Montana Department of
ENVIRONMENTAL QUALITY

Flint Creek Planning Area Sediment and Metals TMDLs and Framework Water Quality Improvement Plan

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Brian Schweitzer, Governor
Richard Opper, Director DEQ

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ACRONYM LIST

Acronym	Definition
AFO	Animal Feeding Operation
AML	Abandoned Mine Lands
ARARS	Applicable or Relevant and Appropriate Requirements and Standards
ARCO	Atlantic Richfield Company
ARM	Administrative Rules of Montana
ARARS	Applicable or Relevant and Appropriate Requirements and Standards
AWRA	American Water Resources Association
BDNF	Beaverhead Deerlodge National Forest
BEHI	Bank Erosion Hazard Index
BLM	Bureau of Land Management (federal)
BMP	Best Management Practices
BUD	Beneficial Use Determination
CAFO	Concentrated (or Confined) Animal Feed Operations
CALA	Controlled Allocation of Liability Act
CECRA	[Montana] Comprehensive Environmental Cleanup and Responsibility Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNMP	Comprehensive Nutrient Management Plans
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DNRC	Department of Natural Resources & Conservation
EPA	Environmental Protection Agency (US)
FWP	Fish, Wildlife, and Parks (Montana)
FWS	Fish & Wildlife Service (US)
GIS	Geographic Information System
GWIC	Groundwater Information Center
INFISH	Inland Native Fish Strategy
IR	Integrated Report
LA	Load Allocation
LWD	Large Woody Debris
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MFWP	Montana Fish, Wildlife and Parks
MMI	Multi-Metric Index
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
MSU	Montana State University
MWCB	Mine Waste Cleanup Bureau (DEQ)
NBS	Near Bank Stress
NF	North Fork
NLCD	National Land Cover Dataset
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List

Acronym	**Definition**
NPS	Nonpoint Source
NRCS	National Resources Conservation Service
NRDP	Natural Resource Damage Program
NRIS	Natural Resource Information System (Montana)
PEL	Probable Effects Levels
PFC	Proper Functioning Condition
PIBO	PACFISH/INFISH Biological Opinion
RIT/RDGP	Resource Indemnity Trust/Reclamation and Development Grants Program
RP	Responsible Party
SAP	Sampling and Analysis Plan
SDWIS	Safe Drinking Water Information System
SF	South Fork
SILC	(Montana's) Satellite Imagery land Cover
SMCRA	Surface Mining Control & Reclamation Act
SMZ	Streamside Management Zone
SOP	Standard Operating Procedure
SSURGO	Soil Survey Geographic database
SWPPP	Storm Water Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TPA	TMDL Planning Area
TSS	Total Suspended Solids
UCFRB	Upper Clark Fork River Basin Grant Program
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	US Fish and Wildlife Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
VCRA	Voluntary Cleanup and Redevelopment Act
VFS	Vegetated Filter Strips
WLA	Wasteload Allocation
WRP	Watershed Restoration Plan
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

This document presents a Total Maximum Daily Load (TMDL) and framework water quality improvement plan for 11 impaired streams or stream segments in the Flint Creek TMDL Planning Area (TPA) (see **Figure A-1** found in **Appendix A**). The document contains a total of 47 TMDLs.

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 Flint Creek TPA encompasses an area of approximately 500 square miles in western Montana, and lies almost entirely in Granite County with a small portion in Deer Lodge County. The Flint Creek watershed originates in the Flint Creek Mountains to the east, the Pintlar Mountains to the south, and the Sapphire and John Long Mountains to the west. Flint Creek drains from Georgetown Lake and bisects two large agricultural valleys, the Philipsburg Valley and the Drummond Valley, which are separated by a narrow bedrock canyon. Flow in Flint Creek is seasonally augmented from a trans-basin diversion in the East Fork of Rock Creek. Approximately 2,200 residents reside within the Flint Creek TPA, with Philipsburg (pop. 911) and Drummond (pop. 315) as the largest towns. Other population centers include Maxville and Hall. Land ownership in the Flint Creek TPA is primarily private and U.S. Forest Service (Beaverhead-Deer Lodge National Forest), with a small amount of land managed by Bureau of Land Management (BLM) or the State of Montana. Private lands are located predominantly in the lower areas where wide, low-gradient valleys are conducive to agriculture and development.

Today, the economy of the Flint Creek watershed is dominated by agriculture and tourism supported through the areas rich recreational opportunities, although historically the Flint Creek watershed has also seen extensive mining activity, and forested lands were harvested for timber. Many roads were built in conjunction with these activities. Currently, forest lands in the Flint Creek TPA are used for recreational purposes as well as some resource extraction. Most of the historic road system is maintained to some degree to supply access for recreation, resource extraction and fire suppression. Other roads are either decommissioned or left in place. Private lands are predominantly agricultural and rural, with some residential areas. Several tracts of land that were historically grazed or farmed are now subdivided into smaller parcels and have been developed into residential units.

DEQ determined that 11 streams or stream segments do not meet the applicable water quality standards. The scope of the TMDLs in this document addresses problems with sediment and metals (see **Table ES-1**). Although DEQ recognizes that there are other pollutant listings for this TPA, this document addresses only sediment and metals. Other pollutant listings will be addressed in future documents.

Sediment was identified as impairing aquatic life and coldwater fishes in the upper segment of Flint Creek, Barnes Creek, Douglas Creek (near Philipsburg), and Smart Creek. Sediment is affecting beneficial uses in these streams by altering aquatic insect communities, reducing fish spawning success and altering habitat, and increasing turbidity. In addition, turbidity was listed as a cause of impairment affecting aquatic life and coldwater fishes, primary contact recreation, and industrial use in the lower segment of Flint Creek, which is addressed in this document via a sediment TMDL. 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 in-stream habitat as it relates 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 most significant sources vary by watershed but impacts from agricultural land uses (hay fields, grazing, etc) and forest roads tend to be the most prominent, along with natural erosion. The Flint Creek TPA watershed sediment TMDLs indicate that reductions in sediment loads ranging from 44% to 59% 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, and for agricultural practices. In addition, they include 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 were identified as impairing one or more of the following beneficial uses: aquatic life and coldwater fishes, drinking water, agricultural, and primary contact recreation in both segments of Flint Creek, Barnes Creek, Boulder Creek, Camp Creek, Douglas Creek (near Philipsburg), North Fork Douglas Creek, Fred Burr Creek, Royal Gold Creek, Smart Creek, and South Fork Lower Willow Creek. Metals such as Antimony, Arsenic, Cadmium, Copper, Iron, Lead, Mercury and Zinc are affecting beneficial uses in these streams by occurring in concentrations that exceed state water quality standards. Water quality restoration goals for these metals were established based on the state water quality standards for each respective metal.

Metals loads are quantified for natural background conditions and for sources such as abandoned mines, mine tailings, adits, and contaminated sediments. The most significant sources vary by watershed but are mostly related to the remnants of historic mining practices, as well as some natural sources.

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, and associated information, as a tool to guide local water quality improvement activities. Such activities can be documented within a watershed restoration plan consistent with DEQ and EPA recommendations.

Although most water quality improvements are based on voluntary measures that address diffuse sources, federal law calls for permit requirements for *point sources* to be consistent with the assumptions and requirements of wasteload allocations (WLAs) on streams where TMDLs have been developed and approved by EPA. The Flint Creek TPA has permitted dischargers requiring the incorporation of WLAs into permit conditions on Flint Creek, South Fork Lower Willow Creek and Smart Creek.

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.

Table ES-1. List of Impaired Waterbodies and their Impaired Uses in the Flint Creek TPA with Completed Sediment and Metals TMDLs Contained in this Document

Waterbody & Location Description	TMDL Prepared	TMDL Pollutant Category	Impaired Use(s)
Upper Flint Creek, Georgetown Lake to Boulder Creek confluence	Sediment	Sediment	Aquatic Life
	Arsenic	Metals	Aquatic Life; Drinking Water
	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life; Drinking Water
	Mercury	Metals	Aquatic Life; Drinking Water
Lower Flint Creek, Boulder Creek to mouth (Clark Fork River)	Sediment	Sediment	Aquatic Life; Primary Contact Recreation
	Arsenic	Metals	Aquatic Life; Drinking Water
	Copper	Metals	Aquatic Life
	Iron	Metals	Aquatic Life
	Lead	Metals	Aquatic Life; Drinking Water
Barnes Creek, headwaters to mouth (Flint Creek)	Sediment	Sediment	Aquatic Life; Primary Contact Recreation
	Iron	Metals	Agricultural; Aquatic Life; Drinking Water
Boulder Creek, headwaters to mouth (Flint Creek)	Arsenic	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
	Mercury	Metals	Aquatic Life; Drinking Water
	Zinc	Metals	Aquatic Life
Camp Creek, headwaters to mouth (Flint Creek)	Arsenic	Metals	Aquatic Life; Primary Contact Recreation
	Cadmium	Metals	Aquatic Life
	Copper	Metals	Aquatic Life; Primary Contact Recreation
	Lead	Metals	Aquatic Life; Primary Contact Recreation
	Zinc	Metals	Aquatic Life; Primary Contact Recreation
Douglas Creek (near Philipsburg), headwaters to mouth (Flint Creek)	Sediment	Sediment	Aquatic Life
	Arsenic	Metals	Agricultural; Aquatic Life; Drinking Water
	Cadmium	Metals	Agricultural; Aquatic Life; Drinking Water
	Copper	Metals	Agricultural; Aquatic Life
	Iron	Metals	Agricultural; Aquatic Life
	Lead	Metals	Agricultural; Aquatic Life; Drinking Water
	Mercury	Metals	Agricultural; Aquatic Life; Drinking Water
	Zinc	Metals	Agricultural; Aquatic Life
North Fork Douglas Creek, headwaters to mouth (Douglas Creek)	Cadmium	Metals	Aquatic Life; Drinking Water
	Copper	Metals	Agriculture; Aquatic Life
	Lead	Metals	Aquatic Life
	Zinc	Metals	Aquatic Life; Drinking Water
Fred Burr Creek, Fred Burr Lake to mouth (Flint Creek)	Arsenic	Metals	Aquatic Life; Drinking Water
	Lead	Metals	Aquatic Life
	Mercury	Metals	Aquatic Life; Drinking Water
Royal Gold Creek, headwaters to mouth (Boulder Creek)	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
Smart Creek, headwaters to mouth (Flint Creek)	Sediment	Sediment	Aquatic Life
	Arsenic	Metals	Drinking Water
	Iron	Metals	Aquatic Life

Table ES-1. List of Impaired Waterbodies and their Impaired Uses in the Flint Creek TPA with Completed Sediment and Metals TMDLs Contained in this Document

Waterbody & Location Description	TMDL Prepared	TMDL Pollutant Category	Impaired Use(s)
South Fork Lower Willow Creek, headwaters to mouth (Lower Willow Creek)	Antimony	Metals	Drinking Water
	Arsenic	Metals	Aquatic Life; Drinking Water
	Cadmium	Metals	Aquatic Life
	Copper	Metals	Aquatic Life
	Lead	Metals	Aquatic Life
	Mercury	Metals	Aquatic Life; Drinking Water

1.0 INTRODUCTION

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for sediment and metals problems in the Flint Creek TMDL Planning Area (TPA). This document also presents a general framework for resolving these problems. **Figure A-1**, found in **Appendix A**, shows a map of waterbodies in the Flint Creek TPA with sediment and metals pollutant listings.

1.1 BACKGROUND

In 1972, the U.S. Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act (CWA). The CWA's goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA requires each state to designate uses of their waters and to develop water quality standards to protect those uses. Each state must monitor their waters to track if they are supporting their designated uses.

Montana's water quality designated use classification system includes the following uses:
- fish and aquatic life
- wildlife
- recreation
- agriculture
- industry
- drinking water

Each waterbody has a set of standards associated with the applicable designated uses from the above list. Montana has established water quality standards to protect these uses, and a waterbody that does not meet one or more standards is called an impaired waters. Each state must monitor their waters to track if they are supporting their designated uses and every two years DEQ prepares a Water Quality Integrated Report (IR) which lists all impaired waterbodies and their identified impairment causes. Impairment causes fall within two main categories: pollutant and non-pollutant.

Montana's biennial IR identifies all the state's impaired waterbody segments. The 303(d) list portion of the IR includes all of those waterbody segments impaired by a pollutant, which require a TMDL. TMDLs are not *required* for non-pollutant causes of impairment. **Table A-1** in **Appendix A** identifies impaired waters for the Flint Creek TPA from Montana's 2012 303(d) List, as well as non-pollutant impairment causes included in Montana's "2012 Water Quality Integrated Report." **Table A-1** provides the current status of each impairment cause, identifying whether it has been addressed by TMDL development.

Both Montana state law (Section 75-5-701 of the Montana Water Quality Act) and section 303(d) of the federal CWA require the development of total maximum daily loads for all impaired waterbodies when water quality is impaired by a pollutant. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

Developing TMDLs and water quality improvement strategies includes the following components, which are further defined in **Section 4.0**:
- Determining measurable target values to help evaluate the waterbody's condition in relation to the applicable water quality standards

- Quantifying the magnitude of pollutant contribution from their sources
- Determining the TMDL for each pollutant based on the allowable loading limits for each waterbody-pollutant combination
- Allocating the total allowable load (TMDL) into individual loads for each source

In Montana, restoration strategies and monitoring recommendations are also incorporated in TMDL documents to help facilitate TMDL implementation.

Basically, developing a TMDL for an impaired waterbody is a problem-solving exercise: The problem is excess pollutant loading that impairs a designated use. The solution is developed by identifying the total acceptable pollutant load (the TMDL), identifying all the significant pollutant-contributing sources, and identifying where pollutant loading reductions should be applied to achieve the acceptable load.

1.2 WATER QUALITY IMPAIRMENTS AND TMDLS ADDRESSED BY THIS DOCUMENT

Table 1-1 below lists all of the impairment causes from the “2010 Water Quality Integrated Report” (IR) that are addressed in this document (also see **Appendix A, Figure A-1**). Each pollutant impairment falls within a TMDL pollutant category (e.g., sediment or metals), and this document is organized by those categories.

New data assessed during this project identified new metals impairment causes for six waterbodies. These impairment causes are identified in **Table 1-1** and noted as not being on the 2012 303(d) List (within the integrated report) or within the most recent 2012 IR, currently at the draft stage of development. Instead, these will be documented within the DEQ assessment files and incorporated into the 2014 IR.

This document contains 47 TMDLs (**Table 1-1**). There are several non-pollutant types of impairment that are also addressed in this document. The overlap between the pollutant TMDLs and non-pollutant impairment causes is discussed in **Section 7**. **Section 8** 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 the Flint Creek TPA without completed TMDLs (**Appendix A, Table A-1**), this document 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. **Table A-1** in **Appendix A** includes impairment causes that will be addressed by future TMDLs, as well as pollutant and non-pollutant impairment causes that need to be addressed by future planning and TMDL development efforts.

Table 1-1. Water Quality Impairment Causes for the Flint Creek TPA Addressed within this Document

Waterbody & Location Description	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status	Included in 2012 Integrated Report*
Upper Flint Creek, Georgetown Lake to Boulder Creek confluence	MT76E003_011	Sedimentation / Siltation	Sediment	Sediment TMDL contained in this document	Yes
		Alteration in streamside or littoral vegetation covers	Not Applicable: Non-Pollutant	Addressed via Sediment TMDL in this document	Yes
		Antimony	Metals	No TMDL developed; updated 303(d) listing status pending	Yes
		Arsenic	Metals	Arsenic TMDL contained in this document	Yes
		Cadmium	Metals	No TMDL developed; updated 303(d) listing status pending	Yes
		Copper	Metals	Copper TMDL contained in this document	Yes
		Iron	Metals	Future monitoring needed	No
		Lead	Metals	Lead TMDL contained in this document	Yes
		Low Flow Alterations	Not Applicable: Non-Pollutant	Partially addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Mercury	Metals	Mercury TMDL contained in this document	Yes
Lower Flint Creek, Boulder Creek to mouth (Clark Fork River)	MT76E003_012	Sedimentation/Siltation	Sediment	Sediment TMDL contained in this document	No
		Alteration in streamside or littoral vegetation covers	Not Applicable: Non-Pollutant	Addressed via Sediment TMDL in this document	Yes
		Arsenic	Metals	Arsenic TMDL contained in this document	Yes
		Cadmium	Metals	No TMDL developed; updated 303(d) listing status pending	Yes
		Copper	Metals	Copper TMDL contained in this document	Yes
		Iron	Metals	Iron TMDL contained in this document	Yes
		Lead	Metals	Lead TMDL contained in this document	Yes
		Turbidity	Sediment	Addressed via Sediment TMDL in this document	Yes
Barnes Creek, headwaters to mouth (Flint Creek)	MT76E003_070	Iron	Metals	Iron TMDL contained in this document	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL contained in this document	Yes

Table 1-1. Water Quality Impairment Causes for the Flint Creek TPA Addressed within this Document

Waterbody & Location Description	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status	Included in 2012 Integrated Report*
Boulder Creek, headwaters to mouth (Flint Creek)	MT76E003_060	Arsenic	Metals	Arsenic TMDL contained in this document	Yes
		Cadmium	Metals	Future monitoring recommended	No
		Copper	Metals	Future monitoring recommended	No
		Lead	Metals	Lead TMDL contained in this document	Yes
		Mercury	Metals	Mercury TMDL contained in this document	Yes
		Physical substrate habitat alterations	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Zinc	Metals	Zinc TMDL contained in this document	Yes
Camp Creek, headwaters to mouth (Flint Creek)	MT76E003_130	Alteration in streamside or littoral vegetation covers	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Arsenic	Metals	Arsenic TMDL contained in this document	Yes
		Cadmium	Metals	Cadmium TMDL contained in this document	No
		Copper	Metals	Copper TMDL contained in this document	Yes
		Fish Passage Barrier	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Lead	Metals	Lead TMDL contained in this document	Yes
		Zinc	Metals	Zinc TMDL contained in this document	Yes
Douglas Creek (Hall), confluence of Middle and South Forks to mouth (Flint Creek), T9N R13W S10	MT76E003_020	Physical substrate habitat alterations	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Cadmium	Metals	Future monitoring recommended	No
		Iron	Metals	Future monitoring recommended	No

Table 1-1. Water Quality Impairment Causes for the Flint Creek TPA Addressed within this Document

Waterbody & Location Description	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status	Included in 2012 Integrated Report*
Douglas Creek (Philipsburg), headwaters to where stream ends, T7N R14W S25	MT76E003_100	Arsenic	Metals	Arsenic TMDL contained in this document	Yes
		Cadmium	Metals	Cadmium TMDL contained in this document	Yes
		Copper	Metals	Copper TMDL contained in this document	Yes
		Iron	Metals	Iron TMDL contained in this document	Yes
		Lead	Metals	Lead TMDL contained in this document	Yes
		Mercury	Metals	Mercury TMDL contained in this document	Yes
		Physical substrate habitat alterations	Not Applicable: Non-Pollutant	Addressed via Sediment TMDL	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL contained in this document	Yes
		Zinc	Metals	Zinc TMDL contained in this document	Yes
North Fork Douglas Creek, headwaters to mouth (Douglas Creek)	MT76E003_030	Alteration in streamside or littoral vegetation covers	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Arsenic	Metals	No TMDL developed; updated 303(d) listing status pending	Yes
		Cadmium	Metals	Cadmium TMDL contained in this document	Yes
		Copper	Metals	Copper TMDL contained in this document	Yes
		Lead	Metals	Lead TMDL contained in this document	No
		Sulfates	Metals	No TMDL developed; updated 303(d) listing status pending	Yes
		Zinc	Metals	Zinc TMDL contained in this document	Yes
Fred Burr Creek, Fred Burr Lake to mouth (Flint Creek)	MT76E003_040	Alteration in streamside or littoral vegetation covers	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes
		Arsenic	Metals	Arsenic TMDL contained in this document	Yes
		Copper	Metals	Future monitoring needed	No
		Lead	Metals	Lead TMDL contained in this document	Yes
		Mercury	Metals	Mercury TMDL contained in this document	Yes
		Zinc	Metals	Future monitoring needed	No
Royal Gold Creek, headwaters to mouth (Boulder Creek)	MT76E003_140	Copper	Metals	Copper TMDL contained in this document	No
		Lead	Metals	Lead TMDL contained in this document	No

Table 1-1. Water Quality Impairment Causes for the Flint Creek TPA Addressed within this Document

Waterbody & Location Description	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status	Included in 2012 Integrated Report*
Smart Creek, headwaters to mouth (Flint Creek), T9N R13W S21	MT76E003_110	Alteration in streamside or littoral vegetation covers	Not Applicable: Non-Pollutant	Addressed via Sediment TMDL	Yes
		Arsenic	Metals	Arsenic TMDL contained in this document	No
		Iron	Metals	Iron TMDL contained in this document	No
		Sedimentation/Siltation	Sediment	Sediment TMDL contained in this document	Yes
South Fork Lower Willow Creek, headwaters to mouth (Lower Willow Creek)	MT76E003_050	Arsenic	Metals	Arsenic TMDL contained in this document	No
		Antimony	Metals	Antimony TMDL contained in this document	No
		Cadmium	Metals	Cadmium TMDL contained in this document	No
		Copper	Metals	Copper TMDL contained in this document	Yes
		Lead	Metals	Lead TMDL contained in this document	Yes
		Mercury	Metals	Mercury TMDL contained in this document	Yes
Princeton Gulch, headwaters to mouth (Boulder Creek)	MT76E003_090	Physical Substrate Habitat Alterations	Not Applicable: Non-Pollutant	Addressed via recommendations in **Sections 7**, **8**, & **9**	Yes

1.3 DOCUMENT LAYOUT

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 and attachments. In addition to this introductory section, this document includes:

Section 2.0 Flint Creek 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 Flint Creek watershed.

