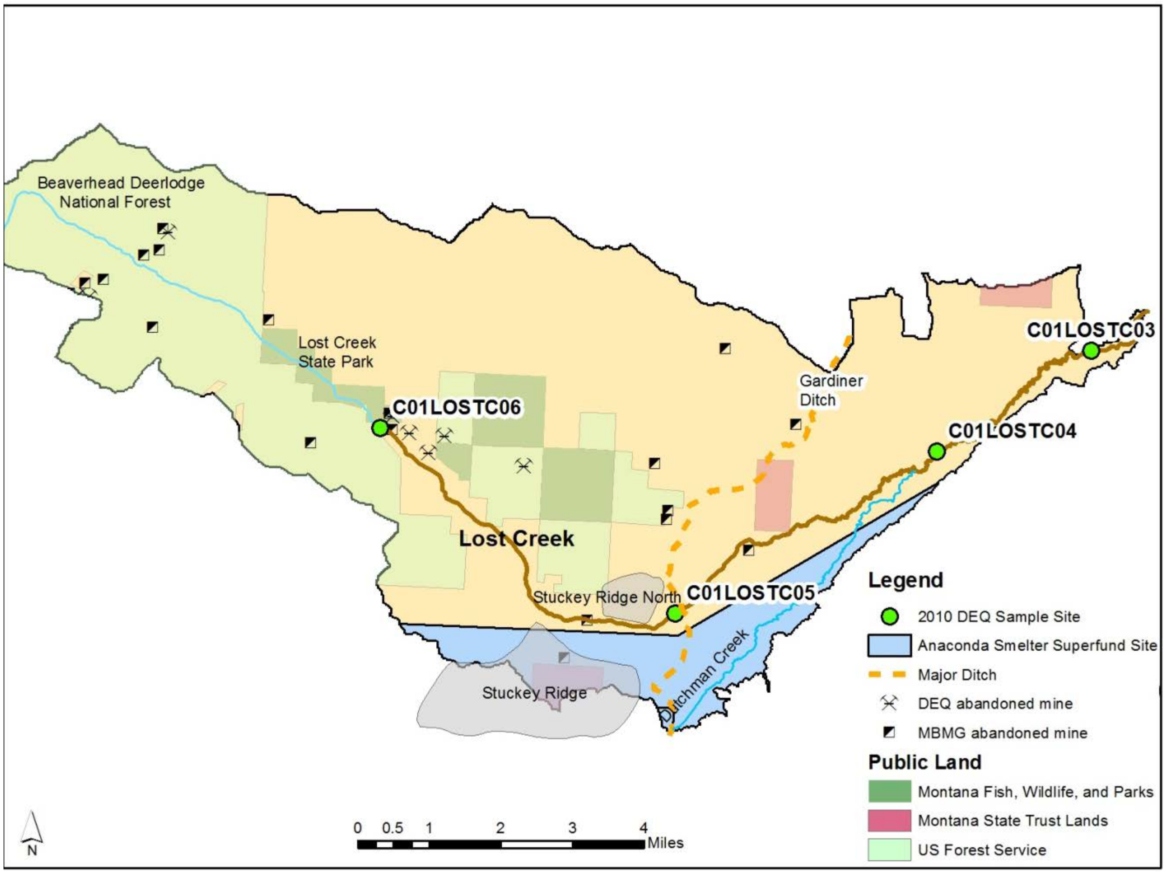

Figure 6-1. Location of Abandoned Mines, Superfund Site Boundary, and 2010 Monitoring Sites

6.4 Water Quality Targets

Water quality data described in **Section 6.3** were compiled and evaluated for attainment of water quality standards using the target value described below and following the evaluation framework.

6.4.1 Target

The sulfate target is provided in **Table 6-1** and additional background is described below.

Table 6-1. Sulfate Water Quality Target

Water Quality Targets	Proposed Criterion
Sulfate	200 mg/L (based on rationale provided in DEQ (2010)

As described in **Section 3.2**, there are no numeric criteria for sulfate, but the “free from” narrative criteria apply. Using DEQ reference data from 71 sites on B-1 streams in Montana, and the results of toxicity tests conducted at the University of Michigan and British Columbia, a target of 200 mg/L was set in the parent document (DEQ, 2010). Based on the literature values, this target is protective of aquatic life, which is the most sensitive use, but because reference data were also used as a basis, it is protective of all designated beneficial uses.

Within DEQ’s assessment methodology (Drygas, 2012), a waterbody-pollutant combination is considered not in compliance with the metals target if the chronic aquatic life standard is exceeded more than 10% of the time, and the desired minimum sample size is 8. Although there is no chronic aquatic life standard for sulfate, 200 mg/L was not identified in the literature as causing acute toxicity. Therefore, the 10% exceedance allowance will be applied for sulfate when evaluating target compliance.

6.4.2 Metals Evaluation Framework

Whether or not a TMDL is developed depends on target compliance, the presence of human sources, and dataset size as follows.

- A TMDL will not be developed if the water quality target is met and the sample size is at least eight.
- A TMDL will be developed if data are not in compliance with the water quality target (i.e., more than 10% of samples exceed 200 mg/L) and human sources are identified.

6.4.3 Existing Conditions and Comparison to Targets

This section will discuss the source evaluation and water quality data relative to the target to make a TMDL development determination.

6.4.3.1 Lost Creek, Lower Segment (MT76G002_072)

The lower segment of Lost Creek was listed for sulfates on the 2012 303(d) List. The lower segment extends 15.9 miles from the Lost Creek State Park boundary to the mouth at the Clark Fork River. The upper segment is not listed for metals.

Sources and Available Data

The following summary of potential sources was excerpted from the parent document (DEQ, 2010) and also applies to sulfate. References to figures within that document were removed and replaced with **Figure 6-1** in this addendum.

> There are no priority abandoned mines in the Lost Creek watershed. The DEQ and MBMG databases identify approximately 25 abandoned mines in the watershed, with the majority of them located near or upstream of the Lost Creek State Park boundary (**Figure 6-1**). Several of the abandoned mines are listed as recreational and none of them are identified in the assessment inventory as having discharging adits or tailings within the floodplain. A portion of the lower segment is located within the Anaconda Smelter Superfund Site (**Figure 6-1**), which has been documented as having widespread soil contamination as a result of atmospheric deposition from the Anaconda Smelter and other historical smelters, groundwater contamination, and historical mining wastes adjacent to numerous waterbodies, including Lost Creek (U.S. Environmental Protection Agency and Montana Department of Environmental Quality, 1998). The primary constituents of concern within the Superfund Site are arsenic, cadmium, copper, lead, and zinc. The lower segment of Lost Creek gains flow from groundwater and also from Gardiner Ditch, which withdraws from Warm Springs Creek (**Figure 6-1**). A source assessment study conducted in 1993 as part of the Anaconda Smelter Superfund Site Remedial Investigation concluded that Gardiner Ditch has a "minimal impact on metals concentrations within Lost Creek" (Environmental Science and Engineering, Inc., 1995).