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

Sections 5.0 – 6.0 Sediment and Metals TMDL Components (sequentially):
Each 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 Framework Water Quality Restoration Strategy:
Discusses water quality restoration objectives and presents a framework for implementing a strategy to meet the identified objectives and TMDLs.

Section 9.0 Monitoring Strategy and Adaptive Management:
Describes a water quality monitoring plan for evaluating the long-term effectiveness of the Flint Creek Planning Area Sediment and Metals TMDLs and Framework Water Quality Improvement Plan.

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

2.0 FLINT CREEK WATERSHED DESCRIPTION

This section includes a summary of the physical characteristics and social profile of the Flint Creek watershed.

2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the Flint Creek watershed.

2.1.1 Location

The Flint Creek TMDL planning area (TPA) is located in the Pend Oreille River Basin (Accounting Unit 170102) of western Montana, as shown on **Figure A-2** in **Appendix A**. The TPA is located within the Middle Rockies Level III Ecoregion. Four Level IV Ecoregions are mapped within the TPA (Woods et al., 2002). These include: Flint Creek – Anaconda Mountains (17am), Alpine (17h), Deer Lodge – Philipsburg – Avon Grassy Intermontane Hills and Valleys (17ak) and Rattlesnake – Blackfoot – South Swan – Northern Garnet – Sapphire Mountains (17x) (**Appendix A**, **Figure A-3**). The majority of the TPA is within Granite County, with a minor percentage (near Georgetown Lake) in Deerlodge County.

The TPA is bounded by the Flint Creek Range to the east, the Anaconda Range to the south, and the John Long Mountains to the west. The total area is 318,537 acres, or approximately 498 square miles.

Topography

Elevations in the TPA range from approximately 1,200 to 2,700 meters (3,900 - 9,000 feet) above mean sea level (**Appendix A**, **Figure A-4**). The highest point in the watershed is Twin Peaks, at 9,067 feet. The lowest point is in the Drummond valley where Flint Creek drains into the Clark Fork River.

The TPA includes two basins: the Philipsburg Valley and the Drummond Valley. The valleys are separated by a narrow canyon. The canyon is confined by Henderson Mountain, a promontory of the John Long Mountains that abuts the Flint Creek Range north of Philipsburg. The Philipsburg Valley ranges from 5,000 - 6,000 feet above sea level, and the Drummond Valley from 4,000 - 4,600 feet above sea level.

2.1.2 Climate

Climate in the area is typical of mid-elevation intermontane valleys in western Montana. Voeller and Warren (1997) described the climate as “modified continental”, characterized by low overnight temperatures. The local climate is milder in the lower elevation Drummond Valley than in the Philipsburg Valley.

Precipitation is most abundant in May and June. Philipsburg receives an annual average of 14.8 inches of moisture, compared to 11.8 reported at Drummond. The mountains may exceed 40 inches average annual moisture (Voeller and Waren, 1997). See **Tables 2-1** and **2-2** for climate summaries; **Figure A-5** in **Appendix A** shows the distribution of average annual precipitation.

Climate Stations

Climate data for the TPA is based upon the stations at Philipsburg and Drummond (although the latter is located outside the TPA). The USDA Natural Resources Conservation Service (NRCS) operates three SNOTEL snowpack monitoring stations within the TPA: Black Pine, Combination and Peterson Meadows.

Figure A-5 in **Appendix A** shows the locations of the NOAA and SNOTEL stations, in addition to average annual precipitation. The precipitation data is mapped by Oregon State University's PRISM Group, based on the records from NOAA stations (PRISM Group, 2004). Climate data is provided by the Western Regional Climate Center, operated by the Desert Research Institute of Reno, Nevada.

Table 2-1. Monthly Climate Summary: Drummond

Drummond Aviation, Montana (242500) Period of Record : 6/ 1/1963 to 4/30/2012

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave. Max. Temp (F)	31.8	38.2	47.9	57.8	66.7	74.4	84.7	83.6	72.8	58.9	41.4	31.3	57.5
Ave. Min. Temp. (F)	12.3	15.6	21.8	27.8	34.8	42.0	45.0	43.5	36.3	28.4	20.0	12.2	28.3
Ave Tot. Precip. (in.)	0.85	0.57	0.76	0.99	1.76	2.00	1.10	1.18	1.12	0.82	0.76	0.84	12.75
Ave.. Snowfall (in.)	8.0	5.3	6.0	3.9	1.8	0.3	0.0	0.1	0.6	1.2	5.4	7.9	40.5
Ave Snow Depth (in.)	3	2	1	0	0	0	0	0	0	0	1	2	1
Drummond FAA Airport, Montana (242511) Period of Record : 11/1/1928 to 5/31/1963													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave. Max. Temp (F)	28.2	34.0	42.1	55.9	64.6	71.1	82.3	80.7	69.4	57.1	40.9	32.8	54.9
Ave. Min. Temp. (F)	5.9	11.1	18.2	26.5	34.1	40.1	43.8	42.0	34.4	26.7	17.5	12.1	26.0
Ave Tot. Precip. (in.)	0.61	0.55	0.67	0.78	1.59	1.87	1.00	0.86	0.91	0.80	0.67	0.58	10.89
Ave.. Snowfall (in.)	6.7	7.3	5.3	2.2	0.7	0.0	0.0	0.0	0.3	1.4	4.9	5.8	34.7
Ave Snow Depth (in.)	3	4	2	0	0	0	0	0	0	0	1	2	1

Table 2-2. Monthly Climate Summary: Philipsburg

Philipsburg Ranger Station, Montana (246472) Period of Record : 10/13/1955 to 4/30/2012

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave. Max. Temp (F)	33.2	37.4	44.3	53.0	62.2	70.4	80.2	79.8	69.8	58.0	41.9	33.9	55.3
Ave. Min. Temp. (F)	13.6	16.0	20.5	26.3	33.0	39.6	42.6	41.3	34.4	28.1	20.3	14.4	27.5
Ave Tot. Precip. (in.)	0.64	0.47	0.85	1.36	2.26	2.49	1.25	1.51	1.31	1.08	0.72	0.64	14.5
Ave. Snowfall (in.)	8.9	5.4	7.2	4.4	1.3	0.0	0.0	0.0	0.2	1.2	5.0	5.6	39.3
Ave Snow Depth (in.)	3	3	1	0	0	0	0	0	0	0	1	2	1
Philipsburg, Montana (246470) Period of Record : 9/16/1903 to 10/12/1955													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave. Max. Temp (F)	30.8	35.2	42.2	53.7	61.6	69.3	80.5	79.2	68.7	57.4	43.5	33.9	54.7
Ave. Min. Temp. (F)	11.7	14.6	19.8	27.0	33.3	39.1	43.8	41.9	35.5	28.9	21.5	15.5	27.7
Ave Tot. Precip. (in.)	0.81	0.78	1.03	1.30	2.15	2.82	1.34	1.03	1.40	1.00	0.81	0.68	15.17
Ave. Snowfall (in.)	9.7	9.6	11.4	8.8	5.9	1.5	0.0	0.2	1.2	4.0	8.0	8.2	68.6
Ave Snow Depth (in.)	3	3	1	0	0	0	0	0	0	0	1	2	1

2.1.3 Hydrology

2.1.3.1 Surface Water

Flint Creek drains from Georgetown Lake to the Clark Fork River near Drummond, a distance of approximately 36 miles. Flint Creek hydrography is illustrated on **Figure A-6** in **Appendix A**.

Flint Creek has three significant tributaries: Fred Burr Creek, Boulder Creek and Lower Willow Creek. Fred Burr Creek enters Flint Creek in the Philipsburg Valley, while Boulder and Lower Willow Creeks join Flint Creek in the Drummond Valley. Interbasin diversion to Trout Creek (described below) has significantly increased flow in that tributary, which drains into Flint Creek in the Philipsburg Valley. Flow in Flint Creek can also be augmented by inter-basin diversion from Silver Lake to Georgetown Lake. The Silver Lake – Georgetown Lake diversion can be reversed (Kendy and Tresch, 1996). Flow from Silver Lake drains to Warm Springs Creek, which meets the Clark Fork River in the Deer Lodge valley.

One hundred forty five lakes are present in the TPA (Montana Department of Natural Resources and Conservation, 2007). Of these, only 22 are large enough to be named. The largest are reservoirs (described below). The other named lakes are generally tarns present in the higher portions of the Flint Creek range, particularly in the upper Boulder Creek watershed.

Impoundments

Two impoundments are located within the watershed: Georgetown Lake (31,000 acre-feet) and Lower Willow Creek Reservoir (4,800 acre-feet). Georgetown Lake was created for hydroelectric power in 1900 by flooding Georgetown Flat (Montana Department of Environmental Quality, 1998). A third impoundment, the East Fork Rock Creek Reservoir (16,000 acre-feet), is within the adjacent Rock Creek watershed but stores water for agricultural use within the Flint Creek watershed. Water from this reservoir is diverted to the Flint Creek basin via the Flint Creek Main Canal, built in 1938. This canal drains to Trout Creek, a tributary of Flint Creek (Voeller and Waren, 1997).

Stream Gauging Stations

The United States Geological Survey (USGS) and DNRC maintain(ed) 11 gauging stations within the watershed (**Table 2-3**). Recent funding limitations have reduced the gauging network in this watershed. The Flint Creek near Drummond station was deactivated in 2004. The Flint Creek at Maxville and Boulder Creek at Maxville stations were converted to seasonal operations in November 2006. The USGS stations are situated on stream, while the DNRC stations are situated on canals and diversions to measure irrigation withdrawals. The USGS gauging stations are shown on **Figure A-6** in **Appendix A**.

Table 2-3. Stream Gages

Name	Number	Drainage Area	Agency	Period of Record
Flint Creek near Southern Cross	12325500	53 miles^2	USGS	1940-
Flint Creek Main Canal below Headgate	76E 02000	—	DNRC	1961-1980, 1982-
Flint Creek Main Canal below County Bridge	76GJ02089	—	DNRC	1961-1980, 1982-
Marshal Canal below Headgate	76GJ04000	—	DNRC	1961-1980, 1982-
Trout Creek below Marshal Canal Diversion	76GJ05000	—	DNRC	1961-1980, 1982-
Fred Burr Creek near Philipsburg	12327100	15.7 miles^2	USGS	1994-1996
Flint Creek at Maxville	12329500	208 miles^2	USGS	1942-
Boulder Creek at Maxville	12330000	71 miles^2	USGS	1940-
Allendale Canal below Headgate	76GJ08000	—	DNRC	1961-
Allendale Canal above Tail End	76GJ08080	—	DNRC	1961-1985, 1987-
Flint Creek near Drummond	12331500	490 miles^2	USGS	1991-2002, 2003-2004

Streamflow

Streamflow data is based on records from the USGS stream gages described above, and is available on the Internet from the USGS (2007). Flows in Flint Creek and its tributaries vary considerably over a calendar year. Hydrographs from stations at Flint Creek near Southern Cross (2007-2011), Flint Creek at Maxville (2007-2011), Boulder Creek at Maxville (2007-2011), Fred Burr Creek near Philipsburg (1994-1996), and Flint Creek near Drummond (2007-2011) are attached in **Appendix B**. Due to data gaps as described above, the date ranges for each hydrograph are not identical.

In the tributaries, peak discharges statistically occur in June, with a steadily declining flow to September, and then a slight increase in flow occurring in the fall; after which flows decline again gradually to a low flow condition through much of the winter until spring runoff. These patterns may in part relate to irrigation practices, with the flows declining steadily through summer as water is used to irrigate hayfields, and then, when fall comes the slight increase, or bump, in the hydrograph may illustrate the discontinuing of irrigation and/or irrigation returns at this time.

The hydrographs from Flint Creek exhibit a slightly different pattern, with a decline from peak flow being much more gradual and even plateauing through some summer months. These somewhat unusual extended high flows and prolonged decline of the hydrograph may reflect the dam management of water releases from Georgetown Lake, coupled with the influence of irrigation practices in the valley.

Annual peak discharge at Flint Creek near Southern Cross occurs over a wider range of dates than at the other gauging stations. Annual peak discharges were recorded in all months except January, March and April. The maximum peak discharge occurred on June 15, 2008 at 192 cfs. 2011 peak discharge occurred on July 4, at 177 cfs. USGS statistics show that the average low flow (over 68 years) is roughly 15 cfs.

The four highest recorded discharges at Flint Creek near Maxville probably represent rain-on-snow events. These discharges were 1,680 cfs (March 28, 1943); 1,280 cfs (April 17, 1948); 1,040 cfs (February 9, 1996); and 900 cfs (February 24, 1986). The maximum peak discharge in 2011 was 567 cfs on June 8.The lowest annual peak discharge measured at this station was 159 cfs (May 30, 1992). Peak annual discharge was measured prior to May 1 in 20 of the 57 years on record. Peak annual discharges were recorded 9 times in March, 5 times in February, 3 times in January and 3 times in April. The lowest flow recorded in 2011 was on October 29 (25 cfs), although USGS statistics report that the average low flow (based on 70 years) is 53 cfs.

Peak annual discharge in Boulder Creek (measured at Maxville) has ranged from 117 cfs (May 25, 1977) to 1,580 cfs (June 8, 2011). All annual peak discharges measured from Boulder Creek have occurred in May or June, with the exception of April 30, 1987. The lowest daily average flow measured was 2.8 cfs on October 13, 1991. The lowest daily average in 2011 was 20, on December 31.

Voeller and Waren (1997) summarized the average total annual discharge of Flint Creek and its tributary streams. Spring Creek, at the head of the Philipsburg Valley, contributes approximately 2,500 acre-feet annually (one acre-foot equals 43,560 cubic feet). Trout Creek has a natural average flow of 3,000 acre-feet annually, but this is considerably increased by the East Fork Rock Creek diversion. Fred Burr Creek's annual average flow is roughly 7,000 acre-feet. Total flow from the Philipsburg Valley via Flint Creek is roughly 70,800 acre-feet annually, as measured by the stream gage at Maxville. Average annual runoff from the Boulder Creek drainage is 32,900 acre-feet. Smart Creek and Douglas Creek contribute average annual flows of 3,500 acre-feet and 4,500 acre-feet, respectively. Lower Willow Creek Reservoir stores 4,800 acre-feet of spring runoff for later agricultural use. Barnes Creek contributes an average 3,500 acre-feet annually.

Rodeo Ground Spring, located near Drummond, flows directly into the Clark Fork River. The spring exists due to Flint Creek return flows (Voeller and Waren, 1997).

The Flint Creek near Drummond (12331500) stream gage does not record total basin outflow. Flood irrigation diversions that enter the Clark Fork River as springs or return flow bypass this stream gage. Voeller and Waren (1997) estimated that the total basin outflow was underrepresented by 35 cubic feet per second (cfs) from July 1 through September 30, and by 20 cfs in all other months.

2.1.3.2 Groundwater

Hydrogeology

Two distinct basins comprise the TPA. Groundwater flow within these valleys is typical of intermontane basins. Groundwater flows towards the center of the basin from the head and sides, and then down valley along the central axis.

The hydrogeology of the lower portion of the TPA is described in Kendy and Tresch (1996), in discussion of the Upper Clark Fork River basin. The Montana Department of Natural Resources Conservation (DNRC) completed a study on irrigation return flow in the Flint Creek watershed (Voeller and Waren, 1997). This report describes the geology, hydrogeology and hydrology of the Philipsburg and Drummond valleys in considerable detail.

While the bedrock surrounding the valleys hosts groundwater, Voeller and Waren studied only the valley aquifers and assumed that the bedrock-sediment interfaces at the valley margins are flow barriers. This is valid for the purposes of their study, and the average groundwater flow velocity in the bedrock is probably several orders of magnitude lower than in the valley fill sediments. However, carbonate and siliciclastic sedimentary rocks in the mountains may have zones of significant permeability. The hydrologic role of the structural geology (faults and folds) is uncertain. Faults may act as flow conduits or flow barriers. No studies of the bedrock hydrogeology were identified.
Natural recharge occurs from infiltration of precipitation, stream loss and flow out of the adjacent bedrock aquifers. Flood irrigation is a major source of recharge to the valley aquifers, particularly on the benches that flank the modern floodplain.

The canyon between the Philipsburg and Drummond Valleys is presumed to act as a groundwater bottleneck. Voeller and Waren (1997) assumed that all water leaving the Philipsburg basin does so as surface water in Flint Creek (and therefore measurable at the Flint Creek at Maxville stream gage). They made no mention of hyporheic water in streambed sediments, which would presumably represent a marginal increase in the total basin discharge.

Groundwater Quality

The Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC) program monitors and samples a statewide network of wells (Montana Bureau of Mines and Geology, 2007). Additionally, the GWIC program is engaged in a statewide characterization of aquifers and groundwater resources, by region. The TPA is in Region 5, the Upper Clark Fork River basin.