The only recent available sulfate data are from eight samples collected by DEQ from four sites during low flow conditions in summer 2010. Sampling results are shown in **Table 6-2**. Two of the eight samples exceed the target of 200 mg/L, which is a 25% exceedance rate and verifies Lost Creek is still impaired for sulfate. Therefore a sulfate TMDL will be developed for the lower segment of Lost Creek.

Table 6-2. Recent DEQ Metals Data for Lost Creek (Values in Bold Exceed the Target)

Sample Site	Historical Site (DEQ, 2010)	Location	Sample Date	Flow (cfs)	Sulfate (mg/L)
C01LOSTC06	LST-01	Lost Creek State Park boundary	7/10/2010	24	5
C01LOSTC05	LC-2/LST-04	Downstream of Lost Creek Rd	7/10/2010	16.1	7
C01LOSTC04	LC-4/LST-06	2.6 miles upstream of I-90	7/10/2010	12.14	**230**
C01LOSTC03	LC-5/LST-07	Near mouth	7/10/2010	4.78	180
C01LOSTC06	LST-01	Lost Creek State Park boundary	9/13/2010	9.81	5
C01LOSTC05	LC-2/LST-04	Downstream of Lost Creek Rd	9/13/2010	0.82	9
C01LOSTC04	LC-4/LST-06	2.6 miles upstream of I-90	9/13/2010	19.06	**220**
C01LOSTC03	LC-5/LST-07	Near mouth	9/13/2010	19.26	190

6.5 Loading Evaluation and Source Assessment

Both sulfate target exceedances occurred at station C01LOSTC04, in the lower portion of the segment (**Figure 6-1**). Both exceedances were slightly above the target and similar in concentration, and then concentrations decreased to below 200 mg/L at the mouth (**Table 6-2**). Concentrations at the two most upstream sites were very low, consistent with concentrations measured in the early 1990s (DEQ, 2010), and likely representative of background conditions.

Lower Lost Creek is heavily used for irrigation, and its flow regime is vastly altered between May and September (DEQ, 2010). Additionally, it receives return flows from Gardiner Ditch (**Figure 6-1**) of 30–50 cfs and substantial groundwater inputs, which can exceed 40 cfs over the 8 miles downstream of site C01LOSTC05 (DEQ, 2010). The extensive irrigation inflows and outflows combined with groundwater inputs make it difficult to evaluate loading along the lower segment of Lost Creek. During the first sampling event in July 2010, flow decreased between site C01LOSTC05 and C01LOSTC04 but the load increased 25-fold. During the September 2010 sampling event, the flow increased 23-fold but the load increased more than 500-fold between site C01LOSTC05 and C01LOSTC04. Concentrations near the mouth were similar during both events, despite a major decrease in flow during July and a slight flow increase in September. Despite vastly differing flow conditions along the entire lower segment between both sampling events, the pattern of a substantial spike in sulfate load between C01LOSTC05 and C01LOSTC04 that then dissipates towards the mouth is consistent. Additionally, the same pattern occurred in the samples collected in 1993.

Sulfate loading in the lower segment of Lost Creek appears to follow the same loading trend as arsenic, which is not surprising, since they are both highly soluble and mobile. Three samples collected in 1993 from Gardiner Ditch (Environmental Science and Engineering, Inc., 1995) were all less than 10 mg/L sulfate, indicating that similarly to arsenic, Gardiner Ditch is not likely a source of excess sulfate to lower Lost Creek. Based on the source assessment within the parent document (DEQ, 2010) and Superfund-related loading studies (Pioneer Technical Services, Inc., 2002), excess sulfate is likely entering lower Lost Creek with the influx of groundwater that originates near Stuckey Ridge and Dutchman Creek (**Figure 6-1**).

6.6 TMDLs and Allocations

TMDLs are based on the most stringent water quality target and the streamflow. Because streamflow varies, the TMDLs presented in this addendum are examples based on measured streamflows from 2010. TMDLs apply to any point along the waterbody and therefore protect uses along the entire stream. The TMDL examples are calculated using the following equation:

TMDL = (X)*(Y)*(5.4) = 200 mg/L * (streamflow in cfs) * 5.4

TMDL = Total Maximum Daily Load in lbs/day for metal of concern
X = the water quality target = 200 mg/L
Y = streamflow in cubic feet per second (cfs)
5.4 = conversion factor

Because this addendum only addresses sulfate impairment on Lost Creek, a TMDL example and corresponding percent reduction will be presented for flow conditions associated with each of the eight samples collected in 2010. The required percent reduction in total load is calculated by subtracting the TMDL from the existing load, and dividing the difference by the existing load. In cases where the sample value is less than the target, the percent reduction is reported as 0%.

As discussed in **Section 4.0**, the total allowable load must be allocated to all contributing sources. A TMDL is generally broken into a WLA, an LA, and an MOS. WLAs are allowable pollutant loads that are assigned to permitted and non-permitted point sources. LAs are allowable pollutant loads assigned to nonpoint sources and may include the pollutant load from naturally occurring sources, as well as human-caused nonpoint loading. TMDLs must also take into account uncertainties in the relationship between loads and the receiving water quality by incorporating a MOS. These elements are combined in the following equation:

TMDL = ∑WLA + ∑LA + MOS
WLA = Wasteload allocation = allocation for point sources
LA = Load allocation = allocation for nonpoint sources and naturally occurring background
MOS = Margin of safety = an implicit or explicit way of accounting for uncertainties

6.6.1 Lost Creek, Lower Segment (MT76G002_072)

Since sulfate loading to the lower segment of Lost Creek is associated with diffuse historical mining sources primarily entering Lost Creek via groundwater and there are no point sources, no WLA will be provided. One LA will be provided to historic mining and wastes ($\mathbf{LA_{Lost}}$) and a separate LA will be provided to naturally occurring sources ($\mathbf{LA_{LostNat}}$). Data from the upper part of the segment will be used to establish a concentration that is representative of natural background: the average concentration at the uppermost site from 1993 in samples collected during high and low flow is 9 mg/L sulfate (n=6) and the median is 8 mg/L, indicating background concentrations are similar under all flow conditions. During sampling in 2010, the four samples collected in the upper part of the segment ranged from 5 mg to 9 mg/L. Based on this sampling data, the $\mathbf{LA_{LostNat}}$ will be calculated using a background sulfate concentration of 9 mg/L. The $\mathbf{LA_{Lost}}$ is calculated by subtracting the LA to naturally occurring sources ($\mathbf{LA_{LostNat}}$) from the TMDL. The TMDL includes an implicit MOS, which is based on conservative assumptions summarized in **Section 6.7.2**. Therefore, the TMDL equation is as follows: $\mathbf{TMDL_{Lost} = LA_{Lost} + LA_{LostNat}}$.