As of January 2007, the GWIC database reports 1,111 wells within the TPA (Montana Department of Natural Resources and Conservation, 2007). Water quality data is available for 42 of those wells. Of these wells, 24 are in the Philipsburg Valley, and 18 are in the Drummond Valley. The locations of these data points are shown on **Figure A-7** in **Appendix A**.

The water quality data include general physical parameters: temperature, pH and specific conductance, in addition to inorganic chemistry (common ions, metals and trace elements). MBMG does not analyze groundwater samples for organic compounds. Groundwater quality data is available from the GWIC database. Data from groundwater sampling sites within the Flint Creek watershed have also been retrieved and included with the DEQ TMDL development files.

A review of GWIC data reports for agricultural chemical monitoring programs did not yield any data points for Granite County.

There are 15 public water supplies within the TPA. The majority of these are small transient, non-community systems (*i.e.* that serve a dynamic population of more than 25 persons daily) located around Georgetown Lake. The Town of Philipsburg uses surface water; all other public water supplies in the TPA utilize groundwater. Water quality data is available from these utilities via the SDWIS State database (Water Quality Bureau, Environmental Sciences Division, Montana State Department of Health and Environmental Sciences, 2007), although the data reflect the finished water provided to users, not raw water at the source.

2.1.4 Geology and Soils

Figure A-8 in **Appendix A** provides an overview of the geology, based on the most recent geologic map of the Butte 1° x 2° quadrangle (Lewis, 1998). Description of the geology is derived from more recent, larger-scale mapping projects. The geology of selected areas of the TPA has been described and mapped in detail by Portner and Hendrix (2005) and Lonn *et al*. (2003). The geology of the Flint Creek area is complex, and has been subjected to considerable reinterpretation in recent years. Much of the recent debate is beyond the scope of this characterization. In summary, recognition of the Anaconda metamorphic core complex (O'Neill et al., 2002), led to the interpretation that the major folds and faults of the Flint Creek Range were produced by extensional and compressional forces.

In general, the TPA encompasses fault-bounded valleys and the bedrock mountains that surround them. At the eastern edge of the Philipsburg Valley, the Philipsburg-Georgetown Thrust defines the eastern edge of a structural unit formerly called the Sapphire Block (no longer considered an intact body), which extends west to the Bitterroot detachment fault (Lonn et al., 2003). This structural unit was also been referred to as the Western Structural Block.

Bedrock

The 'Sapphire Block' includes the John Long Mountains, which separate the Flint Creek and Rock Creek watersheds. Like the Sapphire Mountains, the John Long Mountains are composed of Middle Proterozoic (~1.5 billion years old) Belt Supergroup rocks. These rocks are interpreted as passive margin deposits, and the dominant lithologies are siltstone, sandstone and limestone (and their metamorphic equivalents). Volcanics of Tertiary age are also present, including the Rock Creek volcanic field (in the adjacent watershed), a rhyolitic flow believed to be the source of the eponymous sapphires. These rocks are less resistant than the granitic rocks in surrounding mountain ranges, giving the Sapphire and John Long ranges their subdued topography and lower elevations.

The Flint Creek Range is composed of folded and faulted sedimentary rocks ranging in age from Cambrian (540 million years ago) through Cretaceous (65 million years ago), with overthrusts of Belt Supergroup rocks mapped in places. Cretaceous rocks are the most extensive sedimentary rocks; Portner and Hendrix (2005) report that the Cretaceous section in the northern Flint Creek range is one of the thickest in Montana. The Cretaceous sediments are predominantly fine-grained rocks such as siltstones and shales.

This package of sedimentary rocks has been intruded by several generations of Cretaceous and Tertiary igneous rocks. The range is cored by the Philipsburg pluton, a body of resistant Cretaceous granodiorite that holds up the higher peaks. Metamorphism and hydrothermal activity associated with these rocks produced ores that made Philipsburg a significant silver mining district. Pleistocene glaciation sculpted the Flint Creek range, producing the rugged alpine geomorphology.

Basin Sediments

In the Northern Rockies, the Tertiary is generally characterized as a time of basin filling, followed by renewed uplift, stream erosion and downcutting in the Quaternary. The basins are filled with several thousand feet of Tertiary basin-fill sediments, with a veneer of overlying Quaternary deposits. Stalker and Sherriff (2004) estimate the Tertiary rocks reach a maximum of 4,000 feet thick in the center of the Flint Creek basin (Drummond Valley). Large-scale mapping of the unconsolidated sediments is not available, although cross-sections were prepared by Voeller and Waren (1997). Quaternary sediments include fluvial, colluvial, glacial and proglacial deposits. The lower portion of the Drummond Valley was inundated by Glacial Lake Missoula, and lacustrine sediments are likely.

Voeller and Waren (1997) reported that the upper several hundred feet of basin sediments are dominated by shale and clay. Coarse-grained sediments are limited, generally occurring as alluvium or gravel caps on benches.

The benches above the modern alluvial valley are generally capped by a coarsening-upward sequence of 15-20 feet of sandy or gravelly sediment. In their review of well logs across the watershed, Voeller and Waren (1997) identified a common sequence of shale at depth, commonly overlain by up to 100 feet of clay, with silty sand, gravel and cobble deposits at the surface. A bouldery debris-flow deposit (Beaty, 1961) just north of the [Boulder Creek] canyon mouth is up to 50 feet thick, and hosts a gravel pit (Voeller and Waren, 1997).

Glacial History

The glacial history of the watershed is presumably similar to that of the rest of the Central and Northern Rockies, although no detailed studies were identified. While evidence of earlier glaciations (before 150,000 years ago) is not well-preserved, there is widespread evidence for two recent episodes of significant glacial activity. The earlier (Bull Lake) is generally dated to ~130,000 years ago, and the later (Pinedale) to 23,000 – 16,000 years ago (Chadwick et al., 1997; Pierce et al., 1976). The dates are general; alpine glacial activity varied somewhat according to elevation and other local variables. Each period of glaciation included multiple advances and retreats.

In the absence of detailed Quaternary mapping, discussion of the glacial history is based on aerial photograph interpretation. Bull Lake -aged features are subdued and indistinct, due to their long exposure to weathering. Pinedale -aged features are much easier to identify. The Fred Burr drainage displays distinctive glacial morphology. The valley is a classic U-shaped glacial trough, and a prominent terminal moraine is present just beyond the valley’s mouth. A broad sheet of glacial outwash extends northwestward towards Flint Creek. Fred Burr Creek has incised this deposit.

The Fred Burr glacier is the only valley glacier that extended to the basin floor, and this is the only moraine mapped in the TPA by Alden (1953). The Boulder Creek valley and several of its tributaries were also glaciated, but the (Pinedale-aged) glacier terminated near Princeton Gulch, and did not reach the Drummond Valley. Beaty (1961) reports “stranded lateral moraines from an earlier glaciation” along the walls of the canyon as far as its mouth, but notes that the canyon morphology is inconsistent with recent glaciation.

Soils

The USGS Water Resources Division (Schwartz and Alexander, 1995) created a dataset of hydrology-relevant soil attributes, based on the USDA Natural Resources Conservation Service (NRCS) STATSGO soil

database. The STATSGO data is intended for small-scale (watershed or larger) mapping, and is too general to be used at scales larger than 1:250,000. It is important to realize, therefore, that each soil unit in the STATSGO data may include up to 21 soil components. Soil analysis at a larger scale should use NRCS SSURGO data. The soil attributes considered in this characterization are erodibility and slope.
Soil erodibility is based on the Universal Soil Loss Equation (USLE) K-factor (Wischmeier and Smith, 1978). K-factor values range from 0 to 1, with a greater value corresponding to greater potential for erosion. Susceptibility to erosion is mapped on **Figure A-9 (Appendix A)**, with soil units assigned to the following ranges: low (0.0-0.2), moderate-low (0.2-0.29) and moderate-high (0.3-0.4). Values of >0.4 are considered highly susceptible to erosion. No values greater than 0.4 are mapped in the TPA.

Several patterns are apparent in the distribution of mapped K-factors. The low and moderate-to-low susceptibility soils correspond to timbered uplands, and moderate-to-high susceptibility soils are confined to the valleys. Moderate-to-high susceptibility soils coincide with areas where Tertiary sediments are mapped, and the Quaternary alluvial valleys incised into these deposits generally have moderate-to-low susceptibility. The majority of the low-susceptibility soils coincide with the granitic rocks of the Philipsburg pluton. A smaller area of low K-factor soils occurs in a band at the southwestern margin of the Drummond Valley, against the foot of the John Long Mountains. The geology of this area is mapped as Tertiary sediments (**Appendix A**, **Figure A-9**). These may correspond to gravelly fanglomerate deposits; available geologic maps are of insufficient resolution to differentiate these deposits from the other Tertiary deposits.

The majority of the soil units within the watershed are mapped with slopes ranging from 21°-34°. The alluvium alongside Flint Creek in the Philipsburg valley has a slope of 1.2°. Much of the Drummond Valley (corresponding to the gravel benches) has slopes of 1.2°-21°.

A map of soil slope is provided on **Figure A-10 (Appendix A)**.

2.2 ECOLOGICAL PROFILE

The following information describes the ecological profile of the Flint Creek watershed.

2.2.1 Vegetation

The primary cover in the uplands is conifer forest. Conifers are dominated by Lodgepole pine, giving way to Douglas fir at lower elevations. The valleys are characterized by grassland and irrigated agricultural land, with minor shrublands. Landcover is shown on **Figures A-11 and A-12** in **Appendix A**. Data sources include the University of Montana's Satellite Imagery land Cover (SILC) project (University of Montana, 2002), and USGS National Land Cover Dataset (NLCD) mapping (Montana State Library, 1992).

2.2.2 Aquatic Life

Native fish species present in the TPA include: bull trout, westslope cutthroat trout, mountain whitefish, largescale sucker and longnose sucker. Native redside shiner are present in Georgetown and Echo lakes. Bull trout and westslope cutthroat trout are designated "Species of Concern" by Montana Department of Fish, Wildlife and Parks (FWP). Bull trout are further listed as "threatened" by the US Fish and Wildlife Service (US FWS). Reaches of Flint and Fred Burr Creeks have been designated as critical habitat for bull trout (50 CFR Part 17 (2005)).

As mapped by FWP, bull trout and western cutthroat trout inhabit different portions of the Flint Creek watershed. Bull trout are mapped along the full length of Flint Creek, and in its tributaries of Marshall Creek and Boulder Creek. A small (0.05 mile) length of Fred Burr Creek is mapped with bull trout. Bull trout are not mapped in any tributaries of Boulder Creek. Bull trout are not present in Lower Willow Creek or its tributaries. Westslope cutthroat trout are not present in Flint Creek, but are mapped in its tributary drainages, and in the tributaries of Lower Willow Creek and Boulder Creek.

Introduced species are also present, including: brook, rainbow and brown trout, and kokanee salmon. Additionally, Yellowstone cutthroat trout are reported in Middle Altoona and Lower Boulder Lakes, seemingly beyond their native range.

Data on fish species distribution is collected, maintained and provided by FWP (2006). Fish species distribution is shown on **Figure A-13 (Appendix A)** and tabulated in **Appendix B**.

2.2.3 Fires

One significant burn is mapped within the TPA (University of Montana, 2002), stretching from South Fork Lower Willow Creek to Smart Creek (**Appendix A**, **Figure A-14**). Aerial photographs taken in July 2005 reveal that vegetation is returning to this area. Abundant roads suggest that this area experienced a timber harvest either pre- or post-fire.

The United States Forest Service (USFS) remote sensing applications center provides data on fire locations from 2001 to the present (**Appendix A**, **Figure A-14**). No fires from 2001 or 2002 are mapped within the TPA (U.S. Forest Service, 2006). Isolated fires are mapped from 2003 to 2006, mostly on the western flanks of the Flint Creek range. These are difficult to identify as burned areas on aerial photographs. In general, the TPA has not experienced significant burns in recent years.

2.3 SOCIAL PROFILE

The following information describes the social profile of the Flint Creek watershed.

2.3.1 Population

An estimated 1,951 persons lived within the TPA in 2000. This is an increase of 16% from an estimated 1,682 in 1990. Population estimates are derived from census data (United States Census Bureau, 2000), with spatial analysis of census blocks performed by NRIS' thematic mapper (Montana Department of Natural Resources and Conservation, 2007). The denser populations are located along Montana Highway 1, which links Georgetown Lake with the towns of Philipsburg, Maxville, Hall and Drummond.

2.3.2 Transportation Networks

Roads

The principal transportation route in the TPA is Montana Highway 1. Highway 1 connects Anaconda to Drummond, via Georgetown Lake and Philipsburg. An estimated 613 miles of paved roadways were present in 2000 (Montana Department of Natural Resources and Conservation, 2007). The network of unpaved roads on public and private lands will be further characterized as part of the source assessment.

Railroads

No active railways are present in the TPA. Montana Rail Link maintains 32 miles of railroad rights-of-way in the TPA (Montana Department of Natural Resources and Conservation, 2007). During the peak years of mining and milling, a rail line connected Philipsburg to Drummond, with a spur extending up Douglas Creek.

2.3.3 Land Ownership

Slightly more than one-half of the TPA is under private ownership. The dominant landholder is the USFS, which administers 42.5% of the TPA (**Table 2-4**). There is a distinct pattern of ownership, with private land concentrated in the basins and USFS land concentrated in the uplands (**Appendix A**, **Figure A-15**).

Table 2-4. Land Ownership

Owner	Acres	Square Miles	% of Total
Private	165,387	258.4	51.9%
US Forest Service	135,334	211.5	42.5%
US Bureau of Land Management	8,538	13.3	2.7%
State Trust Land	5,764	9.0	1.8%
Other State Land	333	0.5	0.1%
Water	3,180	5.0	1.0%
Total	318,537	497.7	—

2.3.4 Land Use

Land use within the TPA is dominated by forest and agriculture. Agriculture in the valley is primarily related to the cattle industry: irrigated hay and dry grazing (**Table 2-5**). Information on land use is based on the National Land Cover Dataset (NLCD), from mapping completed by the USGS circa 1992. Land use categories are based on a combination of observed existing land use and existing land cover vegetation analysis. The data is at 1:250,000 scale. Census trends from 1990 to 2000 (described above) suggest that the percentage of residential use has probably increased, but aerial photographs from 2005 show that the watershed is still relatively sparsely populated. Agricultural land use is illustrated on **Figure A-16 (Appendix A)**. Potential sources of human impacts (abandoned mines, livestock feeding areas, and MPDES-permitted discharge sites) are illustrated on **Figure A-17 (Appendix A)**.

Table 2-5. Land Use

Land Use	Acres	Square Miles	% of Total
Evergreen Forest	170,033	265.7	53.4%
Mixed Rangeland	72,183	112.8	22.7%
Crop/Pasture	38,119	59.6	12.0%
Brush Rangeland	14,125	22.1	4.4%
Grass Rangeland	7,500	11.7	2.4%
Deciduous Forest	5,748	9.0	1.8%
Exposed Rock	3,832	6.0	1.2%
Reservoir	2,816	4.4	0.88%
Mixed Forest	1,836	2.9	0.58%
Residential	743	1.2	0.23%
Mine/Quarry	657	1.0	0.21%
Lake	229	0.4	0.072%
Wetland (Existing Woody and/or Emergent Herbaceous Wetland Vegetation)	142	0.2	0.045%

Table 2-5. Land Use

Land Use	Acres	Square Miles	% of Total
Mixed Urban	128	0.2	0.040%
Transportation/Utilities	93	0.1	0.029%
Other Urban	63	0.1	0.020%
Other Agriculture	54	0.1	0.017%
Commercial	51	0.1	0.016%

Information on agricultural land use can be obtained from Department of Revenue data. Nearly 16,000 acres of irrigated land is reported in the TPA. Voeller and Waren (1997) found that a detailed survey of irrigated acreage in a 1959 report prepared by the State Engineer's Office (now DNRC) was still relevant in the mid-1990s. According to this data, 8,200 acres are irrigated in the Philipsburg Valley, and 17,000 acres in the Drummond Valley. Despite the age of the data, these numbers are probably more realistic than the Department of Revenue data, which assigns an agricultural use only if more than 50% of a given parcel is so used. Irrigation infrastructure includes interbasin diversions and impoundments as described above in **Section 2.1.3**.

Mining

The Flint Creek TPA was the scene of considerable mining activity. Like many other mining districts, much of the metal production began with gold placers. Lode mines, particularly silver, and eventually tungsten, manganese and phosphate, came to be of particular importance. The Philipsburg district was a major silver producer, and the hills east of Philipsburg exhibit the highest density of abandoned mine sites (Water Quality Bureau, Environmental Sciences Division, Montana State Department of Health and Environmental Sciences, 2007). MBMG completed an environmental survey of 119 abandoned mining sites in the Flint Creek and Rock Creek watersheds in the mid-1990s (Metesh et al., 1995). The study was limited to sites on Deer Lodge National Forest property.

Milling was performed at many locations within the TPA, both in Philipsburg and at many of the now abandoned mining camps. Waste rock and tailings are still present in many locations. DEQ Remediation Division data on abandoned mine locations are plotted on **Figure A-17 (Appendix A)**. No active mines are present as of early 2007, according to DEQ Environmental Management Bureau files.

Livestock Operations

The Montana Pollution Discharge Elimination System (MPDES) does not include any regulated concentrated animal feeding operations (CAFOs) within the Flint Creek watershed. From interpretation of aerial photographs, DEQ identified 12 denuded areas that are probable livestock operations (**Appendix A**, **Figure A-17**). Four of these locations are directly adjacent to surface waterbodies. DEQ Water Protection Bureau personnel have yet to determine whether any of these sites meet the definitions of a CAFO.

Wastewater

One municipal wastewater system is located within the TPA. The town of Philipsburg is sewered, and the wastewater lagoons are located northwest of town, adjacent to Flint Creek. This discharge location is shown on **Figure A-17 (Appendix A)**.

Septic system density is estimated from the 2000 census block data, based on the assumption that one septic tank and drainfield is installed for each 2.5 persons (Montana Department of Natural Resources and Conservation, 2007). Septic system density is classified as low (<50 per square mile), moderate (51-

300 per square mile) or high (>300 per square mile). Nearly all of the TPA is mapped as low septic system density, with very limited areas of moderate (347 acres) and high (2 acres) density. The moderate density locations are found primarily around Georgetown Lake, outside Philipsburg, and in and around Maxville. The high density areas are limited to two ~1 acre areas south and east of Georgetown Lake. Septic system density is illustrated on **Figure A-17 (Appendix A)**.

3.0 MONTANA WATER QUALITY STANDARDS

The federal Clean Water Act 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 include four 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
4. Prohibitions of practices that degrade water quality

Those components that apply to this document are reviewed briefly below. More detailed descriptions of Montana's water quality standards that apply to the Flint Creek TPA streams can be found **Appendix C**.

3.1 FLINT CREEK TPA STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Waterbodies are classified based on their designated uses. All Montana waters are classified for multiple uses. All streams identified in this document within the Flint Creek watershed are classified as B-1, which specifies that the water must be maintained suitable to support all of the following uses:

- 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
- Agricultural and industrial waters 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. More detailed descriptions of Montana's surface water classifications and designated uses are provided in **Appendix C**.

Twelve waterbodies or waterbody segments in the Flint Creek TPA are listed in the "2012 Water Quality Integrated Report" as not supporting or partially supporting one or more designated uses (**Table 3-1**). In the course of investigations related to the development of this document, Douglas Creek (Hall), and Princeton Gulch were found to be currently supporting their designated uses, whereas Royal Gold Creek, which was not previously assessed, was found to be "not supporting" due to Copper and Lead impairments. Waterbodies that are "not supporting" or "partially supporting" a designated use are impaired and require a TMDL. When TMDLs are written, they are written to protect all designated uses for a waterbody and not just those identified as being not or partially supported. DEQ describes impairment as either partially supporting or not supporting, based on assessment results. Not supporting is applied to not meeting a drinking water standard, and is also applied to conditions where the assessment results indicate a severe level of impairment of aquatic life or coldwater fishery. A non-supporting level of impairment does not equate to complete elimination of the use. Detailed information about Montana's use support categories can be found in **Appendix A** of Montana's Water

Quality Integrated Report (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2010).

Table 3-1. Impaired Waterbodies and their Designated Use Support Status on the "2012 Water Quality Integrated Report" in the Flint Creek TPA

Waterbody & Location Description	Waterbody ID	Use Class	Agriculture	Aquatic Life	Drinking Water	Primary Contact Recreation
Upper Flint Creek, Georgetown Lake to Boulder Creek	MT76E003_011	B-1	F	N	N	P
Lower Flint Creek, Boulder Creek to mouth (Clark Fork River)	MT76E003_012	B-1	F	N	N	P
Barnes Creek, headwaters to mouth (Flint Creek)	MT76E003_070	B-1	P	P	P	P
Boulder Creek, headwaters to mouth (Flint Creek)	MT76E003_060	B-1	F	P	N	X
Camp Creek, headwaters to mouth (Flint Creek)	MT76E003_130	B-1	F	N	F	N
Douglas Creek (Hall), confluence of Middle and South Forks to mouth (Flint Creek), T9N R13W S10	MT76E003_020	B-1	F	P	X	F
Douglas Creek (Philipsburg), headwaters to where stream ends, T7N R14W S25	MT76E003_100	B-1	P	N	N	P
North Fork Douglas Creek, headwaters to mouth (Douglas Creek)	MT76E003_030	B-1	P	N	N	X
Fred Burr Creek, Fred Burr Lake to mouth (Flint Creek)	MT76E003_040	B-1	F	N	N	F
Smart Creek, headwaters to mouth (Flint Creek), T9N R13W S21	MT76E003_110	B-1	F	P	F	F
South Fork Lower Willow Creek, headwaters to mouth (Lower Willow Creek)	MT76E003_050	B-1	F	N	N	X
Princeton Gulch, headwaters to mouth (Boulder Creek)	MT76E003_090	B-1	F	P	X	X

3.2 FLINT CREEK TPA WATER QUALITY STANDARDS

In addition to the use classifications described above, Montana's water quality standards include numeric and narrative criteria that protect the designated uses. Numeric criteria define the allowable concentrations of specific pollutants so as not to impair designated uses. Narrative criteria are more "free from" descriptions, or statements, of unacceptable conditions. **Appendix C** defines both the numeric and narrative water quality criteria for the Flint Creek TPA. For the sediment and metals TMDL development in the Flint Creek TPA the narrative standards are applicable to sediment impairments, and numeric standards are applicable to metals impairments.

Numeric standards apply to pollutants that are known to have adverse effects on human health or aquatic life (e.g., metals, organic chemicals, and other toxic constituents). Human health standards are set at levels that protect against long-term (lifelong) exposure, as well as short-term exposure through direct contact such as swimming. Numeric standards for aquatic life include chronic and acute values. Chronic aquatic life standards prevent long-term, low level exposure to pollutants. Acute aquatic life standards protect from short-term exposure to pollutants. Chronic standards are usually more stringent than acute standards.

Narrative standards are developed when there is insufficient information to develop specific numeric standards. Narrative standards describe either the allowable condition or an allowable increase of a pollutant above “naturally occurring” conditions. DEQ uses the naturally occurring condition, called a “reference condition,” to determine whether or not narrative standards are being met (see **Appendix C**).

Reference defines the condition a waterbody could attain if all reasonable land, soil, and water conservation practices were put in place. Reasonable land, soil, and water conservation practices usually include, but are not limited to, best management practices (BMPs).

The specific water quality standards that apply to the Flint Creek TPA are summarized in **Appendix C**.

4.0 DEFINING TMDLS AND THEIR COMPONENTS

A Total Maximum Daily Load (TMDL) is a tool for implementing water quality standards and is based on the relationship between pollutant sources and water quality conditions. More specifically, a TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive from all sources and still meet water quality standards.

- Pollutant sources are generally defined as two categories: point sources and nonpoint sources. Point sources are discernible, confined and discrete conveyances, such as pipes, ditches, wells, containers, or concentrated animal feeding operations, from which pollutants are being, or may be, discharged. Some sources such as return flows from irrigated agriculture are not included in this definition. All other pollutant loading sources are considered nonpoint sources. Nonpoint sources are diffuse and are typically associated with runoff, streambank erosion, most agricultural activities, atmospheric deposition, and groundwater seepage. Natural background loading is a type of nonpoint source.

As part of TMDL development, the allowable load is divided among all significant contributing point and nonpoint sources. For point sources, the allocated loads are called “wasteload allocations” (WLAs). For nonpoint sources, the allocated loads are called “load allocations” (LAs).

A TMDL is expressed by the equation: $\text{TMDL} = \Sigma\text{WLA} + \Sigma\text{LA}$, where:

ΣWLA is the sum of the wasteload allocation(s) (point sources)
ΣLA is the sum of the load allocation(s) (nonpoint sources)

TMDL development must include a margin of safety (MOS), which can be explicitly incorporated into the above equation. Alternatively, the MOS can be implicit in the TMDL. A TMDL must also ensure that the waterbody will be able to meet and maintain water quality standards for all applicable seasonal variations (e.g., pollutant loading or use protection).

Development of each TMDL has four major components:

- Determining water quality targets
- Quantifying pollutant sources
- Establishing the total allowable pollutant load
- Allocating the total allowable pollutant load to their sources

Although the way a TMDL is expressed can vary by pollutant, these four components are common to all TMDLs, regardless of pollutant. Each component is described in further detail in the following subsections.

Figure 4-1 illustrates how numerous sources contribute to the existing load and how the TMDL is defined. The existing load can be compared to the allowable load to determine the amount of pollutant reduction needed.

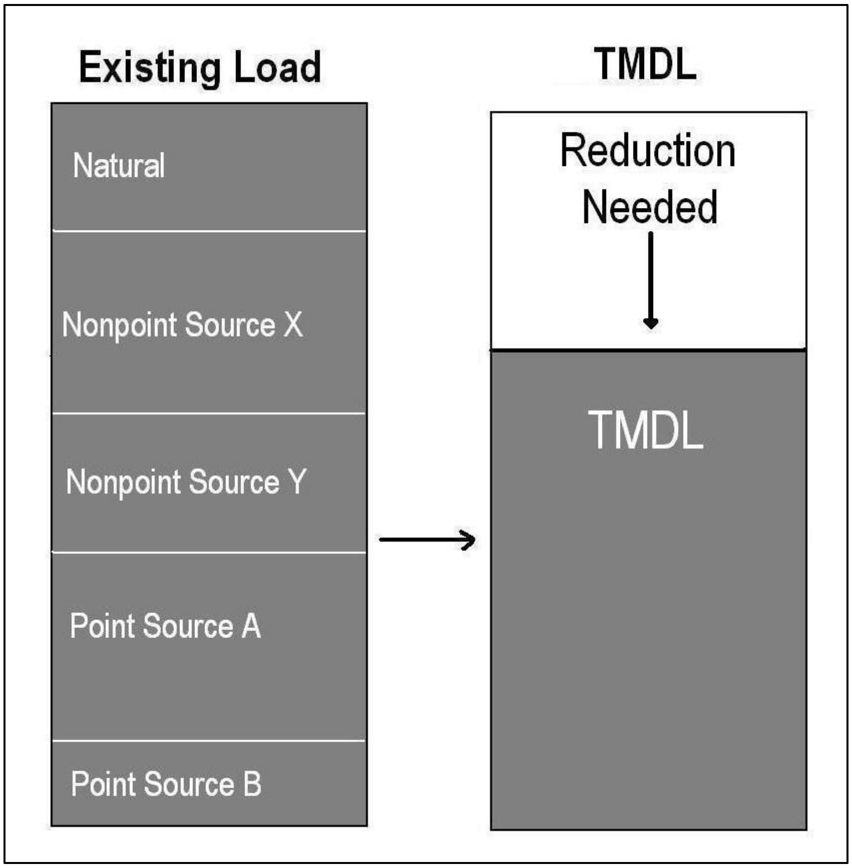

Figure 4-1. Schematic Example of TMDL Development

4.1 DEVELOPING WATER QUALITY TARGETS

TMDL water quality targets are a translation of the applicable numeric or narrative water quality standard(s) for each pollutant. For pollutants with established numeric water quality standards, the numeric value(s) are used as the TMDL targets. For pollutants with narrative water quality standard(s), the targets provide a waterbody-specific interpretation of the narrative standard(s).

Water quality targets are typically developed for multiple parameters that link directly to the impaired beneficial use(s) and applicable water quality standard(s). Therefore, the targets provide a benchmark by which to evaluate attainment of water quality standards. Furthermore, comparing existing stream conditions to target values allows for a better understanding of the extent and severity of the problem.

4.2 QUANTIFYING POLLUTANT SOURCES

All significant pollutant sources, including natural background loading, are quantified so that the relative pollutant contributions can be determined. Because the effects of pollutants on water quality can vary throughout the year, assessing pollutant sources must include an evaluation of the seasonal variability of the pollutant loading. The source assessment helps to define the extent of the problem by linking the pollutant load to specific sources in the watershed.

A pollutant load is usually quantified for each point source permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Nonpoint sources are quantified by source categories (e.g., unpaved roads) and/or by land uses (e.g., grazing or forestry). These source categories and land uses can be divided further by ownership, such as federal, state, or private. Alternatively, most, or all, pollutant sources in a sub-watershed or source area can be combined for quantification purposes.

Because all potentially significant sources of the water quality problems must be evaluated, source assessments are conducted on a watershed scale. The source quantification approach may produce reasonably accurate estimates or gross allotments, depending on the data available and the techniques used for predicting the loading (40 CFR Section 130.2(I)). Montana TMDL development often includes a combination of approaches, depending on the level of desired certainty for setting allocations and guiding implementation activities.

4.3 ESTABLISHING THE TOTAL ALLOWABLE LOAD

Identifying the TMDL requires a determination of the total allowable load over the appropriate time period necessary to comply with the applicable water quality standard(s). Although “TMDL” implies “daily load,” determining a daily loading may not be consistent with the applicable water quality standard(s), or may not be practical from a water quality management perspective. Therefore, the TMDL will ultimately be defined as the total allowable loading during a time period that is appropriate for applying the water quality standard(s) and which is consistent with established approaches to properly characterize, quantify, and manage pollutant sources in a given watershed. For example, sediment TMDLs may be expressed as an allowable annual load.

If a stream is impaired by a pollutant for which numeric water quality criteria exist, the TMDL, or allowable load, is typically calculated as a function of streamflow and the numeric criteria. This same approach can be applied when a numeric target is developed to interpret a narrative standard.

Some narrative standards, such as those for sediment, often have a suite of targets. In many of these situations it is difficult to link the desired target values to highly variable, and often episodic, instream loading conditions. In such cases the TMDL is often expressed as a percent reduction in total loading based on source quantification results and an evaluation of load reduction potential (**Figure 4-1**). The degree by which existing conditions exceed desired target values can also be used to justify a percent reduction value for a TMDL.

Even if the TMDL is preferably expressed using a time period other than daily, an allowable daily loading rate will also be calculated to meet specific requirements of the federal Clean Water Act. Where this occurs, TMDL implementation and the development of allocations will still be based on the preferred time period, as noted above.

4.4 DETERMINING POLLUTANT ALLOCATIONS

Once the allowable load (the TMDL) is determined, that total must be divided among the contributing sources. In addition to basic technical and environmental analysis, DEQ also considers economic and social costs and benefits when developing allocations. The allocations are often determined by quantifying feasible and achievable load reductions through application of a variety of best management practices and other reasonable conservation practices.

Under the current regulatory framework (40 CFR 130.2) for developing TMDLs, flexibility is allowed in allocations in that “TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure." Allocations are typically expressed as a number, a percent reduction (from the current load), or as a surrogate measure (e.g., a percent increase in canopy density for temperature TMDLs).

Figure 4-2 illustrates how TMDLs are allocated to different sources using WLAs for point sources and LAs for natural and nonpoint sources. Although some flexibility in allocations is possible, the sum of all allocations must meet the water quality standards in all segments of the waterbody.

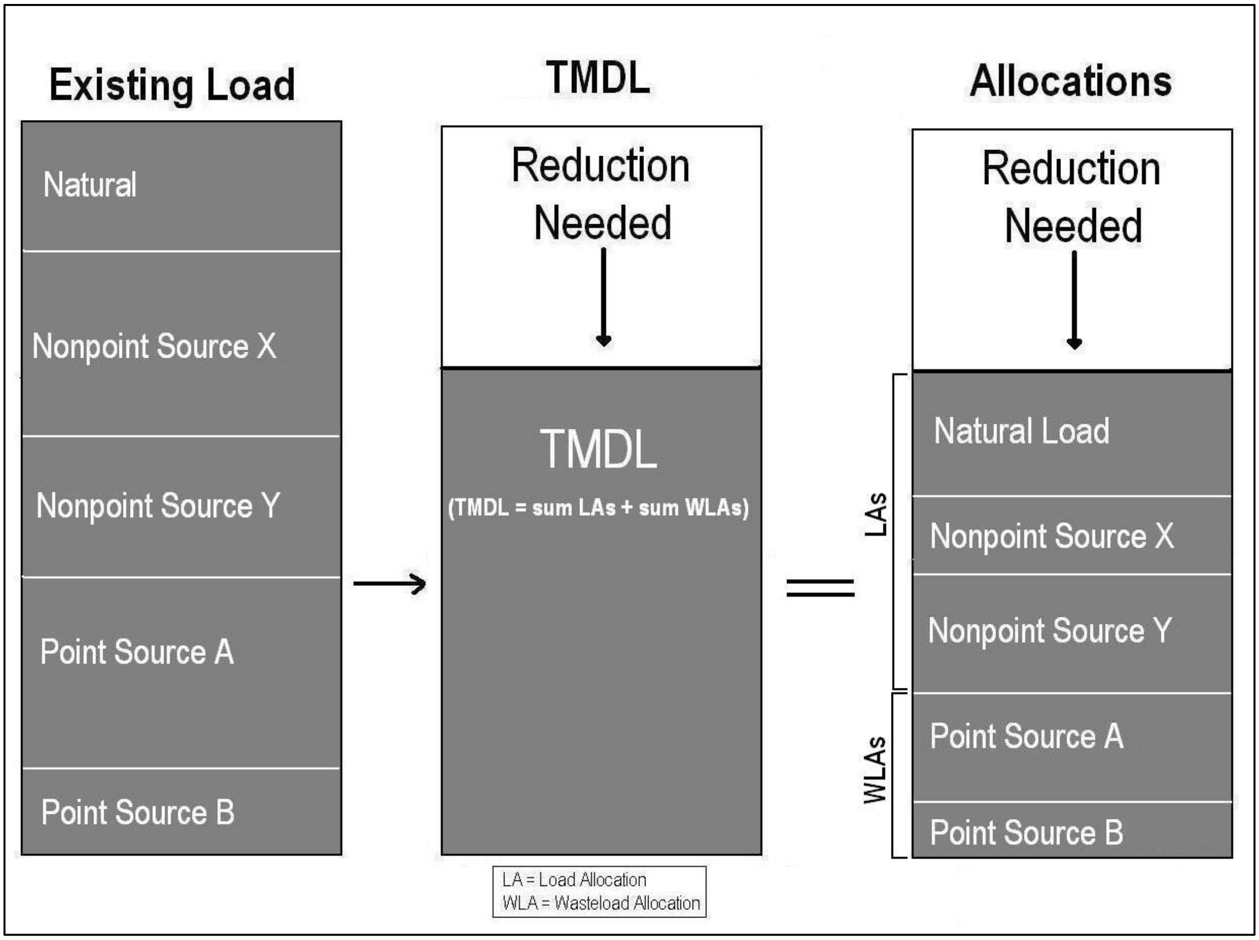

Figure 4-2. Schematic Diagram of a TMDL and its Allocations

Incorporating an MOS is required when developing TMDLs. The MOS accounts for the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to support beneficial uses. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999).

For TMDLs with waters impaired by both nonpoint sources and MPDES permitted point sources, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in situations where the point source wasteload allocation (WLA) is based on an assumption that nonpoint source load reductions will occur. In such situations (where nonpoint source load allocations (LAs) are made more stringent so that WLAs can be made less stringent), reasonable assurances that water quality standards will be achieved is needed because WLAs for permitted point sources are implemented via incorporation into associated enforceable MPDES permits while LA implementation relies primarily on voluntary measures.

For all TMDLs (whether a combination of WLAs and LAs or only LAs), DEQ develops LAs based on a feasible scenario of nonpoint source load reductions with the LAs always set at levels that will result in achievement of the applicable water quality standard(s). To help facilitate successful implementation of LAs, this TMDL document includes strategies for implementation and monitoring, as well as details on DEQ's adaptive management approach. Although implementation of the nonpoint source controls necessary to meet the LAs is mostly via a voluntary program defined within Montana's Nonpoint Source Plan, Montana State Law requires TMDL implementation reviews, thus addressing an important component of adaptive management.

For TMDLs in this document where there is a combination of nonpoint source LAs and one or more permitted point source WLAs discharging into an impaired stream reach, the WLAs are not based on the LAs. Instead, DEQ sets the WLAs and LAs at levels necessary to achieve water quality standards throughout the watershed. Under these conditions, the LAs are developed independently of the WLA such that they would satisfy the TMDL target concentration within the stream reach immediately above the point source. In order to ensure that the water quality standard or target concentration is achieved below the point source discharge, the WLA is based on the point source's discharge concentration set equal to the standard or target concentration for each TMDL pollutant.

5.0 SEDIMENT TMDL COMPONENTS

This portion of the document focuses on sediment as an identified cause of water quality impairment in the Flint Creek TPA. It includes: 1) the mechanisms by which sediment can impair beneficial uses, 2) the specific stream segments of concern, 3) the presently available data pertaining to sediment impairment characterization in the watershed, including target development and a comparison of existing water quality to targets, 4) quantification of the various contributing sources of sediment based on recent data and studies, and 5) identification of and justification for the sediment TMDLs and the TMDL 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, turbidity, or alterations to habitat or channel shape and characters that may affect sediment delivery and transport, and sediment deposition on the stream bottom.