Example TMDLs using sampling data from 2010 are presented in **Table 6-3**. The reductions necessary to meet the TMDL correspond with the loading summary—they are limited to the lower portion of the segment between Gardiner Ditch and the confluence with Dutchman Creek (**Figure 6-1**). The **LA_{Lost}** addresses the entire Lost Creek watershed, but implementation is expected to be achieved by focusing remediation on the sources in the area where target exceedances are occurring. Although it may take some time for concentrations in the groundwater to decrease after the sources of loading to groundwater are eliminated or mitigated, sampling data indicate only small reductions are necessary along a portion of the segment to meet the target (**Table 6-3**).

Table 6-3. Lost Creek Example Sulfate TMDLs and Allocations

Site	Flow (cfs)	$TMDL_{Lost}$ (lbs/day)	$LA_{LostNat}$ (lbs/day)	LA_{Lost} (lbs/day)	Existing Load (lbs/day)	Percent Reduction
C01LOSTC06	24	25,920	1,166	24,754	648	0%
C01LOSTC05	16.1	17,388	782	16,606	609	0%
C01LOSTC04	12.14	13,111	590	12,521	15,078	13%
C01LOSTC03	4.78	5,162	232	4,930	4,646	0%
C01LOSTC06	9.81	10,595	477	10,118	265	0%
C01LOSTC05	0.82	886	40	846	40	0%
C01LOSTC04	19.06	20,585	926	19,658	22,643	9%
C01LOSTC03	19.26	20,801	936	19,865	19,761	0%

6.7 Seasonality and Margin of Safety

All TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and LAs. TMDL development must also incorporate an MOS into the LA process to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes the considerations of seasonality and an MOS in the Lost Creek sulfate TMDL development process.

6.7.1 Seasonality

Seasonality addresses the need to ensure year round beneficial-use support. Seasonality is addressed in this document as follows:

- Metals concentrations and loading conditions, as well as example TMDLs and load reductions, are evaluated for varying flow conditions.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- The sulfate target applies year round.

6.7.2 Margin of Safety

The MOS is to ensure that TMDLs and allocations are sufficient to sustain conditions that will support beneficial uses. The sulfate TMDL incorporates an implicit MOS in several ways. The implicit MOS is applied by using conservative assumptions throughout the TMDL development process and is addressed by the following:

- Reference data were used to select a conservative target value on the low end of literature values, particularly considering that hardness values tend to increase in the lower segment and sulfate is less toxic at higher hardness values (Elphick et al., 2011).
- Although a 10% exceedance rate of the sulfate target is allowed, the TMDL is set so the target is satisfied 100% of the time.

- Target attainment, refinement of LAs, and TMDL-development decisions are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.

6.8 Uncertainty and Adaptive Management

Uncertainties in the accuracy of field data, applicable target value, source assessment, loading calculations, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. Uncertainties, assumptions, and considerations are addressed throughout this document and point to the need to refine analysis, conduct further monitoring, and address unknowns in order to develop a better understanding of impairment conditions and the processes that affect impairment. For instance, additional water quality sampling under high flow conditions may help refine the source assessment. However, given the high solubility of sulfate, and the consistent loading trend observed under different flow conditions during 2010, it is unlikely that high flow samples will change the conclusions of the source assessment presented in **Section 6.5**.

Adaptive management is predicated on the premise that targets, TMDLs, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood. The adaptive management process allows for continual feedback on the progress of restoration activities and status of beneficial uses. It provides the flexibility to refine targets as necessary to ensure protection of the resource or to adapt to new information concerning target achievability. For instance, DEQ is considering incorporating hardness values into future impairment evaluations for sulfate, and if that change occurs, the sulfate target applied in this addendum may need to be modified in the future.

In order to achieve the sulfate TMDL and water quality target of 200 mg/L, all significant sources of sulfate loading must be addressed via all reasonable land, soil, and water conservation practices. It is recognized however, that in spite of all reasonable efforts, attainment of the sulfate water quality target may not be possible due to the potential presence of unalterable human-caused sources and/or natural background sources of metals loading. For this reason, an adaptive management approach will be used to evaluate target attainment. Under this adaptive management approach, sulfate in Lost Creek will ultimately fall into one of the three categories identified below:

- Implementation of restoration activities resulting in full target attainment;
- Implementation of restoration activities fails to result in target attainment due to underperformance or ineffectiveness of restoration actions. Under this scenario the waterbody remains impaired and will require further restoration efforts. The target may or may not be modified based on additional information, but conditions still exist that require additional load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.
- Implementation of restoration activities fails to result in target attainment, but target attainment is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards and/or the reclassification of the waterbody may be necessary. This would then lead to a new target (and TMDL) for the pollutant(s) of concern, and the new target could either reflect the existing

conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The DEQ Remediation Division and/or DEQ Standards Program personnel will lead this effort within DEQ to make determinations concerning the appropriateness of specific mine cleanup activities relative to expectations for mining cleanup efforts for any impairment condition associated with mining impacts. Determinations on the performance of all aspects of restoration activities, or lack thereof, will then be used along with available instream data to evaluate the appropriateness of any given target and beneficial-use support. Reclamation activities and monitoring conducted by other parties, including but not limited to the USFS and BLM, should be incorporated into the process as well. The information will also help determine any further cleanup/load reduction needs for any applicable waterbody and will ultimately help determine the success of water quality restoration.

It is acknowledged that construction or maintenance activities related to restoration and future development may result in short term increases in surface water metals concentrations. For any activities that occur within the stream or floodplain, all appropriate permits should be obtained before commencement of the activity. Federal and State permits necessary to conduct work within a stream or stream corridor are intended to protect the resource and reduce, if not completely eliminate, pollutant loading or degradation from the permitted activity. The permit requirements typically have mechanisms that allow for some short term impacts to the resource, as long as all appropriate measures are taken to reduce impacts to the least amount possible.

7.0 Other Identified Issues or Concerns

7.1 Non-Pollutant Causes of Impairments

Water quality issues are not limited simply to those streams where TMDLs are developed. In some cases, streams have not yet been reviewed through the assessment process and do not appear on the 303(d) list. In other cases, streams in this addendum to the parent document may appear on the 303(d) list but may not always require TMDL development for a pollutant, but do have non-pollutant impairment causes such as "alteration in streamside or littoral vegetation covers" that could be linked to a pollutant. These habitat related pollution causes are often associated with sediment issues as is the case with the upper segment of Warm Springs Creek near Phosphate (**Table 7-1**). In some cases, pollutant and non-pollutant causes are listed for a waterbody, and the management strategies as incorporated through the TMDL development for the pollutant, inherently address some or all of the non-pollutant listings.