5.1 MECHANISMS OF EFFECTS OF EXCESS SEDIMENT TO BENEFICIAL USES

Sediment is a naturally occurring component of healthy and stable stream and lake ecosystems. Erosion through natural processes such as wind, water, or ice constantly supplies our waters with some amounts of sediment. Regular flooding allows sediment deposition to build floodplain soils and point bars, and it prevents excess scour of the stream channel. Riparian and wetland vegetation and natural instream barriers such as large woody debris, beaver dams, or overhanging vegetation help trap sediment and build channel and floodplain features. When these barriers are absent, or human causes create excessive sediment loads from bank erosion or other sources on the landscape, it may alter channel form and function. These alterations may affect fish and other aquatic life by increasing turbidity and causing excess sediment to accumulate in critical aquatic habitat areas not naturally characterized by high levels of fine sediment.

More specifically, sediment may block light and cause a decline in primary production, and it may also interfere with fish and macroinvertebrate survival and reproduction. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or hatchlings. Effects from excess sediment are not limited to suspended or fine sediment; an accumulation of larger sediment (e.g. cobbles) can fill pools, reduce the percentage of desirable particle sizes for fish spawning, and cause channel overwidening (which may lead to additional sediment loading and/or increased temperatures). This larger sediment can also reduce or eliminate flow in some stream reaches where sediment aggrades within the channel, causing flow to go subsurface (May and Lee, 2004). Although fish and aquatic life are typically the most sensitive beneficial uses regarding sediment, excess sediment may also affect other uses. For instance, high concentrations of suspended sediment in streams can also cause water to appear murky and discolored, negatively impacting recreational use, and excessive sediment can increase filtration costs for water treatment facilities that provide safe drinking water.

5.2 STREAM SEGMENTS OF CONCERN

A total of five waterbody segments in the Flint Creek TPA appeared on the 2012 Montana 303(d) List due to sediment impairments (**Table 5-1**). These include: Barnes Creek, Douglas Creek (near Philipsburg), Flint Creek (two segments), and Smart Creek. As shown in **Table 5-1**, many of the waterbodies with sediment impairments are also listed for habitat alterations, which are non-pollutant causes of impairment frequently associated with sediment. TMDLs are developed for pollutants, but implementation of land, soil, and water conservation practices to reduce pollutant loading will inherently address some non-pollutant impairment causes.

Table 5-1. Waterbody segments in the Flint Creek TPA with sediment related pollutant and pollution listings on the 2012 303(d) List

Waterbody ID	Stream Segment	2012 Probable Causes of Impairment
MT76E003_070	**BARNES CREEK**, headwaters to mouth (Flint Creek)	**Sedimentation/siltation**
MT76E003_100	**DOUGLAS CREEK,** headwaters to where stream ends (T7N R14W S25)	**Sedimentation/siltation,** *Physical substrate habitat alterations*
MT76E003_011	**FLINT CREEK**, Georgetown Lake to confluence with Boulder Creek	**Sedimentation/siltation**, *Alteration in streamside or littoral vegetation covers*
MT76E003_012	**FLINT CREEK,** Boulder Creek to mouth (Clark Fork River)	**Turbidity*,** *Alteration in streamside or littoral vegetation covers*
MT76E003_110	**SMART CREEK**, headwaters to the mouth (Flint Creek), T9N R13W S21	**Sedimentation/siltation**, *Alteration in streamside or littoral vegetation covers*

*Turbidity is a pollutant that falls within the Sediment pollutant category
Pollution listings are presented in *italics*

At the time of the 2009 field investigation, additional Flint Creek TPA streams were included for data collection and analysis as a result of their appearance on the state's list of impaired waters for non-pollutant impairment causes frequently associated with sediment. This inclusion of additional sites within the Flint Creek TPA helped provide the foundation for target development, and give a broader representation of sediment issues throughout the watershed. Additional streams included in the analysis for this report are listed in **Table 5-2**. Data for these additional streams is included in **Attachment A**.

Data from these streams were reviewed relative to sediment targets but none indicated an overwhelming link to excess sediment. Therefore, a full analysis of data for the streams in **Table 5-2** is not included within **Section 5.0** and no TMDLs were developed for these streams. However, because of the strong link between habitat and sediment impairments and the fact that all sediment sources to Flint Creek must be considered, the sediment reduction strategies discussed for the TMDL streams are also applicable to the streams in **Table 5-2** as well as other streams in the Flint Creek watershed.

Table 5-2. Additional waterbody segments in the Flint Creek TPA included for TMDL related investigation

Waterbody ID	Stream Segment	Previous Probable Causes of Impairment Listings
MT76E003_060	**BOULDER CREEK,** headwaters to mouth (Flint Creek)	*Physical substrate habitat alterations*
MT76E003_020	**DOUGLAS CREEK,** confluence of Middle and South Forks to mouth (Flint Creek) T9N R13W S10	*Physical substrate habitat alterations*
MT76E003_040	**FRED BURR CREEK,** Fred Burr Lake to mouth (Flint Creek)	*Alteration in streamside or littoral vegetative covers*
	LOWER WILLOW CREEK*	
	TROUT CREEK*	

Pollution listings are presented in *italics*
**Previously unassessed and do not currently have waterbody IDs or impairment determinations assigned to them*

5.3 INFORMATION SOURCES AND ASSESSMENT METHODS TO CHARACTERIZE SEDIMENT CONDITIONS

For TMDL development, information sources and assessment methods fall within two general categories. The first category, discussed within this section and **Section 5.4**, is focused on characterizing overall stream health with focus on sediment and related water quality conditions. The second category, discussed within **Section 5.5**, is focused on quantifying sources of sediment loading within the watershed.

5.3.1 Summary of Information Sources

To characterize sediment conditions for TMDL development purposes, a sediment data compilation was completed and additional monitoring was performed during 2009. The below listed data sources represent the primary information used to characterize water quality and/or develop TMDL targets.

- DEQ Assessment Files
- DEQ 2009 Sediment and Habitat Assessments
- Relevant Local and Regional Reference Data

5.3.2 DEQ Assessment Files

The DEQ assessment files contain information used to make the existing sediment impairment determinations. The files include a summary of physical, biological, and habitat data collected by DEQ on most waterbodies between 2003 and 2008 as well as other historical information collected or obtained by DEQ. The files also include information on sediment water quality characterization and potentially significant sources of sediment, as well as information on non-pollutant impairment determinations and associated rationale.

5.3.3 DEQ's 2009 Sediment and Habitat Assessments

Field measurements of channel morphology and riparian and instream habitat parameters were collected in 2009 from 24 reaches on 9 waterbodies to aid in TMDL development. (Detailed locations and further information included in **Attachment A**.)

Initially, all streams of interest underwent an aerial assessment by which reaches were characterized by four main attributes: stream order, valley gradient, valley confinement, and ecoregion. These four attributes represent main factors influencing stream morphology, which in turn influence sediment transport and deposition. These four attributes are also assumed to be unaffected by human influence.

The next step in the aerial assessment involved identification of near-stream land uses since land management practices can have a significant influence on stream morphology and sediment characteristics. The resulting product was a stratification of streams into reaches that allow for comparisons among those reaches of the same natural morphological characteristics, while also indicating stream reaches where land management practices may further influence stream morphology. The stream stratification, along with field reconnaissance, provided the basis for selecting the above-referenced monitoring reaches. Stream stratification results are included with the TMDL development files at DEQ.

Monitoring reaches were chosen with the goal of being representative of various reach characteristics, land use categories, and anthropogenic influence. However, there was a preference to ensure sampling of some reaches where anthropogenic influences would likely be apparent since it is a primary goal of sediment TMDL development to characterize sediment impairment conditions. Thus, it is not a random sampling design intended to sample stream reaches representing all potential impairment and non-impairment conditions. Instead, it is a targeted sampling design that aims to assess a representative subset of reach types while ensuring that reaches within each [sediment] 303(d) listed waterbody with potential impairment conditions are incorporated into the overall evaluation. Typically, the effects of excess sediment are most apparent in low gradient, unconfined streams larger than 1st order (i.e. having at least one tributary); therefore, this stream type was the focus of the field effort. Although the TMDL development process necessitates this targeted sampling design, it is acknowledged that this approach results in less certainty regarding conditions in 1st order streams and higher gradient reaches, and that conditions within sampled reaches are not necessarily representative of conditions throughout the entire stream.

The field parameters assessed in 2009 include standard measures of stream channel morphology, fine sediment, stream habitat, riparian vegetation, and streambank erosion. Although the sampling areas are frequently referred to as “sites” within this document, to help increase sample sizes and capture variability within assessed streams, they were actually sampling reaches ranging from 500 to 2000 feet (depending on the channel bankfull width) that were broken into five cells. Generally, channel morphology and fine sediment measures were performed in three of the cells, and stream habitat, riparian, and bank erosion measures were performed in all cells. Field parameters are briefly described in **Section 5.4**, and summaries of all field data are contained in the 2009 monitoring summary report (**Attachment A**).

5.3.4 Relevant Local and Regional Reference Data

Relevant local and regional reference data was reviewed from Beaverhead Deerlodge National Forest (BDNF) reference sites, sites of the PACFISH/INFISH Biological Opinion Effectiveness Monitoring Program (PIBO) from the Pintler Ranger District in the BDNF, and results from an 2008/2009 FWP fish habitat study. The PIBO reference dataset includes USFS and BLM sites throughout the Pacific Northwest, but to increase the comparability of the data to conditions in the Flint Creek watershed, only data collected within the Pintler Ranger District were evaluated. Discussion on how reference data is used for target development and comparison of conditions is described in **Appendices C** and **D**. Locations of reference data sites is included in **Figure A-23** in **Appendix A**.

5.4 WATER QUALITY TARGETS

5.4.1 Targets

In order to determine the relative impact of sediment on a stream’s beneficial uses, multiple parameters related to stream habitat and morphology are used. These parameters provide a quantitative translation of a narrative standard. The values for these parameters are referred to as targets and they represent the in-stream conditions that would likely be found when all TMDL allocations are met. Usually, not one single water quality target is sufficient for determining the condition of a stream; however, when viewed in combination measures of in-stream siltation, habitat features that demonstrate the effects of sediment, and biological response to increased sediment provide a good representation of impact from sediment. 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.

In developing these targets, consideration must be made to account for natural variation throughout the river. Specifically, some reaches have a natural tendency for storage of sediment and others are prone to sediment transport. In addition, stream size and power factor into the response of a stream to increased sediment. Therefore, targets may be broken into sub-categories, such that they can be applied appropriately.

The water quality targets presented in this section (**Table 5-3**) are based on the best science and information available at the time this document was written. However, targets may be assessed during future TMDL reviews for their appropriateness and can be modified if new information provides a better understanding of reference conditions. 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 D**.

Table 5-3. Flint Creek TPA Morphology, Substrate, and Habitat Targets

TARGET PARAMETER	TARGET VALUE
Morphology	
Width/Depth Ratio	
Streams 3rd order or less	≤20
Streams 4th order or greater	≤28
Entrenchment	Literature values based on Rosgen stream type
Substrate Composition	
Wolman Riffle Pebble Count, % <2mm	≤7
Wolman Riffle Pebble Count, % <6mm	≤14
Pool Tail Grid Pebble Count, % <6mm	≤15
Pool Habitat	
Pool Frequency (#/mile)	
Bankfull Width <20 feet	≥95
Bankfull Width 20-39 feet	≥70
Bankfull Width >40 feet	≥50
Residual Pool Depth (feet)	
Bankfull Width <20 feet	≥0.9
Bankfull Width 20-39 feet	≥1.4
Bankfull Width >40 feet	≥1.7
Riparian Indicators	
Large Instream Wood (#/mile)	
Bankfull Width <20 feet	≥500
Bankfull Width 20-39 feet	≥250
Bankfull Width >40 feet	≥150
Percent Streamside Shrub Cover	≥70%
Percent Streamside Bare Ground	0%
Biological Indicators	
O/E Model value	≥ 0.80

5.4.1.1 Morphology

Parameters related to stream morphology describe channel shape and dimension, and thereby indicate the ability of the stream to store and transport sediment. Stream gradient and valley confinement are two significant controlling factors that determine stream form and function, however alterations to the landscape, and sediment input beyond naturally occurring amounts can affect stream morphology. Numerous scientific studies have found trends and common relationships between channel dimensions in properly functioning stream systems and those with a sediment imbalance. Two of those relationships are used as targets in the Flint Creek TPA and are described below.

Width/Depth Ratio and Entrenchment Ratio

The width/depth ratio and the entrenchment ratio are fundamental aspects of channel morphology; each provides a measure of channel stability and indicates a stream's ability to transport and naturally sort sediment into a heterogeneous composition of fish habitat features (i.e., riffles, pools, and near-bank zones). Changes in both the width/depth ratio and entrenchment ratio can be used to indicate change in the relative balance between the sediment load and the transport capacity of the stream channel. As the width/depth ratio increases, streams become wider and shallower, suggesting an excess coarse sediment load (MacDonald et al., 1991). As sediment accumulates, the depth of the stream channel decreases, which is compensated for by an increase in channel width as the stream attempts to regain a balance between sediment load and transport capacity. Conversely, a decrease in the entrenchment ratio signifies a loss of access to the floodplain. Low entrenchment ratios signify that stream energy is concentrated in-channel during flood events rather than dissipating energy to the floodplain. Accelerated bank erosion and an increased sediment supply often accompany an increase in the width/depth ratio and/or a decrease in the entrenchment ratio (Knighton, 1998; Rosgen, 1996; Rowe et al., 2003).

5.4.1.2 Substrate Composition

Percent surface fines provide a good measure of the siltation occurring in a river system and serve as an indicator of the ability of stream bottom habitat to support aquatic life. Although it is difficult to correlate percent surface fines with sediment loads in mass per time directly, the Clean Water Act allows "other applicable measures" for the development of TMDL water quality restoration plans. Percent surface fine measures have been used successfully in other sediment TMDLs in western Montana to address stream bottom deposits, siltation, and aquatic life uses.

Percent Fines <2mm

Surface fine sediment measured using the Wolman (1954) pebble count method can indicate excessive sediment loading. Studies have shown that increased substrate fine materials less than 2mm can adversely affect embryo development success by limiting the amount of oxygen needed for development (Meehan, 1991). In addition, as described in the Flathead Headwaters TMDL (Montana Department of Environmental Quality, 2004), work completed in the Boise National Forest in Idaho showed a strong correlation between the health of macroinvertebrate communities and percent surface fine particles less than two millimeters.

Percent Fines <6mm

As with surface fine sediment smaller than 2mm diameter, an accumulation of surface fine sediment less than 6mm diameter may also indicate excess sedimentation, and may have detrimental impacts on aquatic habitat. Size distribution of substrate material in the streambed is also indicative of habitat quality for salmonid spawning and egg development. Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material less than 6.35 mm and the emergence success of westslope cutthroat trout and bull trout.

5.4.1.3 Pool Features

Pools are stream features characterized by slow moving, deep sections of the stream. These important components aid the balance between flow and sediment load by reducing stream velocity and storing water and sediment. The measure and comparison of pool features can have direct links to sediment load increases and its affect on stream form and function, as well as biological integrity. Pool features play an important role for aquatic life and fisheries by providing refuge from warm water, high velocity, and terrestrial predators. However, when sediment loads are excessive, pool habitat quality and frequency is often diminished as pools fill with sediment. When this happens, velocities increase, stream channels widen, and sediment is transported to other areas of the stream where it may be deposited into areas that have an additional impact on fisheries and aquatic life.

Residual Pool Depth

Residual pool depth, defined as the difference between the maximum depth and the tail crest depth, is a discharge-independent measure of pool depth and an indicator of pool habitat quality. Deep pools are important resting and hiding habitat for fish, and provide refugia during temperature extremes and high flow periods (Baigun, 2003; Bonneau and Scarnecchia, 1998; Nielson et al., 1994). Similar to channel morphology measurements, residual pool depth integrates the effects of several stressors; pool depth can be decreased as a result of filling with excess sediment (fine or coarse), a reduction in channel obstructions (such as large woody debris), and changes in channel form and stability (Bauer and Ralph, 1999). A reduction in pool depth from channel aggradation may not only alter surface flow during the critical low flow periods, but may also harm fish by altering habitat, food availability, and productivity (May and Lee, 2004; Sullivan and Watzin, 2010). Residual pool depth is typically greater in larger systems. During DEQ sampling in 2009, pools were defined as depressions in the streambed bounded by a “head crest” at the upstream end and “tail crest” at the downstream end with a maximum depth that was 1.5 times the pool-tail depth (Kershner et al., 2004).

Pool Frequency

Pool frequency is another indicator of sediment loading that relates to changes in channel geometry and is an important component of a stream’s ability to support the fishery beneficial use (Muhlfeld and Bennett, 2001). Sediment may limit pool habitat by filling in pools with fines. Alternatively, aggradation of larger particles may exceed the stream’s capacity to scour pools, thereby reducing the prevalence of this critical habitat feature. Pool frequency generally decreases as stream size (i.e. watershed area) increases.

5.4.2 Supporting Information/Supplemental Water Quality Parameters

Although the following categories are not a direct measure of sediment, they do provide insight into the overall riparian quality. Riparian condition is often associated with factors that may be leading to increased sediment loads and the reduction of in-stream habitat.

During the 2009 DEQ sediment and habitat data collection, a riparian assessment method (ie, Greenline) (Montana Department of Environmental Quality, 2010) was used to conduct a coarse survey of the riparian corridor and its general vegetation composition. The results are used here to infer riparian corridor health and bank stability. In addition, large woody debris counts were conducted and results were tallied to develop targets.

Understory Shrub Cover along Green Line

Riparian shrub cover is one of the most important influences on streambank stability. Removal of riparian shrubs can dramatically increase streambank erosion and increase channel width/depth ratios. Shrubs stabilize streambanks by holding soil and armoring lower banks with their roots, and reduce scouring energy of water by slowing flows with their branches.

Good riparian shrub cover is also important for fish habitat. Riparian shrubs provide shade, reducing solar inputs and increases in water temperature. The dense network of fibrous roots of riparian shrubs allows streambanks to remain intact while creating important fish habitat in the form of overhanging banks and lateral scour pools. Overhanging branches of riparian shrubs provide important cover for aquatic species. In addition, riparian shrubs provide critical inputs of food for fish and their feed species. Terrestrial insects falling from riparian shrubs provide one main food source for fish. Organic inputs from shrubs, such as leaves and small twigs, provide food for aquatic macroinvertebrates, which are an important food source for fish.

Bare Ground along Green Line

Percent bare ground is an important indicator of erosion potential, as well as an indicator of land management influences on riparian habitat. Bare ground was noted in the greenline inventory in cases where recent ground disturbance was observed, leaving bare soil exposed. Bare ground is often caused by trampling from livestock or wildlife, fallen trees, recent bank failure, new sediment deposits from overland or overbank flow, or severe disturbance in the riparian area, such as from past mining, road-building, or fire. Ground cover on streambanks is important to prevent sediment recruitment to stream channels. Sediment can wash in from unprotected areas due to snowmelt, storm runoff, or flooding. Bare areas are also much more susceptible to erosion from hoof shear. Most stream reaches have a small amount of naturally-occurring bare ground. As conditions are highly variable, this measurement is most useful when compared to reference values from best available conditions within the study area or literature values.