Table 7-1. Waterbody Segments Addressed in this Document with Non-Pollutant Listings on 2012 303(d) List

Waterbody ID	Stream Segment	2012 Probable Causes of Impairment
MT76G005_111	**Warm Springs Creek**, from headwaters to line between R9W and R10W (near Phosphate)	Alteration in streamside or littoral vegetative covers

Alteration in Streamside or Littoral Vegetation Covers

Alteration in streamside or littoral vegetation covers refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. Such instances may be riparian vegetation removal for a road or utility corridor, or overgrazing by livestock along the stream. As a result of altering the streamside vegetation, destabilized banks from loss of vegetative root mass could lead to overwidened stream channel conditions, elevated sediment and/or nutrient loads, and the resultant lack of canopy cover can lead to increased water temperatures.

7.1.1 Linkage to TMDL

In the case of the upper segment of Warm Springs Creek near Phosphate, success in meeting the sediment TMDL will most likely equal success in addressing the alteration in streamside or littoral vegetative covers listing. The pollutant and non-pollutant impairment causes on this segment are certainly linked and efforts to address one will in turn address the other.

8.0 Water Quality Improvement Plan

While certain land uses and human activities are identified as sources and causes of water quality impairment during TMDL development, the management of these activities is of more concern than the activities themselves. This document does not advocate for the removal of land and water uses to achieve water quality restoration objectives, but instead for making changes to current and future land management practices that will help improve and maintain water quality. This section describes an overall strategy and specific on-the-ground measures designed to restore beneficial water uses and attain water quality standards in Upper Clark Fork TPA streams. The strategy includes general measures for reducing loading from sediment.

8.1 Water Quality Restoration Objectives

The following are general water quality goals provided in this TMDL document:

- Provide technical guidance for full recovery of aquatic life beneficial uses to all impaired streams within the Upper Clark Fork TPA by improving water quality conditions. This technical guidance is provided by the TMDL components in the document which include:
  - water quality targets,
  - pollutant source assessments, and
  - a restoration and TMDL implementation strategy.

A WRP for the Upper Clark Fork TPA was accepted by DEQ in December 2012. The WRP was developed by the WRC. The WRP provides a framework strategy for water quality restoration and monitoring in the Upper Clark Fork TPA, focusing on how to meet conditions that will likely achieve the Browns Gulch sediment TMDL presented in this document, as well as other water quality issues of interest to local communities and stakeholders. The Upper Clark Fork WRP outlines watersheds of high and medium priority. Browns Gulch and Lost Creek are listed as high priority watersheds. Warm Springs Creek near Phosphate, Montana, is not included in the WRP watershed priorities list.

WRPs identify considerations that should be addressed during TMDL implementation and should assist stakeholders in developing a more detailed adaptive plan in the future. A locally developed WRP will provide more detailed information about restoration goals and spatial considerations but may also encompass more broad goals than this framework includes. A WRP serves as a locally organized “road map” for watershed activities, sequences of projects, prioritizing of projects, and funding sources for achieving local watershed goals, including water quality improvements. The Upper Clark Fork WRP is intended to be a living document that can be revised based on new information related to restoration effectiveness, monitoring results, and stakeholder priorities.

8.2 Agency and Stakeholder Coordination

Successful implementation requires collaboration among private landowners, land management agencies, and other stakeholders. The DEQ does not implement TMDL pollutant reduction projects for nonpoint source activities, but can provide technical and financial assistance for stakeholders interested in improving their water quality. The DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administer funding specifically to help fund water quality improvement and pollution prevention projects, and can help identify other sources of funding.

Because most nonpoint source reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers continue to work collaboratively with local and state agencies to achieve water quality restoration which will progress toward meeting water TMDL targets and load reductions. Specific stakeholders and agencies that have been, and will likely continue to be, vital to restoration efforts include the Clark Fork Coalition, Watershed Restoration Council, Deer Lodge Conservation District, Mile High Conservation District, USFS, NRCS, Montana Department of Natural Resources & Conservation (DNRC), FWP, NRDP, EPA, and DEQ. Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include Montana Water Center, University of Montana Watershed Health Clinic, and Montana State University Extension Water Quality Program.

8.3 Restoration Strategy by Pollutant

Refer to the parent document (DEQ, 2010) for an explanation of restoration approaches by pollutant.

8.4 Restoration Approaches by Source Category

Refer to the parent document (DEQ, 2010) for an explanation of restoration approaches by source category.

8.5 Potential Funding Sources

Funding and prioritization of restoration or water quality improvement project is integral to maintaining restoration activity and monitoring successes and failures. Several government agencies fund watershed or water quality improvement projects. Below is a brief summary of potential funding sources to assist with TMDL implementation. Note, as discussed in **Section 6.5**, excess sulfate appears to be coming from groundwater originating within the boundary of the Anaconda Smelter Superfund Site, and restoration at that site is being addressed under the regulatory Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Additional information about CERCLA and other regulatory programs specific to metals are contained in the parent document (DEQ, 2010).

8.5.1 Section 319 Nonpoint Source Grant Program

Section 319 grant funds are typically used to help identify, prioritize, and implement water quality protection projects with focus on TMDL development and implementation of nonpoint source projects. Individual contracts under the yearly grant typically range from $20,000 to $150,000, with a 25% or more match requirement. 319 projects typically need to be administered through a non-profit or local government such as a conservation district, a watershed planning group, or a county.

8.5.2 Future Fisheries Improvement Program

The Future Fisheries grant program is administered by FWP and offers funding for on-the-ground projects that focus on habitat restoration to benefit wild and native fish. Anyone ranging from a landowner or community-based group to a state or local agency is eligible to apply. Applications are reviewed annually in December and June. Projects that may be applicable to the Upper Clark Fork River watershed include restoring streambanks, improving fish passage, and restoring/protecting spawning habitats.

8.5.3 Watershed Planning and Assistance Grants

The DNRC administers Watershed Planning and Assistance Grants to watershed groups that are sponsored by a Conservation District. Funding is capped at $10,000 per project and the application cycle is quarterly. The grant focuses on locally developed watershed planning activities; eligible activities include developing a watershed plan, group coordination costs, data collection, and educational activities.

8.5.4 Environmental Quality Initiatives Program

The Environmental Quality Initiatives Program (EQIP) is administered by NRCS and offers financial (i.e., incentive payments and cost-share grants) and technical assistance to farmers and ranchers to help plan and implement conservation practices that improve soil, water, air and other natural resources on their land. The program is based on the concept of balancing agricultural production and forest management with environmental quality, and is also used to help producers meet environmental regulations. EQIP offers contracts with a minimum length of one year after project implementation to a maximum of 10 years. Each county receives an annual EQIP allocation and applications are accepted continually during the year; payments may not exceed $300,000 within a 6-year period.

8.5.5 Resource Indemnity Trust/Reclamation and Development Grants Program

The Resource Indemnity Trust/Reclamation and Development Grants Program (RIT/RDG) is a biennial program administered by DNRC that can provide up to $300,000 to address environmental issues. This money can be applied to low-priority sites included on the Abandoned Mine Lands (AML) priority list for which cleanup under AML is uncertain. RIT/RDG funds can also be used for conducting site assessment and characterization activities such as identifying specific sources of water quality impairment. RIT/RDG projects typically need to be administered through a non-profit or local government such as a conservation district, watershed planning group, or county government office.

8.5.6 Other Funding Sources

Numerous other funding opportunities exist for addressing nonpoint source pollution. Additional information regarding funding opportunities from state agencies is contained in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012c) and information regarding additional funding opportunities can be found at http://www.epa.gov/nps/funding.html.

9.0 Monitoring for Effectiveness

Refer to the parent document (DEQ, 2010) for an explanation of monitoring for effectiveness in the Upper Clark Fork TPA.

10.0 Stakeholder and Public Participation

Stakeholder and public involvement is a component of total maximum daily load (TMDL) planning supported by EPA's guidelines and required by Montana state law (MCA 75-5-703, 75-5-704) which directs DEQ to consult with watershed advisory groups and local conservation districts during the TMDL development process. Technical advisors, stakeholders and interested parties, state and federal agencies, interest groups, and the public were solicited to participate in differing capacities throughout the TMDL development process in the Upper Clark Fork Phase 2 TMDL Planning Area (TPA).

10.1 Participants and Roles

Throughout completion of the Addendum to the Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs, DEQ worked with stakeholders to keep them apprised of project status and solicited input from a TMDL advisory group. A description of the participants in the development of the TMDLs in the Addendum to the Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs and their roles is contained below.

10.1.1 Montana Department of Environmental Quality

Montana state law (MCA 75-5-703) directs DEQ to develop all necessary TMDLs. DEQ has provided resources toward completion of these TMDLs in terms of staff, funding, internal planning, data collection, technical assessments, document development, and stakeholder communication and coordination. DEQ has worked with other state and federal agencies to gather data and conduct technical assessments. DEQ has also partnered with watershed organizations to collect data and coordinate local outreach activities for this project.

10.1.2 U.S. Environmental Protection Agency

EPA is the federal agency responsible for administering and coordinating requirements of the CWA. Section 303(d) of the CWA directs states to develop TMDLs (see **Section 1.1**), and EPA has developed guidance and programs to assist states in that regard. EPA has provided funding and technical assistance to Montana's overall TMDL program and is responsible for final TMDL approval. Project management was primarily provided by the EPA Regional Office in Helena, Montana.

10.1.3 TMDL Advisory Group

The Upper Clark Fork TPA TMDL Advisory Group consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Upper Clark Fork TPA, and also representatives of applicable interest groups. All members were solicited to participate in an advisory capacity per Montana state law (75-5-703 and 704). DEQ requested participation from the interest groups defined in MCA 75-5-704 and included local city and county representatives, livestock-oriented and farming-oriented agriculture representatives, conservation groups, watershed groups, state and federal land management agencies, and representatives of recreation and tourism interests. The advisory group also included additional stakeholders and landowners with an interest in maintaining and improving water quality and riparian resources.

Advisory group involvement was voluntary and the level of involvement was at the discretion of the individual members. Members had the opportunity to provide comment and review of technical TMDL assessments and reports and to attend meetings organized by DEQ for the purpose of soliciting feedback on project planning. Typically, draft documents were released to the advisory group for review under a limited timeframe, and their comments were then compiled and evaluated. Final technical decisions regarding document modifications resided with DEQ.

Communications with the group members was typically conducted through email and draft documents were made available through DEQ's wiki for TMDL projects (http://montanatmdlflathead.pbworks.com). Opportunities for review and comment were provided for participants at varying stages of TMDL development, including opportunity for review of the draft TMDL document prior to the public comment period.

10.1.4 Area Landowners

Since much of the Browns Gulch and upper Warm Springs Creek watersheds are in private ownership, local landowner cooperation in the TMDL process has been critical. Their contribution has included access for stream sampling and field assessments and personal descriptions of seasonal water quality and streamflow characteristics. The DEQ sincerely thanks the planning area landowners for their logistical support and informative participation in impromptu water resource and land management discussions with our field staff and consultants.

10.2 Response to Public Comments

Upon completion of the draft TMDL document, and prior to submittal to EPA, DEQ issues a press release and enters into a public comment period. During this timeframe, the draft TMDL document is made available for general public comment, and DEQ addresses and responds to all formal public comments.

The public review period began on March 4, 2014, and ended on April 2, 2014. DEQ made the draft document available to the public, solicited public input and comments, and announced public meetings at which the TMDLs were presented to the public. These outreach efforts were conducted via emails to watershed advisory group members and other interested parties, posts on the DEQ website, and announcements in the following newspapers: the Montana Standard (Butte), the Anaconda Leader, the Silver State Post (Deer Lodge), and the Missoulian. DEQ provided an overview of these TMDLs at public presentations in Butte and Deer Lodge on March 11.

No public comments were received by DEQ for the *Addendum to Upper Clark Fork River Tributaries Sediment, Metals, and Temperature TMDLs and Framework for Water Quality Restoration* during the public comment period.

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APPENDIX J – BROWNS GULCH SEDIMENT ASSESSMENT

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ACRONYMS

Acronym	Definition
DEQ	Department of Environmental Quality (Montana)
FWP	Fish, Wildlife & Parks (Montana)
NRCS	Natural Resources Conservation Service
PIBO	PACFISH/INFISH Biological Opinion
RM	River Mile
TMDL	Total Maximum Daily Load
USFS	United States Forest Service
WRC	Watershed Restoration Coalition

Browns Gulch upstream of Telegraph Gulch Confluence (Pioneer Technical Services, Inc. et al., 2011)

J1.0 INTRODUCTION

Browns Gulch is a tributary to Silver Bow Creek in Silver Bow County, Montana. The assessment unit (MT76G003_040) includes the full stream length of 18.1 miles from the headwaters to the mouth (Silver Bow Creek) which is located ½ mile west of Ramsey, Montana. As a large tributary to Silver Bow Creek, the Watershed Restoration Coalition (WRC) and the Mile High Conservation District have spent significant resources to investigate water quality and possible impairments in the drainage. Additional studies have also been completed for riparian and fish habitat assessments by state and federal agencies. The purpose of this report is to compile and present available data for the watershed with the express purpose of making an impairment determination.