Large Woody Debris

Large woody debris in the form of branches, trunks, rootwad, and other manner of downed wood within the active stream channel is a vital component of most western Montana stream ecosystems. Large wood in the channel provides multiple benefits for fish and other aquatic life by creating cover and habitat, encouraging scour resulting in pool development and sediment transport, and being a component in the overall foodweb for the various lifeforms in and around the stream. In addition, large woody debris may also be an indicator of riparian community health and maturity, which also has impacts on the overall form and function of a stream ecosystem.

Although large woody debris does not, by itself, suggest impairment from sediment, because of the common linkages that large woody debris has on stream health, it is commonly reviewed in combination with other sediment parameters to provide a better picture of the overall issues affecting a stream. Large woody debris discussion within the context of this document is used for that purpose and is not suggested as a target value per say; but simply to provide a stronger weight of evidence when discussing the condition of streams in the Flint Creek TPA.

Macroinvertebrates

Siltation exerts a direct influence on benthic macroinvertebrates assemblages by filling in spaces between gravel and by limiting attachment sites. Macroinvertebrate assemblages respond predictably to siltation with a shift in natural or expected taxa to a prevalence of sediment tolerant taxa over those that require clean gravel substrates. Macroinvertebrate bioassessment scores are an assessment of the macroinvertebrate assemblage at a site, and DEQ uses one bioassessment methodology to evaluate stream condition and aquatic life beneficial-use support. Aquatic insect assemblages may be altered as a result of different stressors such as nutrients, metals, flow, and temperature, and the biological index values must be considered along with other parameters that are more closely linked to sediment.

The macroinvertebrate assessment tool used by DEQ is the Observed/Expected model (O/E). The rationale and methodology for the index is presented in the DEQ Benthic Macroinvertebrate Standard Operating Procedure (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2006). The O/E model compares the taxa that are expected at a site under a variety of environmental conditions with the actual taxa that were found when the site was sampled and is expressed as a ratio of the Observed/Expected taxa (O/E value). The O/E community shift point for all Montana streams is any O/E value < 0.80. Therefore, an O/E score of ≥ 0.80 is established as a sediment target in the Flint Creek TPA.

An index score greater than the threshold value is desirable, and the result of each sampling event is evaluated separately. Because index scores may be affected by other pollutants or forms of pollution such as habitat disturbance, they will be evaluated in consideration of more direct indicators of excess sediment. In other words, not meeting the biological target does not automatically equate to sediment impairment. Additionally, because the macroinvertebrate sample frequency and spatial coverage is typically low for each watershed and because of the extent of research showing the harm of excess sediment to aquatic life, meeting the biological target does not necessarily indicate a waterbody is fully supporting its aquatic life beneficial use. For this reason, measures that indicate an imbalance in sediment supply and/or transport capacity, such as the targets presented in this document, are also used for TMDL development determinations.

5.4.3 Comparison of Listed Waters to Targets (by stream segment)

5.4.3.1 Barnes Creek, headwaters to the mouth (Flint Creek); MT76E003_070

Three reaches were evaluated by the DEQ during the 2009 field effort (**Table 5-4** and **5-5**). Each of the reaches are 3rd order, unconfined, and within a low gradient valley (less than 2%). Percent fines data were well above target values for each parameter in each reach. Residual pool depths did not meet the target in each of the three reaches, and pool numbers were low in BARN 11-01 and BARN 13-03. In addition, percent shrub cover was well below expected values for BARN 11-01 and BARN 13-01, particularly in the latter, suggesting anthropogenic influence on the riparian corridor. This inference from the data is confirmed in the field notes. The low shrub cover percent in 13-01 may also have a direct relationship to the significantly low large wood numbers in that reach.

Table 5-4. Barnes Creek Morphology and Pool Data (Water & Environmental Technologies, PC, 2010)

Reach	Ecoregion	Reach Type	Expected Rosgen	Bankfull Width	Width/ Depth	Entrench-ment	Residual Pool Depth	Pools #/mile
BARN 11-01	17ak	3-U-0	C	12.9	**23.0**	4.1	**0.5**	**48**
BARN 13-01	17ak	3-U-0	E	6.5	6.9	23.5	**0.7**	116
BARN 13-03	17ak	3-U-0	E	9.1	9.3	**2.1**	**0.7**	**63**

Values in **BOLD** indicate an exceedance of the target value.

Table 5-5. Barnes Creek Substrate and Riparian Condition Data (Water & Environmental Technologies, PC, 2010)

Reach	Wolman Pebble Count		Grid Toss in Pool Tails	Greenline Shrubs	Greenline Bare Ground	Large Wood #/mile
	Percent Fines <2mm	**Percent Fines <6mm**	**Percent Fines <6mm**			
BARN 11-01	**29**	**45**	**62**	**41**	**16**	581
BARN 13-01	**16**	**33**	**25**	**13**	0	**32**
BARN 13-03	**17**	**26**	**41**	**57**	0	502

Values in **BOLD** indicate an exceedance of the target value.

Field notes from the 2009 field assessment describe the conditions of the DEQ Barnes Creek reaches further:

- BARN 11-01 field notes documented heavy grazing impacts and overall poor condition of the site. This is witnessed in the exaggerated width/depth ratio when compared to the two other Barnes reaches, the excessive fines, and the amount of bare ground and lack of shrub cover witnessed in the reach.

- BARN 13-01 also describes heavy grazing impact however not to the extent of BARN 11-01. Bank erosion through this reach appears to be highly attributed to hoof shear.

- BARN 13-03 field notes describe more stable bank conditions in this reach, with willows providing a major influence on bank stability and pool formation.

DEQ Assessment files, otherwise known as (SCD/BUD files) provide data and information used during the assessment process which led to the impairment determination. The most recent assessment record for Barnes Creek was conducted in 2006. A brief summary review of that information provides the following description:

The drainage is dominated by hayfields and pastures, with forest covering only the upper 20%. In the middle of the watershed, Barnes Creek was dominated by glides, not riffles, with a U-shaped channel, few meanders and mostly silt/sand bottom. Bank vegetation was primarily grasses with a few willows present in the riparian corridor. Closer to the mouth, the substrate was predominantly silt with some gravels in the riffles. Riffle development was marginal. Erosion was occurring in some areas; vegetation consisted mainly of grasses and cropland with little to no woody vegetation present. Cattle had access to the stream. Water quality at the upper site may have been impaired as the biotic index value (4.25) was elevated compared to expectations for a montane stream, and stoneflies were absent from the sample. Stony substrate habitats could have been compromised by sediment deposition, and monotonous instream habitats were likely. No sensitive taxa were collected at the lower site, and the biotic index value (6.32) was substantially elevated, indicating a much more tolerant assemblage than expected.

As a result of the 2009 field data and the assessment file summary a TMDL for sediment on Barnes Creek is well justified and will be developed.

5.4.3.2 Douglas Creek, headwaters to where the stream ends (T17N, R14, S25); MT76E003_100

Only one site on Douglas Creek was evaluated by DEQ during the 2009 field effort (**Table 5-6** and **5-7**). Access issues prohibited further investigation of sites above the town of Philipsburg. The one reach that was accessible occurred in town, not far from the mouth of the creek. Douglas Creek at this location is a small, 2nd order stream with a valley slope between 2 and 4%. Despite this reach being slightly higher gradient, which would tend to flush fine sediment accumulation to areas of lower gradient, percent fines values still well exceeded the target values. Residual pool depths did not meet target values either. In addition, low percent shrub cover and lack of large wood indicate disturbance to the riparian corridor that may further influence sediment input and habitat quality.

Table 5-6. Douglas Creek Morphology and Pool Data (Water & Environmental Technologies, PC, 2010)

Reach	Ecoregion	Reach Type	Expected Rosgen	Bankfull Width	Width/ Depth	Entrench-ment	Residual Pool Depth	Pools #/mile
DOUS 19-02	17ak	2-U-2	E	4.2	4.1	5.7	**0.6**	180

Values in **BOLD** indicate an exceedance of the target value.

Table 5-7. Douglas Creek Substrate and Riparian Condition Data (Water & Environmental Technologies, PC, 2010)

Reach	Wolman Pebble Count		Grid Toss in Pool Tails	Greenline Shrubs	Greenline Bare Ground	Large Wood #/mile
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
DOUS 19-02	**39**	**64**	NA	**35**	0	**211**

Values in **BOLD** indicate an exceedance of the target value.

Field notes from the 2009 field assessment describe the conditions of the DEQ Douglas Creek reaches further:

- Douglas Creek is dramatically altered by channelization in this reach. The stream occurs in an urban setting, and in general, no woody vegetation occurs beyond 5' of the channel. The channel is frequently bordered by dense manicured grasses.

DEQ Assessment files, otherwise known as (SCD/BUD files) provide data and information used during the assessment process which led to the impairment determination. The most recent assessment record for Douglas Creek was conducted in 1999. A brief summary review of that information provides the following description:

Limited data existed for the high headwaters of this stream; however the midreach section (1-3 miles above the mouth) was listed as severely impaired. The Stream has been extensively mined and large tailings piles compose much of the streambanks. Poor SMZ management during logging has left stream channel in poor condition and the stream is channelized through town.

Although actual quantifiable data is limited on this stream, descriptions of the condition of the stream in combination with the data from DOUS 19-02 indicate significant sediment sources and accumulation of that sediment within the stream channel. As a result, a TMDL will be developed for Douglas Creek.

5.4.3.3 Flint Creek, Georgetown Lake to the confluence with Boulder Creek; MT76E003_011

Four sites were evaluated in the upper segment of Flint Creek (**Table 5-8** and **5-9**). The upper most reach, FLIN 06-01 is a second order stream in a higher gradient valley (2-4%). Residual pool depths are slightly below target values and pool numbers are considerably beneath the target of ≥70, however percent fines values are not elevated. Large wood is meeting the target. Reach FLIN 09-02 occurs in a low gradient section of Flint Creek and is 3rd order in size. The width/depth value for this reach is well above the target of ≤20 indicating overwidening of the stream, and the number of pools per mile is quite low as well. Fine substrate percentages are all within the target range. Shrub cover is diminished however. Reaches FLIN 11-01 and FLIN 11-04 are 4th order streams. FLIN 11-01 is slightly below the target for residual pool depth however based on the bankfull width this reach is right between the two target categories and therefore may not have as issue with this parameter. Pool numbers are considerably diminished however. Percent fines results in two of the three categories are slightly exceeding the target values, with percent fines results in the <6mm Wolman pebble count just under the target value. Percent shrub cover is almost entirely absent, with some bare ground noted as well. Large wood per mile is also almost nonexistent through this reach. FLIN 11-04 has low residual pool depths but all other target parameters appear to be within the target ranges or just straddling the target value.

Table 5-8. (Upper) Flint Creek Morphology and Pool Data (Water & Environmental Technologies, PC, 2010)

Reach	Ecoregion	Reach Type	Expected Rosgen	Bankfull Width	Width/Depth	Entrenchment	Residual Pool Depth	Pools #/mile
FLIN 06-01	17am	2-U-2	B	23.1	15	8.8	**1.2**	**21**
FLIN 09-02	17ak	3-U-0	C	34.5	**34**	6.1	1.6	**32**
FLIN 11-01	17am	4-U-0	C	40.0	20.5	4.2	**1.4**	**21**
FLIN 11-04	17am	4-U-0	C	52.0	25.3	**2.1**	**1.1**	100

Values in **BOLD** indicate an exceedance of the target value.

Table 5-9. (Upper) Flint Creek Substrate and Riparian Condition Data (Water & Environmental Technologies, PC, 2010)

Reach	Wolman Pebble Count		Grid Toss in Pool Tails	Greenline Shrubs	Greenline Bare Ground	Large Wood #/mile
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
FLIN 06-01	1	3	1	97	0	438
FLIN 09-02	7	12	1	**37**	0	280
FLIN 11-01	**12**	14	**16**	**3**	**3**	**11**
FLIN 11-04	**8**	12	10	94	0	**148**

Values in **BOLD** indicate an exceedance of the target value.

Field notes from the 2009 field assessment describe the conditions of the DEQ Flint Creek reaches further:

- FLIN 06-01 occurs just downstream of the old power station and within a public campground. Significant and widespread channel alterations exist due to the road, campground, old dam, and other remnants of historic structures at this site. River-left actively was eroding, particularly where encroachment from road is directly adjacent to the creek. Bank vegetation was comprised of primarily non-native grasses and weeds.

- Riparian grazing, a road crossing, irrigation, and adjacent dirt road all influence Flint Creek at FLIN 09-02. Few quality pools present. Substrate dominated by large cobble but appear embedded. Eroding banks are generally low profile and contribute low to moderate amounts of erosion. Where erosion occurs it appears to be largely influenced by lack of good riparian.

- FLIN 11-01 is confined on two sides by the railroad and highway. Ice scour is reportedly common in this reach. There is evidence of past grazing, although currently grazing appears minimal. High sinuosity and low channel slope indicate that this stream may have been an E channel at one time, but high width/depth ratios currently identify this reach as more similar to a C channel. The site has poor riffle development with long lateral scour pools on outside meander bends. Stream bed is embedded with fine substrate. Channel has signs of instability and many long eroding banks, primarily on outside meander bends. Banks comprised of mostly fine, unconsolidated material. There is no overstory or understory present throughout this reach and no large woody in the channel.

- A railroad, residences, and evidence of mining all occur along Flint Creek reach FLIN 11-04, although they don’t appear to be having an immediate impact on the site itself. A steep C type stream type, few well-developed pools are present but there are many small step pools. Pool tails do not appear to have much fine accumulation. Overall, the riparian area appears to have good diversity. Site has minimal streambank erosion, mostly naturally influenced.

DEQ Assessment files provide data and information used during the assessment process which led to the impairment determination. The most recent assessment record for the upper segment of Flint Creek was conducted in 1999. A brief summary review of that information provides the following description:

For assessment investigation, the stream has been segmented into three separate reaches: headwaters (below Georgetown Lake dam), midreach (above and below Marshall Creek influence), and the lower reach in the canyon area above confluence with Boulder Creek. Some minor impact, specifically bank erosion, is noted in the headwaters reach. Midreach is described as having severe impairment. The entire reach is grazed and bank and riparian degredation is common. The lower reach has also been classified as having severe impairment, also displaying common bank erosion and riparian degredation as a result of grazing.

In addition to the DEQ information, the FWP conducted an assessment of fish populations and riparian habitat in tributaries of the Upper Clark Fork Basin (Lindstrom et al., 2008). Flint Creek was included in that study. Of four sites assessed on Flint Creek, the upper three roughly correspond with DEQ sites FLIN 06-01, FLIN 09-02, and FLIN 11-01. Description of the riparian assessments at the upper three sites is as follows:

- Below the dam at river mile 41.2, Flint Creek received a riparian assessment score of 61/70 (87%). The controlled flows out of Georgetown Lake are believed to have prevented deep pools from scouring in this reach, which limited the diversity of the habitat. Noxious weeds such as spotted knapweed (*Centaurea biebersteinii*) were also abundant, likely due to disturbance of the high use of campground located in this reach.

- At the site located at river mile 35.5, Flint Creek received a relatively low riparian assessment score 41/68 (60%). At this site, riparian grazing by cattle appeared to be the primary land use impacting the stream. Some of the direct negative impacts included heavy browse on all of the riparian vegetation by cattle and relatively little willow regeneration. Cattle hoof shear and associated bank instability were also observed. Overall, the impacts of riparian grazing were bank instability, channel overwidening, low densities of LWD [Large Woody Debris], and reduced stream shading. These impacts were particularly evident for a pasture found lower in the electrofishing reach in which past stock densities appeared to have been higher than in the upstream pasture. Despite these deficiencies, the fish habitat was still rated as good in this reach because of the presence of many deep pools, undercut banks, and some LWD.

- At river mile 23.4, Flint Creek received a riparian assessment score of 49/68 (72%). Cattle utilization of this site was high; however more riparian vegetation remained intact at this site than at the site located at river mile 35.5. Some shortcomings of this site were bank erosion from cattle hoof shear and the resulting increased fine sediment in the creek, as well as the abundance of noxious and disturbance-induced plants. Fish habitat was rated good because of the presence of deep pools and undercut banks.

Despite the limited exceedance of target values, the additional information regarding adjacent land use and obvious controllable sources of sediment justify the development of a TMDL for this stream segment.

5.4.3.4 Flint Creek, Boulder Creek to the mouth (Clark Fork River); MT76E003_012

Four sites were evaluated in the lower Flint Creek segment (**Table 5-10** and **5-11**). The upper most reach, FLIN 17-01, is located in a higher gradient valley (2-4%); all other reaches are low gradient (0-2%). The upper most three sites are 4th order streams, however the stream order increases to 5th order in the lowest reach in the watershed, FLIN 19-01. Width/depth ratios are not meeting or very near the target value at all four sites. Residual pool depths are low in FLIN 17-01 and FLIN 18-05, and pools per mile are low in the lower three reaches. Percent fines are meeting the targets for all parameters in all sites. Riparian condition appears fine in the upper two reaches. Shrub cover in FLIN 18-05 is slightly under the target value, and shrub cover in FLIN 19-01 is extremely below the target at a mere 4%. Large wood is also deficient in this reach, which may partly be related to the lack of riparian vegetation.

Table 5-10. (Lower) Flint Creek Morphology and Pool Data (Water & Environmental Technologies, PC, 2010)

Reach	Ecoregion	Reach Type	Expected Rosgen	Bankfull Width	Width/ Depth	Entrench-ment	Residual Pool Depth	Pools #/mile
FLIN 17-01	17ak	4-U-2	C	62.9	**34.2**	2.0	**0.8**	79
FLIN 18-02	17ak	4-U-0	B	57.0	27.6	**1.9**	1.8	**37**
FLIN 18-05	17ak	4-U-0	B	49.2	**28.8**	3.1	**1.3**	**26**
FLIN 19-01	17ak	5-U-0	C	50.8	**31.2**	3.5	2.2	**26**

Values in **BOLD** indicate an exceedance of the target value.

Table 5-11. (Lower) Flint Creek Substrate and Riparian Condition Data (Water & Environmental Technologies, PC, 2010)

Reach	Wolman Pebble Count		Grid Toss in Pool Tails	Greenline Shrubs	Greenline Bare Ground	Large Wood #/mile
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
FLIN 17-01	3	5	4	76	0	164
FLIN 18-02	7	14	7	92	0	306
FLIN 18-05	3	6	2	**60**	0	190
FLIN 19-01	4	9	3	**4**	**3**	**58**

Values in **BOLD** indicate an exceedance of the target value.

Field notes from the 2009 field assessment describe the conditions of the DEQ Flint Creek reaches further:

- No obvious human impacts were noted within the stream channel at site FLIN 17-01. Agricultural practices occur on both sides of the river however riparian fencing is present to protect the riparian area and streambanks. No actively eroding banks noted, and the riparian condition is good with multiple grasses, alder understory, and mature cottonwood overstory. Substrate is dominated by boulders and cobble and riffle features dominate, with infrequent pools. Cell 2 is entrenched and appears to be actively downcutting.

- FLIN 18-02 is adjacent to agricultural lands (hay fields) with a narrow riparian buffer, although grazing impacts appear minor. An irrigation ditch does exist with associated riprap along the bank. Minimal streambank erosion however; some slowly eroding banks but most well armored and with dense root mass. Reach is riffle dominated with minimal pools. Pools present only as a results of large boulders or woody debris.

- FLIN 18-05 is also adjacent to agricultural land but does have riparian fencing throughout the reach and good riparian vegetation. There is some evidence of historical grazing but site appears to be recovering well. Most erosion appears to be natural or recovering from the historic grazing and agricultural practices. This site has good riffle development and the substrate is dominated by gravel and cobble, although some embeddedness is apparent in places.

- The lowest reach, FLIN 19-01, has evidence of historic and recent hay/pasture use. Riparian fencing occurs on only one side of the stream. Reach doesn't appear to be heavily grazed recently, however hoof shear evident in places, and little riparian vegetation to help stabilize banks. Long stretches of actively eroding banks on meander bends; one section has approximately 80'-100' of rip rap where fence is falling into the stream. There is decent pool habitat throughout the reach but not much woody debris. Good riffle development with some point bars. Substrate consists mainly of large gravel and cobble, and does not appear as embedded as in upper reaches.

DEQ Assessment files provide data and information used during the assessment process which led to the impairment determination. The most recent assessment record for the lower segment of Flint Creek was conducted in 2003. A brief summary review of that information provides the following description:

For the assessment investigation, the lower segment was separated into three sections. The section directly below the confluence with Boulder Creek is described as having minor impairment, although sediment is still a problem. Midreach (near the Douglas Creek confluence) is categorized as having minor-moderate impairment, with bank instability and remnants of hydraulic mining. The final reach, near the mouth, is described as having severe impairment, in part, due to bank instability from grazing and riparian degradation. In addition, turbidity is noted as being over 200 times the ntu level of similar reference streams.

In addition to the DEQ information, the FWP conducted an assessment of fish populations and riparian habitat in tributaries of the Upper Clark Fork Basin (Lindstrom et al., 2008). Flint Creek was included in that study. Of four sites assessed on Flint Creek, one occurred in this segment of concern. Description of the riparian assessments for this site is as follows:

- At river mile 12.1, Flint Creek received a riparian assessment score of 39/70 (56%). Habitat was limited by a lack of pools, with a majority of the pools being formed by boulder pockets. Riparian vegetation was insufficient on many of the banks despite a mature overstory of cottonwoods located in the floodplain. Despite this lack of woody riparian vegetation, the width to depth ratio in this reach of Flint Creek appeared appropriate which is likely due to the large substrate found in this reach and the resilient nature of this B_c channel type.

Data and descriptions of the lower segment of Flint Creek seem to correlate between information sources. Upper portions have minimal to no apparent impact from sediment, however the lower portion (near the mouth) has noticeable impacts from adjacent land use and sediment input and therefore a sediment TMDL will be pursued.

5.4.3.5 Smart Creek, headwaters to the mouth (Flint Creek); MT76E003_110

Four locations on Smart Creek were evaluated during the 2009 DEQ field effort (**Table 5-12** and **5-13**). All four sites are 2nd order streams, the uppermost occurring in a slightly higher gradient reach (2-4%) than the other reaches which are of low gradient (0-2%). Reaches SMAR 18-01-01 and SMAR 18-01-02 occur directly adjacent to one another. These two reaches were split by a fence line, with the upper reach (SMAR 18-01-02) occurring in a well vegetated, protected riparian area, and the lower reach (SMAR 18-01-01) displaying obvious recent and recurring cattle grazing and open access to the stream. These two reaches were sampled to see if the differences in the resultant data would illustrate the dramatic differences in land use. Width/depth ratios are within the target range, except for reach 18-01-01 (where cattle grazing has had a large impact on streamside vegetation and bank stability). Residual pool depths are not meeting the target value in any of the four reaches, and pool numbers are either meeting the target values, or slightly under the target. Percent shrub cover is limited however throughout all four reaches, particularly in SMAR 21-01. In addition, 8% of SMAR 18-01-01 is bare ground, which is a direct result of the cattle access to the stream at this point. Large wood is also lacking in two of the reaches.

Table 5-12. Smart Creek Morphology and Pool Data (Water & Environmental Technologies, PC, 2010)

Reach	Ecoregion	Reach Type	Expected Rosgen	Bankfull Width	Width/ Depth	Entrench-ment	Residual Pool Depth	Pools #/mile
SMAR 13-01	17am	2-U-2	B	8.9	15.6	2.0	**0.6**	**100**
SMAR 18-01-01	17ak	2-U-0	B	13.8	**21.6**	10.6	**0.7**	116
SMAR 18-01-02	17ak	2-U-0	B	8.4	11.5	**2.0**	**0.6**	137
SMAR 21-01	17ak	2-U-0	E	6.9	10.7	**1.7**	**0.6**	**90**

Values in **BOLD** indicate an exceedance of the target value.

Table 5-13. Smart Creek Substrate and Riparian Condition Data (Water & Environmental Technologies, PC, 2010)

Reach	Wolman Pebble Count		Grid Toss in Pool Tails	Greenline Shrubs	Greenline Bare Ground	Large Wood #/mile
	Percent Fines <2mm	Percent Fines <6mm	Percent Fines <6mm			
SMAR 13-01	4	9	3	**30**	0	**195**
SMAR 18-01-01	7	13	**21**	**43**	**8**	634
SMAR 18-01-02	7	14	14	**49**	0	803
SMAR 21-01	**9**	**18**	**16**	**4**	0	**58**

Values in **BOLD** indicate an exceedance of the target value.

Field notes from the 2009 field assessment describe the conditions of the DEQ Smart Creek reaches further:

- A road parallels the stream for much of reach SMAR 13-01, however road impacts appear minor. Grazing from cattle within the riparian is obvious by the denuded vegetation and invasive weeds are present throughout. Past mining and logging is known to have occurred in the upper watershed of Smart Creek. SMAR 13-01 has moderate entrenchment and appears to be downcutting. Substrate composed of small gravels. The best pools formed by sloughing vegetation and woody debris. Many tall eroding banks, the erosion exacerbated by the fine soil bank composition and poor vegetation (little root mass and depth; very limited good quality woody vegetation). Improvements to riparian vegetation in this reach would be very beneficial to reducing sediment.

- SMAR 18-01-01 is extensively grazed with lots of hummocking and hoof shear to the banks. Stream channel is overwidened in many places and shows evidence of aggradation. Poorly developed pools through this reach; pool tails often trampled by cattle. Spawning gravel potential existed in some pool tails, but many had a high percentage of fines, apparently as a result of the eroding banks and heavy grazing. Existing woody debris is poor quality and provides little habitat. Streambank erosion is fairly limited as the banks are low profile, but all noticeable erosion is caused by hoof shear and cattle grazing. Vegetation is grazed very short. Some grasses and sedges established on slumped banks, the understory mostly alder with a few sparse conifers.

- SMAR 18-01-02 occurs directly upstream of SMAR 18-01-01. In contrast however, SMAR 18-01-02 is protected by riparian fencing. There is some evidence of past grazing in this reach, but effects are minor and the current fence protection is allowing for good recovery. This reach resembles a B stream channel, although the low width depth ratios are reminiscent of an E channel in places. SMAR 18-01-02 has well developed pools and riffles, and good small gravel substrate for spawning, however pool depths are somewhat shallow. Streambanks are well vegetated and provide very limited sediment contribution. There is good diversity of riparian vegetation and functional woody debris in the channel.

- SMAR 21-01 has a headgate at the top of the reach, which may be contributing to some overwidening in the channel. In addition, there is evidence of past grazing, but the reach does not appear recently grazed at the time of investigation. Sheep and llama are present just downstream. The stream is crossed by numerous small bridges to accommodate pivot wheels. Eroding banks prevalent throughout the reach with whole sections of bank are slumping into the

> channel. The reach has small gravel substrate, poor riffle-pool development, and resembles an entrenched step-pool system in some places as a result of the slumping banks and active downcutting. Limited large wood creating backwater affects where it does occur. Landowner describes ice scour occurring during periods of thaw. Dense grasses are the predominant streamside vegetation, with some sedges on the slumped areas within the channel but little other vegetation present.

DEQ Assessment files, otherwise known as (SCD/BUD files) provide data and information used during the assessment process which led to the impairment determination. The most recent assessment record for Smart Creek was conducted in 2006. A brief summary review of that information provides the following description:

The Smart Creek drainage is approximately 60% National Forest, 30% private land, and 10% BLM, with the majority of private land concentrated near the mouth of the stream. The upper watershed burned in the Combination fire of 1988 and was logged. There was heavy utilization by livestock in the past, and several former mines in the watershed. The upper reach had good fish habitat, the channel was not embedded, and banks were relatively stable with a few outside bends eroding. The riparian zone was generally in good condition with alders and fir present, but some age classes missing due to grazing. Noxious weeds were present including Canada thistle, houndstongue and knapweed. The lower reach had trampled and eroded banks, and the channel was moderately embedded. There was evidence of serious overgrazing, with no brush or shrubs, only a few dying trees, and no other riparian vegetation evident – in some places, not even grass. A landowner says the area has been grazed for 145 years, and until 16 years ago, the stream had ample willows. After the 1988 fire, a severe flood occurred, washing gravels downstream, and, according to a local landowner, killing the willows that used to grow by the stream. Smart Creek was designated a fisheries resource of substantial value by Montana Fish, Wildlife and Parks (MFWP). At the upper site, evidence of probable water quality impairment could be discerned in the taxonomic composition of the macroivertebrate sample collected there. It seems unlikely that periodic dewatering, scouring sediment pulses, or thermal extremes occurred here recently, since the semivoltine riffle beetles in 3 genera were so abundant. The functional mix was dominated by scrapers, suggesting that riparian shading may have been limited. Water quality impairment was suggested at the lower site, where only 2 mayfly taxa were collected and the biotic index value (5.30) indicated that the assemblage was more tolerant than expected for a foothill stream. Low richness among the caddisflies and “clingers” strongly suggest that sediment deposition limited access to stony substrate habitats in this reach. Stoneflies were represented by a single genus; unstable streambanks, altered channel morphology, or disrupted riparian vegetation may be implicated. The Low Valley MMI and RIVPACS results for both sites indicated that the macroinvertebrate communities were moderately impaired. Although the percentage of fine sediment was high at both sites, this is most likely due to the fact that the stream is still recovering from a severe flood event.

In addition to the DEQ information, the FWP conducted an assessment of fish populations and riparian habitat in tributaries of the Upper Clark Fork Basin (Liermann et al., 2009). Smart Creek was included in that study. Description of the riparian assessments at for this site is as follows:

- The main land use observed in the drainage is cattle grazing with grazing allotments existing on federal lands in the drainage. Two sections were electrofished on Smart Creek in August 2008. In both sections, westslope cutthroat trout were the sole fish species captured. At the upper site located at river mile 5.7, Smart Creek was classified as a C channel and woody riparian vegetation consisted of willows, alder, and cottonwoods. At this site, cattle grazing was quite heavy and cattle hoof shear was observed throughout the reach. Bank erosion was common in

> the reach and the channel appeared to be slightly overwidened. Both the density and recruitment of woody riparian vegetation in the reach appeared to be low and browse on the adult woody vegetation was heavy. However, this reach still maintained some quality pool habitat and fish densities were quite high, so the fish habitat was still rated as "good". At the lower site (river mile 3.0), Smart Creek was classified as a C channel type and the woody riparian vegetation observed at this site was primarily alders and spruce. The width to depth ratio at this site appeared reasonable however bank erosion was observed throughout the reach. Woody riparian vegetation was relatively abundant at this site, however, the diversity of woody species was low with only alder and spruce observed. Past grazing impacts were evident in the reach, although it appeared that the reach had not been grazed in 2008 at the time of the survey. Noxious weeds and disturbance-induced plants were common, likely indicative of past grazing in this reach. Fish habitat in the reach was classified as "good" due to the low width to depth ratio and abundant pool habitat, but the pools in the reach appeared to be relatively shallow and fine sediment was also common.

Data and qualitative descriptions of Smart Creek justify the development of a sediment TMDL.

5.4.4 TMDL Development Summary

Based upon the results of **5.4.3**, the following streams will be included for TMDL development for sediment (**Table 5-14**). 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 5-14. Flint Creek TPA waterbodies included in sediment TMDL development

Waterbody ID	Stream Segment	2012 Probable Causes of Impairment
MT76E003_070	**BARNES CREEK,** headwaters to mouth (Flint Creek)	**Sedimentation/Siltation**
MT76E003_100	**DOUGLAS CREEK**, headwaters to where stream ends (T7N R14W S25)	**Sedimentation/Siltation,** *Physical substrate habitat alterations*
MT76E003_011	**FLINT CREEK**, Georgetown Lake to confluence with Boulder Creek	**Sedimentation/Siltation**, *Alteration in streamside or littoral vegetation covers*
MT76E003_012	**FLINT CREEK**, Boulder Creek to mouth (Clark Fork River)	**Turbidity***, *Alteration in streamside or littoral vegetation covers*
MT76E003_110	**SMART CREEK**, headwaters to the mouth (Flint Creek), T9N R13W S21	**Sedimentation/Siltation**, *Alteration in streamside or littoral vegetation covers*

*Turbidity is a pollutant that falls within the Sediment pollutant category.
Pollution listings are presented in *italics*

5.5 SOURCE QUANTIFICATION FOR ALL WATERBODIES

When developing TMDLs, sediment loads must be quantified for each significant source category, and where appropriate, strategies for reducing those loads from human caused sources must be developed such that streams meet all applicable water quality standards. Sources are described in two broad ways: point sources and nonpoint sources. Point sources are a specific and discrete source of a pollutant, such as the end of a wastewater discharge pipe or municipal stormwater drain. Point sources are addressed through permit requirements and addressed in the TMDL via wasteload allocations (WLAs). Two permitted sediment point sources are present in the Flint Creek TPA (Philipsburg's wastewater treatment plant and Black Pine Mine). Nonpoint sources are sources of pollutants that come from diffuse locations across the landscape and are often cumulative in their effects. Examples of nonpoint source pollution include bank erosion, the leaching of nutrients or agricultural chemicals into groundwater from farm fields, or increased surface runoff and the associated pollutants runoff carries from timber harvest. Nonpoint source pollution is addressed in the TMDL via load allocations (LAs). Three major nonpoint source categories of sediment have been identified in the Flint Creek TPA (bank erosion, sediment from unpaved roads, and hillslope erosion). This section describes the methodology, rationale, and assumptions in sediment source load quantification and load reduction that is used as the basis for TMDLs in the Flint Creek TPA.

5.5.1 Bank Erosion

Rivers and streams are dynamic, ever changing systems that are constantly seeking equilibrium with their surrounding environment. The size, force, and shape of these flowing waters fluctuate throughout the seasons, and over the years. Streams tend to shift across the landscape, cutting new channels either slowly or subtly, or quickly and dramatically. Sediment from eroding banks may alter channel shape, alter the erosive properties of the stream itself, prohibit or encourage aquatic life and fisheries, and affect water chemistry and quality.

Bank erosion as a result of these shifts in direction and energy is a natural and necessary function of an active stream channel. However, in some cases bank erosion can be exacerbated or accelerated by human activities that result in altered bank stability or stream morphology. In investigating bank erosion as one source of the total watershed sediment load to derive the TMDL, methods were used to quantify sediment loads from eroding banks, identify the cause and effects of the eroding banks and therefore differentiate between existing and desired conditions (under all applicable land, water, and soil best management practices).

5.5.1.1 Quantifying Pollutant Sources

In 2009, a field study was conducted throughout the Flint Creek watershed that investigated the sediment and habitat conditions in selected reaches. In preparation for that study, an aerial assessment and GIS exercise organized streams into representative reaches based on naturally occurring geomorphic constraints. The reaches were further categorized by the apparent influences of land use, land cover, and human activities. Study sites were chosen to represent the variability in natural and human influences throughout the watershed. The data collected is the basis for quantifying loads from individual banks and their associated conditions. The extrapolated bank erosion load was used as a component of the Total Maximum Daily Load for sediment.

5.5.1.2 Bank Erosion Assessment

For each monitoring reach selected in the aerial photo assessment, measurements were collected to calculate the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS), in accordance with the Watershed Assessment of River Stability and Sediment Supply guidelines (Rosgen, 2006). BEHI evaluates the susceptibility to erosion from multiple erosional processes. The process integrates multiple variables that relate to “combined” erosional processes leading to annual erosion rates. Erosion risk is then established for a variety of BEHI variables and is eventually used to establish corresponding streambank erosion rates (Rosgen, 1996).

In addition to the recorded BEHI and NBS information, each bank was categorized as either actively/visually eroding or slowly eroding/vegetated. Individual banks were also assigned percent influence contributing to the erosion of the bank and distributed among natural and anthropogenic causes such as transportation, grazing, timber harvest, etc. Reaches with less than 25% of the influence attributed to human activity were classified as “naturally influenced” reaches. Once a sediment load was generated for each analyzed bank in a given site, the sum of the bank loads was calculated to derive the total load for the sampled site.

5.5.1.3 Bank Erosion Sediment Loads

In order to determine sediment loads from bank erosion, results from the field study (results are presented in **Attachment A**) were used to develop reasonable estimates to represent the total sediment loads from bank erosion for each watershed.

In the Flint Creek TPA, the sediment load for each eroding bank in a sampled reach was calculated, and then the total sediment load for that reach was summed. Sampled reaches were sorted by their influence category (natural or human) and reach type (a reach type is defined by its combination of stream order, valley slope, and valley confinement), and the average sediment loads (tons/1000’) from these representative groupings determined. To estimate a total bank erosion load for each stream of interest, the average sediment load from the reach types were applied to their respective reaches. For those reach types without a derived average sediment load, the average sediment load from the most appropriate comparable reach type was applied. Actual loads from sampled reaches were applied to those individual reaches where sampled data exists. **Table 5-15** presents the average existing sediment load by reach type.

Table 5-15. Average Bank Erosion Sediment Load by Reach Type

Reach Type (valley gradient – stream order – valley confinement)^	Number of Sampled Reaches	Sampled Reaches	Existing Average Bank Erosion Sediment Load per 1000 feet (tons/year)
0-1-C; 0-1-U; 2-1-U; (valley gradients >4)	2*	BOUL 16-01; FLIN 17-01	0.6
0-2-C; 0-2-U	5	DOUN 08-02; FRED 29-02; SMAR 18-01-01; SMAR 18-01-02; SMAR 21-01	17.9
0-3-U	6	BARN 11-01; BARN 13-01; BARN 13-03; BOUL 21-02; FLIN 09-02; TROU 09-03	7.0
0-4-U	5	FLIN 11-01; FLIN 11-04; FLIN 18-02; FLIN 18-05; LOWI 02-05	18.0
0-5-U	1	FLIN 19-01	23.9
2-2-C; 2-2-U	4	DOUN 07-01; DOUS 19-02; FLIN 06-01; SMAR 13-01	20.4
2-3-U	2	BOUL 16-01; TROU 10-01	4.0
2-4-U	1	FLIN 17-01	0.8

^Reach Type presented as Valley Slope-Stream Order-Valley Confinement. Valley Slope Categories: 0 = 0-2%; 2 = 2-4%, 4 = 4-10%, 10 = >10%. Valley Confinement Categories: U = Unconfined (>150 feet wide); C = Confined (<150 feet wide)

*For reaches with a stream order of one, or a valley gradient greater than 4%, a sediment load of 0.6 tons/year was applied. This value was derived from the average load of naturally influenced reaches occurring in valley gradients of 2-4% (Two reaches: BOUL 16-01 and FLIN 17-01). It is assumed that the loads from 1st order reaches, and higher gradients are generally minimal, as the associated terrain is often less influenced by human activity and the low stream orders are small headwater streams with less erosive power.