J2.0 PHYSICAL WATERSHED CHARACTERISTICS

A map of Browns Gulch identifies the spatial location of some data presented in this report (**Figure J2-1**).

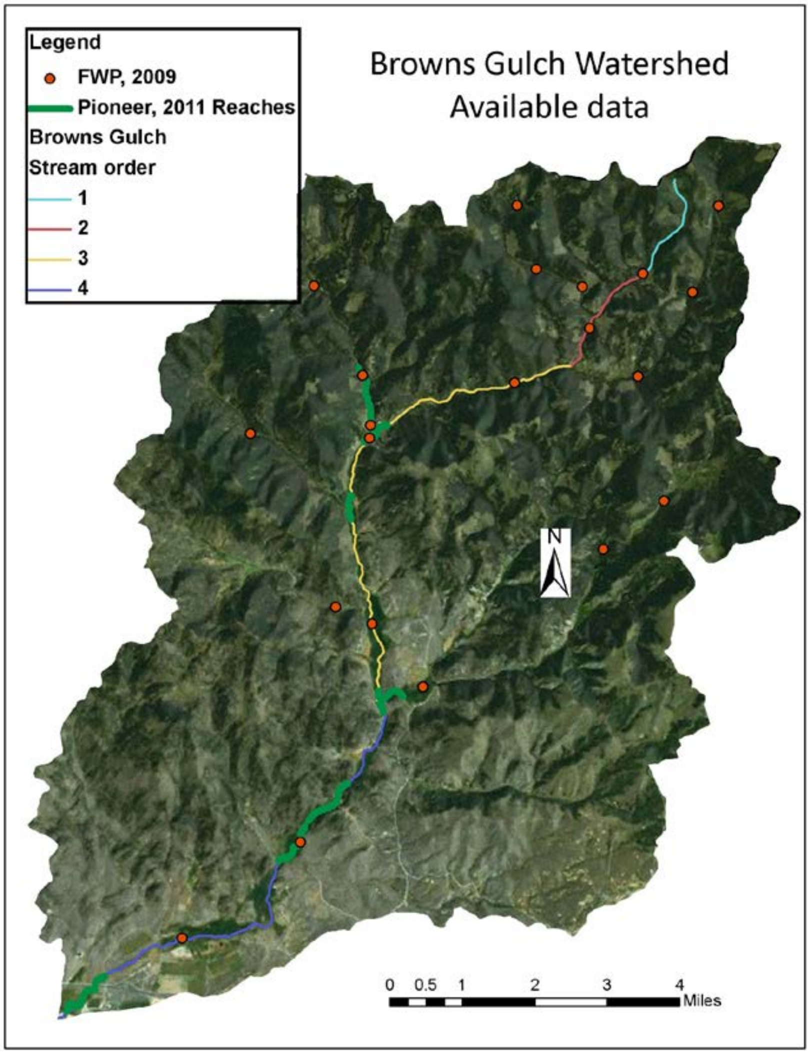

Figure J2-1. Map of Browns Gulch with Stream Order and Sampling Sites (Liermann et al., 2009; Pioneer Technical Services, Inc. et al., 2011)

As summarized in the Natural Resources Damage Program of the State of Montana Department of Justice report from 2005, the Browns Gulch sub-watershed is located in the northeastern portion of the Silver Bow Creek watershed and covers 84.5 square miles (54,380 acres), making it the third largest sub-watershed in the study area. The sub-watershed consists of two distinct ecological settings; a forested montane region, and a drier valley foothill region. Mean elevation is 6242 feet above sea level and average annual precipitation is approximately 16.8 inches/year.

Land ownership is approximately 52% private, 47% United States Forest Service (USFS), and 1% state. Land use is primarily agricultural in the lower elevation, valley foothill portions of the sub-watershed. Coniferous forest covers much of the higher elevation, montane portion of the watershed (USFS ownership). Several tributary streams contribute significant flow to Browns Gulch. These include Meadow Gulch, Telegraph Gulch, Flume Gulch, American Gulch, Alaska Gulch, Hail Columbia Gulch, Bull Run Creek, and Orofino Gulch.

J2.1 Soils/Sediment

Underlain by the Lowland Creek volcanics, the soils are derived from the geologic parent material of ash-fall tuffs that weather to coarse and fine grained sediments. The saprolite (lower zone of soil profile) contains 30–50% clay, which is unusual for this area (Ruppert, Dave E., personal communication 2012). Soils were likely developed as part of extensive beaver complexes, contain high organic matter, and are highly erosive (Pioneer Technical Services, Inc. et al., 2011). Field observations support the notion that the land clearing period in the late 1800s in the basin may have been accompanied by accelerated sediment loading to the stream bottoms. This includes fan-shaped deposits at the mouth of tributaries, and exposures of gray sands in the banks that overlie beaver dam remnants (Pioneer Technical Services, Inc. et al., 2011). The uplands have been partially or entirely recolonized by timber and loading rates have likely been significantly reduced. However, sediment loads generated during that period may still be working through the system.

Investigations as part of the Silver Bow Creek remediation determined that there is no evidence of an alluvial fan at the confluence of Browns Gulch and Silver Bow Creek (Montana Department of Environmental Quality, 2003). From this 2003 study, Wolman pebble counts and bulk samples found no systematic variation along the study reach in Silver Bow Creek which included where Browns Gulch enters Silver Bow Creek. Upstream of the confluence, Browns Gulch is a low gradient, meandering channel flowing through a relatively wide valley. Based on field observations, the authors determined that the material carried by the downstream portion of Browns Gulch is fine-grained, and, therefore provides primarily suspended sediment loads to Silver Bow Creek (Montana Department of Environmental Quality, 2003). However, instream Total Suspended Solids sampling (*n*=21) indicated that suspended sediment is not a chronic condition in Browns Gulch and that the stream does not deliver a large suspended sediment load to Silver Bow Creek (KirK Environmental, LLC, 2006).

Sedimentation impacts are evident in the Rosgen data from reaches throughout Browns Gulch. KirK Environmental, LLC (2006) noted that in performing Rosgen surveys and during general hydrologic measurements that large deposits of silt and sand were observed in the streambed in the form of elongated dunes or slugs of fines on top of coarse substrate. The (KirK Environmental, LLC, 2006) report also stated that D_{50} values were often much smaller than reference data in the upper reaches of Browns Gulch but their impairment determination was based on the assumption that the headwaters have a gravelly substrate potential (KirK Environmental, LLC, 2006).

J2.2 Hydrology

Browns Gulch is a 4th order stream at the mouth (Silver Bow Creek) and encompasses a drainage area of 84.5 mi^2. Synoptic flow data for the lower watershed below Bull Run Creek indicate that much of the lower length of Browns Gulch loses water to the alluvial aquifer. The authors also determined that Browns Gulch is responsible for approximately 26% of the flow in Silver Bow Creek below the Creek (Montana Department of Environmental Quality, 2003). This is in agreement with Montana Department of Environmental Quality (DEQ) data. Silver Bow Creek has been sampled by DEQ (Remediation Division) immediately upstream and downstream of the confluence with Browns Gulch since 2007. In six September events, Browns Gulch was only observed to be discharging to Silver Bow Creek in three events. In instances where Browns Gulch was flowing, it comprised 12–32% (mean = 21.1%) of the flow in Silver Bow Creek below the confluence. Irrigation withdrawals during summer low flow often dewater Browns Gulch in the lower segment as was observed in three of the DEQ sampling events on Silver Bow Creek. This condition was documented by stream measurements done by KirK Environmental, LLC

(2006) and the WRC in 2010 and 2011 in the reaches downstream of the largest irrigation diversions. Dewatering in the lower reaches of Browns Gulch has been listed as one of the key resource concerns in the Silver Bow Restoration Plan for fish habitat (Natural Resources Damage Program, 2005).

J2.3 Rosgen Classification

From KirK Environmental, LLC (2006): Surveyed tributary and headwater reaches of Browns Gulch exhibit B or Eb type channel forms. Middle and lower watershed reaches of Browns Gulch exhibit F and Gc channel types and appear to be highly altered over natural conditions. Stream channel incisement is common on these reaches and the channels are accordingly entrenched and in some circumstances are gullies. Under improved conditions these lower F and Gc channel reaches may have the potential to be C or E type channels, which are more typical of this type of physiographic setting under less altered conditions (**Table J2-1**). The two lowest survey sites, BG3 and BG1 show signs of significant substrate siltation. Sources of anthropogenic sediment in the watershed are numerous and suggest that under less impaired conditions average substrate (D_{50}) would be significantly coarser in the lower watershed.

Table J2-1. Rosgen Level II Characterization (WRC Survey) (KirK Environmental, LLC, 2006)

Site	Rosgen Level III	Substrate Class Potential	Channel Class Potential	Entrenchment Ratio	Width/ Depth Ratio	Sinuosity	Channel Slope	D50 (mm)	Notes
BG01	F6	3/4/5	E5 or C5	1.4	10.6	1.8	0.0031	0.062	
BG03	F6	3/4/5	E5 or C5	1.5	11.5	1.5	0.0038	0.5	
BG06	G5c	3/4/5	E5 or C5	1.1	7.7	1.3	0.0043	0.5	W/D fits G
BGDM	G4c	3/4/5	E5 or C5	1.5	6.0	1.4	0.004	4	W/D fits G
BG12	B4c	3/4	E4 or C4	1.8	6.7	2.3	0.017	5.6	W/D fits G or E; entrenchment fits B

J2.4 Riparian Conditions

From KirK Environmental, LLC (2006): Major factors affecting riparian condition include land and water use management, road and irrigation infrastructure, and noxious weed infestation. The riparian conditions in Browns Gulch itself are more variable than the tributaries. Dominant impairments to riparian condition identified in the riparian assessment include channel incisement, bank instability and excessive lateral erosion, woody riparian vegetation clearing, heavy browsing and lack of reestablishment of woody vegetation, and absence of vegetation with a binding root mass.

From Pick and Kellogg (2006): Overall, only about 16% of the total length evaluated (70,460 feet) was found to be in the Sustainable (desirable) category. Fifty-four percent of the assessed length was Sustainable, At-Risk, while the balance, some 30% or nearly one-third of the assessed length was ranked Not Sustainable. Several reasons are responsible for the latter categories' significant presence: bank instability and slumping due to excessive saturation during the irrigation season; lack of durable and strongly rooted vegetation (woody and herbaceous plants); loss of floodplain due to channel incisement and avulsion (process whereby a new channel is spontaneously created by the force of water as the old channel is abandoned); and the impacts of the Superfund fill on the lowest reach.

J2.5 Fish Surveys

In the Silver Bow Creek drainage, Browns Gulch has been identified as one of a few potential trout refugia that are capable of restocking Silver Bow Creek. Fish inventories in the Browns Gulch basin have focused on characterization of trout speciation and genetic purity.

A 2009 Fish, Wildlife & Parks (FWP) fish population and riparian habitat assessment observed that fish populations were dominated by non-native eastern brook trout (*Salvelinus fontinalis*). In the mainstem of Browns Gulch, fish populations generally decline downstream (Liermann et al., 2009). Native westslope cutthroat trout (*Oncorhyncus clarki lewisi*) were present only in the tributaries and in the upper reaches of the mainstem of Browns Gulch near and above Telegraph Gulch (Liermann et al., 2009).

Liermann et al. (2009) performed fish surveys and riparian assessments at six sites on the mainstem of Browns Gulch. Fish habitat was rated fair in the lower sampling sites (River Mile [RM] 2.6 and 5.3) and good in the middle and upper sampling sites with the exception of RM 16.5, which was rated fair. Common remarks for downgrading from good to fair included excessive fine sediment in the streambed along with poor riparian health/lack of shading. The assessments of fish habitat and riparian health (based on the Natural Resources Conservation Service [NRCS] method) were acknowledged by the author as being relatively limited and subjective based on the NRCS assessment method. However, they are included here as they are useful in describing the results of fish sampling.

On the mainstem of Browns Gulch, Liermann et al. (2009) noted that fish habitat was most usually limited by fine sediment accumulation in the streambed. The following were excerpted directly from Liermann et al. (2009):

RM 2.6: Fish habitat at RM 2.6 was limited by high fine sediment accumulation and an overall lack of woody shrubs along the streambanks. Channel substrate consisted mostly of sand and silt, and areas suitable for trout spawning were largely absent.

RM 5.3: Fish habitat at RM 5.3 was rated only fair (score: 3 points out of a potential of 10), and was limited by high fine sediment accumulation and a lack of habitat complexity. Channel substrate was again comprised primarily of sand and silt, and areas suitable for trout spawning were absent.

RM 8.8: Fish habitat was rated good at RM 8.8, but was limited by a lack of woody vegetation along the streambanks that would have increased shade and cover, as well as added to habitat complexity. Fine sediment accumulation was also notable in the reach, but was not as severe as at downstream reaches.

RM 11.6: Fish habitat was rated as good but was limited by relatively high fine sediment accumulation. Spawning substrate suitable for trout was present throughout the reach, but it tended to be quite embedded.

RM 13.9 and 16.5: Fine sediment accumulation was not observed in the stream bottom at these sampling locations.

J2.6 Roads

The Pioneer Technical Services, Inc. et al. (2011) report does include some coarse evaluations of sediment deposition from roads to Browns Gulch and a few tributaries. However, it was not meant to be a comprehensive analysis of the entire basin. The objective was to identify potential restoration projects. However, roads do have an influence on the total sediment load to Browns Gulch and are considered a source area.

Appendix E of Montana Department of Environmental Quality, Planning, Prevention and Assistance Division (2010) contains an aerial assessment of roads that was used for Total Maximum Daily Load (TMDL) development on tributaries in the Upper Clark Fork drainage. This assessment did not include Browns Gulch but following the methodology provided in this appendix, it was determined that there are 183 road crossings of perennial and intermittent streams in the Browns Gulch drainage (2.6 miles of road per square mile in the drainage). Sixty-five and one-half percent of the road network is within 100 feet of a stream. The estimated existing sediment load to Browns Gulch is 252.5 tons/year based on a mean sediment load of 1.38 tons/crossing.

J3.0 Comparison to TMDL Targets

Table J3-1 includes the sediment and habitat targets for sediment impaired tributaries in the Upper Clark Fork River watershed developed for the 2010 TMDL document (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, 2010). Morphology and pool habitat targets were kept the same for Browns Gulch, but pebble counts were changed to reflect the highly erosive soils in the Elkhorn Mountains-Boulder Batholith level IV ecoregion which includes much of the Browns Gulch drainage. These targets were developed by compiling pebble count statistics for other sediment-impaired streams that drain from the Elkhorn Mountains-Boulder Batholith level IV ecoregion. These streams are in the Big Hole and Jefferson River drainages as well as the Little Blackfoot River and Boulder River watersheds. The 25th percentile of these data was used to identify the target for high gradient streams and the 35th percentile was used for the low gradient streams. Most of the available data from this compilation were from high gradient systems. Therefore the 35th percentile was used for low gradient stream reaches assuming that diminished transport capacity translates to higher natural accumulations of fine sediment in low gradient reaches.

Table J3-1. Browns Gulch Sediment and Habitat Targets

Sediment and Habitat Water Quality Target	High Gradient Reaches (>2% slope, including Rosgen A and B stream types)	Low Gradient Reaches (<2% slope, including Rosgen C and E stream types)
Morphology		
Width/Depth Ratio	≤15	≥12–≤22
Entrenchment	1.4–2.2	≥2.2
Substrate Composition		
Browns Gulch, Pebble Count, % <2mm	≤18	≤20
Browns Gulch, Pebble Count, % <6mm	≤31	≤36
Pool Habitat		
Residual Pool Depth (feet)	≥0.8	≥1.0
Pool Frequency (per 1,000 feet of stream)	≥15	≥12

DEQ has not conducted sediment or habitat assessments in the Browns Gulch drainage, but data collection efforts by the WRC, the Mile High Conservation District, and PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program included metrics used by DEQ to assess stream health. In **Table J3-2**, data relevant to DEQ's assessment method has been compiled.

Table J3-2. Compilation of Sediment and Habitat Field Study – Selected Data for Browns Gulch (Target Exceedances Are in Bold)

Site Information					Morphology		Substrate Composition[b]		Pool Habitat	
DEQ Reach	Data Source[a]	Collection Date	Site ID	Gradient Category	W/D Ratio	Entrnch. Ratio	<2mm (%)	<6mm (%)	Residual Pool Depth (ft)	Pool Frequency (per 1000')
BRWN 09	WRC	2011	BG01	Low	**10.6**	**1.4**	**84.0**	**96.0**	*NR*	*NR*
BRWN 09	WRC	2011	BG03	Low	**11.5**	**1.5**	**74.0**	**80.0**	*NR*	*NR*
BRWN 06	WRC	2011	BG06	Low	**7.7**	**1.1**	**59.0**	**69.0**	*NR*	*NR*
BRWN 05	WRC	2011	BGDM	Low	**3.0**	**1.5**	**32.0**	**52.0**	*NR*	*NR*
BRWN 04	WRC	2011	BG12	Low	**6.7**	**1.8**	**43.0**	**47.0**	*NR*	*NR*
BRWN 04	PIBO	2008	237	Low	**26.1**	*NR*	*NA*	*NA*	1.18	24.20
BRWN 03	WRC	2011	BG16	High	10.5	1.5	*NA*	*NA*	*NR*	*NR*
BRWN 03	PIBO	2008	2635	High	8.85	*NR*	*NA*	*NA*	**0.49**	49.56

[a] Greenline information comparable to DEQ methods was not collected by others
[b] WRC – 100 pebbles from 1 transect at a riffle; PIBO – 100 pebbles from 20 transects (5 per transect) from all stream features (*NA*=not applicable); *NR* = not recorded

Comparing the compiled data in **Table J3-2** with the Upper Clark Fork TMDL Planning Area sediment and habitat targets in **Table J3-1** for low gradient streams, none of the measured width/depth ratios or entrenchment ratios met the targets. Pebble counts (<2mm, <6mm) were also all above targets for Browns Gulch. The single pool frequency measurement from a low gradient stream did meet the target. For high gradient streams, targets were met for width/depth ratio, entrenchment ratio and pool frequency.

J4.0 Photos

There are extensive photos available in the 2011 report prepared for the Mile High Conservation District and the WRC as well as in Pick and Kellogg (2006).

J5.0 Summary

For the purpose of impairment determination, data for Browns Gulch are compiled and presented in this report. There is evidence of erosion and deposition of fine sediment occurring in Browns Gulch and is most evident downstream of the Telegraph Gulch confluence. A notable source of fine sediment to the Browns Gulch is Hail Columbia Gulch, a tributary in the lower drainage. Low flows and channel alteration are well documented in the lower segment of the stream corridor and dewatering prevents Browns Gulch from flowing to Silver Bow Creek in some years. Browns Gulch likely has higher natural sediment loads compared with other sub-watersheds in the Upper Clark Fork sub-basin, but is also at a higher risk of erosion given the nature of its soils and existing land uses. Land clearing and removal of the beaver population in the late 1800s in Browns Gulch and its tributaries likely accelerated mass wasting in sub-watersheds with highly erosive soils, and evidence of poor benthic substrate quality was observed throughout the mainstem. While stabilization has occurred since that period, current land use is still contributing fine sediment at loads greater than would naturally occur. Significant improvement is possible by limiting fine sediment deposition to Browns Gulch.

The FWP report from 2009 (Liermann et al., 2009) identified fine sediment accumulation as a condition limiting fish habitat at several locations in the lower segment of the Browns Gulch assessment unit. A comparison between sediment and habitat metrics collected by WRC and USFS (PIBO) and targets for Upper Clark Fork tributaries do indicate that sediment deposition is impairing beneficial uses in Browns Gulch.

J6.0 References

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