5.5.1.4 Establishing the Total Allowable Load

Once the existing bank erosion sediment load was derived, an allowable (desired) load was established to determine the target conditions and allocation of sediment reductions.

It is difficult to precisely quantify total sediment loads from bank erosion without assessing the entire length of streambanks. However, quantitative data coupled with qualitative information from the sample reaches provides a good basis to estimate the total load and potential for sediment load reduction.

During the field effort, each eroding bank encountered was classified as actively eroding or slowly eroding. Actively eroding banks are those banks that appear to be an obvious active, and possibly chronic, sediment source. Slowly eroding banks are those banks where some erosion processes appear to be occurring, but vegetation and bank material provide stability and greatly reduce the rate of erosion. Slowly eroding banks are generally expected to occur under most natural conditions, in most environments.

Eroding banks measured in the field were also classified by those sources that appear to be influencing erosion. Determinations were made for each bank based on the witnessed adjacent or upstream activities/sources of instability and best professional judgment. Banks were collectively reviewed for each reach, and a classification of natural or human influence was given to each reach based on overall percentage of influence. Reaches with less than 25% human influence were deemed natural. Eight of the twenty-four reaches in the Flint Creek TPA were classified as naturally influenced.

To determine the total allowable load, analysis was conducted on the naturally influenced reaches. For each naturally influenced reach, the percent of the reach length that was eroding was reviewed for actively eroding banks, slowly eroding banks, and total eroding banks. The averages of these percentages for all naturally influenced reaches were then calculated to be 1.3% actively eroding and 5.8% slowly eroding, for a total of 7.1% of the stream reach length with eroding banks. In contrast, the average for human influenced reaches was 9.1% active and 4.9% slowly, for a total of 14.0% of the stream length with eroding banks. It is assumed that the averages of percent eroding banks for naturally influenced reaches provides a reasonable expectation for streams under natural conditions, including those streams with all reasonable land, soil, and water conservation practices.

A comparison between average total load of natural and human influenced reaches finds 3.6 tons/year/1000’ reach for natural reaches, in contrast to 19.0 tons/year/1000’ for human influenced reaches. This provides further illustration of the apparent difference between the sediment loads of natural and human influenced reaches. However, this is simply an average of all human or natural reaches. The rate of erosion and subsequent load for each bank, and each reach, is presumed to be affected by those characteristics of the reach type (stream order, valley gradient, and valley confinement), and therefore the extrapolation of existing loads are based on the variations of loading among reach types.

As a result, a simple equation was derived to determine a reasonable load per reach type, based on the results of the percent reach length of eroding banks witnessed in natural and human influenced reaches. For each reach type, the percent of actively eroding banks relative to the total percent eroding banks in naturally influenced reaches (1.3/7.1=0.18) was multiplied by the average load for that reach type; this represents the percent length of actively eroding banks and associated load that would be expected under natural or full application of BMP conditions. Similarly, the average load for slowly eroding banks in each reach type was also multiplied by the percent of stream length containing slowly eroding banks in naturally influenced reaches (5.8/7.1=0.82). The sum of the actively eroding load and slowly eroding loads, based on the percent length of eroding bank types in naturally influenced reaches, serves as the extrapolated load (per reach type) to determine the total allowable load from bank erosion. Extrapolated bank erosion loads, by stream, are presented in **Table 5-16**.

Desired load = (average active load per reach type * 0.18) + (average slowly eroding load per reach type * 0.82)

Example: Desired Load Reach Type 0-4-U = (15.5 * 0.18) + (2.5 * 0.82) = 4.9 tons/year/1000’

Table 5-16. Extrapolated Bank Erosion Loads and Reductions

Stream	Existing Bank Erosion Load	Desired Bank Erosion Load	Percent Reduction
Barnes Creek	408.6	185.8	55%
Boulder Creek	302.0	193.9	36%
Douglas Creek (Hall)	398.1	172.4	57%
Douglas Creek (Philipsburg)	132.0	73.6	44%
Flint Creek (upper)	2306.8	596.5	74%
Flint Creek (lower)	1467.1	389.7	73%
Fred Burr Creek	599.9	216.8	64%
Lower Willow Creek	692.1	232.7	66%
Smart Creek	952.6	374.6	61%
Trout Creek	508.9	229.3	55%

5.5.1.5 Allocations and achievement

The desired sediment load is a gross estimate based on limited data. As such, the quantified load is not as significant for management and TMDL achievement purposes as the potential percent reduction. Since the desired load is based on analysis of natural and human influenced bank erosion, it is assumed that this is a reasonable estimate for what is achievable. The percent reduction allocation encompasses all adjacent land use categories and land management practices, and expects land owners to manage their properties with all applicable and reasonable land, water, and soil conservation practices to protect, improve, and restore stable and healthy streambanks and riparian corridors. Reasonable land, water, and conservation practices in this context may include limiting riparian livestock grazing durations to reduce effect on riparian vegetation, directing livestock to designed water gaps or off-site watering locations, establishing a specific riparian corridor with free from human-related activity, or re-establishment of key riparian vegetation. It is acknowledged that recovery of stable banks and improvement of riparian vegetation communities may take many decades to achieve. It is encouraged that, in addition to managing current activities with all reasonable land, soil, and water conservation practices, management decisions to promote floodplain functionality and native vegetation establishment throughout the riparian corridor will be reviewed and implemented wherever and whenever possible.

Although it is difficult to discern between bank erosion influenced from current or historic human practices and bank erosion as a result of natural processes using aerial photography and GIS methodology, it is possible to identify potential present-day influencing factors with these methods. Through the stratification process used during the assessment method, adjacent land use and potential current influences on bank erosion was noted for each reach. Simple breakouts of the apparent percent influence of major land use types allows a general, but useful, overlook of those activities that may be affecting bank erosion. This data can be used to help assist land managers with prioritizing areas to expedite sediment load reductions and eventually achieve the TMDL. Rough estimates of potential influence at the watershed scale are presented in **Table 5-17** below.

It is acknowledged that the developed sediment loads and the method by which to attribute anthropogenic and historic influence are estimates based on aerial photography, best professional judgment, and limited access to on-the-ground reaches. The assignment of bank erosion loads to the various land uses is not definitive; however it does provide helpful guidance for directing focus and efforts at reducing the loads from those causes which are likely having the biggest impacts on the investigated streams. Ultimately, it is the responsibility of local land owners and managers to identify the causes of bank erosion, and adopt practices to reduce bank erosion where ever practicable and possible. Complete TMDLs and allocations are presented in **Section 5.6**.

Table 5-17. Percent Adjacent Land Use With Potential Influence on Bank Erosion (as identified through GIS/aerial imagery)

Watershed	Natural	Tranport.	Grazing	Mining	Forestry	Irrigation	Other*
Barnes	27	6	31			27	9
Boulder	57	25	1	4	2		11
Douglas (N)	10	49	12	3	8	17	
Douglas (S)	28	45		20	6		1
Flint	6	24	20	1		45	4
Flint	2	9	23			56	10
Fred Burr	55	12	1	3	7	11	12
L. Willow	10	7	29			53	1
Smart	37	26	23		4	9	1
Trout	7	3	28			54	8

* 'Other' typically refers to adjacent land use that appears to be obviously related to past human activity, but an activity that is not as easily discernable due to the length of time that has elapsed. For example, historic placer mining and historic timber harvest may be designated as 'Other' based on judgment regarding how long ago the activity occurred, and the likelihood that the activity will occur again at that location in the future.

5.5.1.6 Assumptions and Considerations

- The annual streambank erosion rates used to develop the sediment loading numbers were based on Rosgen BEHI studies developed using Colorado USDA Forest Service data for streams found in sedimentary and/or metamorphic geology. While the geologies between the Rosgen research sites and the Flint Creek TPA are not identical, they are similar enough in character to warrant their application.
- The bank erosion data collected during the 2009 field effort is representative of conditions throughout the Flint Creek watershed.
- The assignment of influence to the eroding banks, and distinction between natural and human caused bank erosion is based on best professional judgment by qualified and experienced field personnel.
- The application of percent length of eroding bank in naturally influenced stream reaches, and the differences between actively eroding and slowly eroding banks provides a reasonable expectation for achievable conditions under natural and/or properly managed conditions.
- Specific quantification of the load reductions estimated here is not as significant as the complete application of best management practices in each of the watersheds of interest. With application of all reasonable land, soil, and water conservation practices it is expected that the allocation will be achieved.

- The land use percentages identified in **Table 5-17** are general and may not be entirely accurate. They are intended to provide a starting point for further investigation and activity to address bank erosion by land use planners and watershed managers.

5.5.2 Sediment from Roads

Roads located near stream channels can impact stream function through a degradation of riparian vegetation, channel encroachment, and sediment loading. The degree of impact is determined by a number of factors including road type, construction specifications, drainage, soil type, topography, precipitation, and the use of Best Management Practices (BMPs). In the Flint Creek watershed, sediment from roads has been identified as one of three major source categories potentially affecting sediment loads in impaired tributary streams.

In the summer of 2010, DEQ conducted a study of road systems in the Flint Creek TMDL planning area (TPA) to estimate sediment contributions and potential load reductions from unpaved roads. Data was collected from randomly selected road crossings and parallel segments and entered into a soil erosion model (WEPP:Roads) to quantify the amount of sediment produced at each location. The model was used to quantify loads from both existing conditions and potential BMP conditions. Results from assessed road features were then extrapolated to non-assessed features based on ownership, road-type, and precipitation characteristics. The following subsections present summary information regarding the road assessment and load calculations. Expanded details of this assessment are provided in **Appendix E**.

5.5.2.1 Quantifying Sediment From Roads

Computer models are often used to simulate road surface erosion response to the hydrology and climate for a given area. These models take into account weather, road condition, road shape, road orientation, topography, buffering vegetation, and other factors. Most models require a certain amount of specific field information as input parameters to derive loads from discrete locations; however, in large areas of study, representative conditions from a subset of locations may be modeled, and the results extrapolated to the remaining roads.

In 2010, DEQ used GIS to identify crossings and parallel segments in the road network, and classified them relative to the subwatersheds of interest, land ownership, precipitation zone and road type. Then, a total of 38 unpaved crossings and 8 parallel segments were measured in the field to provide a subset of data related to these road attributes. General results of the GIS assessment are presented in **Table 5-18**.

Assessment of data from the field evaluation was conducted using the WEPP:Road forest road erosion prediction model (http://forest.moscowfsl.wsu.edu/fswepp/). WEPP:Road is an interface to the Water Erosion Prediction Project (WEPP) model (Flanagan and Livingston, 1995), developed by the USDA Forest Service and other agencies, and is used to predict runoff, erosion, and sediment delivery from forest roads. The model predicts sediment yields based on soil, climate, ground cover, and topographic conditions. Specifically, the following model input data was collected in the field: soil type, percent rock, road surface, road design, traffic level, and specific road topographic values (road grade, road length, road width, fill grade, fill length, buffer grade, and buffer length). In addition, supplemental data was collected on vegetation condition of the buffer, evidence of erosion from the road system, and potential for best management practice implementation.

Table 5-18. Road Statistics for Streams in the Flint Creek TPA

Watershed	Watershed Area (mi^2)	Stream Miles	Road Miles	Road Density (mi/mi^2)	Number of Crossings	Unpaved Parallel Road Length w/in 150 feet of streams (mi)
Barnes Creek	21.33	37.6	36.36	1.70	29	1.62
Boulder Creek	70.64	67.7	148.55	2.10	74	6.96
Douglas Creek (North)	14.68	20.6	51.24	3.49	34	7.13
Douglas Creek (South)	6.43	7.8	27.60	4.29	21	2.34
Fred Burr Creek	15.75	14.2	25.15	1.60	9	0.91
Lower Flint Creek	24.41	92.3	115.24	4.72	79	10.40
Middle Flint Creek	35.26	94.3	199.53	5.66	112	10.77
Upper Flint Creek	69.85	62.0	203.34	2.91	86	12.12
Smart Creek	77.32	27.0	97.46	1.26	72	10.48
Trout Creek	14.11	42.3	63.44	4.50	41	3.49
Lower Willow Creek	76.03	27.2	19.11	0.25	20	0.96
North Fork Willow Creek	30.4	40.5	62.36	2.05	38	5.54
South Fork Lower Willow Creek	40.21	51.3	98.55	2.45	52	4.30

5.5.2.2 Sediment from Road Crossings

Often, the majority of sediment loading from roads occurs at road crossings. Intersections of road and stream are natural drainage locations and often have limited capacity for buffering or diverting sediment laden runoff from the road. The contributing sediment load at road crossings is a function of the road length and condition adjacent to the crossing, and other physical and hydrologic characteristics of the immediate area. Addressing road/stream crossings and their contributing sediment load is an important component to managing the sediment load from road networks.

Each site was individually modeled and the results were organized based on the ecoregion, land ownership, road type and associated climate station. The combination of these characteristics is defined as a road category. Loads for the measured sites were then averaged by road category.

Sediment loads for the Flint Creek TPA road crossings were then extrapolated by multiplying the average sediment load for each road category by the total number of road crossings within that category. In those instances where no representative sites were sampled within a particular road category, the average load for **all** sites of a given road surface and climate station was applied. A total of 711 road crossings were identified in the Flint Creek TPA. Of these, 44 crossings were paved and therefore determined to not contribute road related sediment. (**Table E-3** in **Appendix E** presents the extrapolated loads.)

Of the 55 road crossings visited during the field assessment, 17 of them were determined to be “false stream crossings”. False stream crossings are those crossings that, upon investigation, do not appear to contribute any sediment load because of a lack of a defined waterway or conveyance of sediment load to a stream, or errors in GIS analysis. It can be assumed therefore, that not all of the road crossings identified through the GIS analysis contribute sediment. In order to account for this, and thereby provide a more accurate representation of the sediment loads after extrapolation, a reduction factor was calculated using the difference between “true crossings” to “false crossings” as observed in the field. As described in **Section 3.0**, 31% of the sites encountered in the field were determined to be false crossings. That percentage was then considered the reduction factor. The reduction factor was applied to the total calculated loads for each watershed. Sediment loads from road crossings per watershed are presented in **Table 5-19**.

Table 5-19. Estimated Sediment Loads for Road Crossings, by Watershed

Watershed	Number Crossings	Estimated Total Load (lb/year)	Estimated Total Load (tons/year)	Total Load with 31% Reduction Factor (tons/year)
Barnes Creek	29	5,202	2.60	1.79
Boulder Creek	74	17,474	8.74	6.03
Douglas Creek (North)	34	7,145	3.57	2.46
Douglas Creek (South)	21	3,184	1.59	1.10
Fred Burr Creek	9	1,468	0.73	0.50
Lower Flint Creek	79	13,151	6.58	4.54
Middle Flint Creek	112	22,086	11.04	7.62
Upper Flint Creek	86	16,699	8.35	5.76
Smart Creek	72	16,793	8.40	5.80
Trout Creek	41	4,411	2.21	1.52
Lower Willow Creek	20	2,931	1.47	1.01
North Fork Willow Creek	38	5,892	2.95	2.04
South Fork Lower Willow Creek	52	7,976	3.99	2.75
Total	667	124,412	62.22	42.92

5.5.2.3 Sediment from Parallel Segments

Sediment contributed from road/stream crossings addresses discrete locations in a watershed where the road and stream intersect. However, road sediment from those parallel sections of road which may not have a direct entry point to the stream channel must also be considered and included with the overall sediment load quantification.

In the Flint Creek TPA, parallel road segments were also investigated to calculate sediment contribution from roads. Parallel road segments were modeled with WEPP:Roads to calculate the amount of sediment from roads that are within a distance of 150 feet of the stream. Eight parallel segments were measured in the field. For modeling purposes, contributing road lengths were given a maximum contributing length of 1000’. The calculated load for each parallel segment was converted to an annual load per mile of road length. In this case, since the number of sampled parallel road segments was too few to allow to effectively discern differences between road type, climate station, or ownership, a general average sediment load for parallel road segments was determined.

The average load per mile was then multiplied by the total miles of parallel road segments in each watershed (as was identified during the GIS analysis) and an estimate of sediment load from parallel segments was determined for each watershed. Due to time and resource constraints, data collected for parallel segments during the road assessment came from a smaller representative sample of sites. Therefore, the same reduction factor that was used with road crossings (31%) was used for parallel segments based on the assumption that the same general analysis error and geographic features present throughout the watershed apply to the parallel segments as do the road crossings. Sediment loads from parallel segments per watershed are presented in **Table 5-20**.

Table 5-20. Estimated Sediment Loads for Parallel Segments, by Watershed

Watershed	Miles of Gravel Road	Miles of Native Road	Total Road Miles	Estimated Total Load (tons/year)	Total Load 31% RF (tons/year)
Barnes Creek	0.88	0.74	1.62	1.55	1.07
Boulder Creek	3.86	3.10	6.96	6.66	4.60
Douglas Creek (North)	5.57	1.56	7.13	6.82	4.71
Douglas Creek (South)	1.32	1.02	2.34	2.24	1.56
Fred Burr Creek	0.16	0.75	0.91	0.87	0.60
Lower Flint Creek	3.03	7.37	10.40	9.94	6.86
Middle Flint Creek	5.70	5.07	10.77	10.30	7.11
Upper Flint Creek	3.18	8.94	12.12	11.59	8.00
Smart Creek	4.55	5.93	10.48	10.02	6.91
Trout Creek	1.64	1.85	3.49	3.34	2.30
Lower Willow Creek	0.66	0.30	0.96	0.92	0.63
North Fork Willow Creek	1.72	3.82	5.54	5.30	3.66
South Fork Lower Willow Creek	1.00	3.30	4.30	4.11	2.84
Total	33.27	43.76	77.02	73.65	50.85

5.5.2.4 Establishing the Total Allowable Load

The sum of the loads from road crossings and parallel segments is an estimate of the existing sediment load from the road networks in the Flint Creek TPA. To determine the reductions necessary to achieve a desired condition, or total allowable load from roads, data for each of the measured sites was rerun in WEPP:Roads, with changes to represent the implementation of BMPs. BMP modifications were based on photographs and notes, taken during data collection, of potential improvements that could be made specific to each investigated site. Potential improvements include improving road surface type, reducing the contributing length of road to the crossing through installation of waterbars or additional drainage features, and improvement of roadside vegetation for filtering purposes. As in calculating the existing loads, sites were then grouped according to road type, ownership, and precipitation zone; averages developed for road categories; and values extrapolated throughout the watersheds **Table 5-21**. **Table 5-21** also provides a normalized load (load/1000 acres) to illustrate relative degree of loading between watersheds.

Table 5-21. Estimated Sediment Loads From Roads With Application of BMPs, by Watershed

Watershed	Acres	Crossings Load	Parallel Load	Total Load	Percent Reduction	Load/1000 acres
Barnes Creek	13,649	0.39	0.23	0.62	78%	0.05
Boulder Creek	45,207	0.70	0.99	1.69	84%	0.04
Douglas Creek (North)	9393	0.28	1.01	1.29	82%	0.14
Douglas Creek (South)	4118	0.31	0.33	0.64	76%	0.16
Fred Burr Creek	10,082	0.15	0.13	0.28	75%	0.03
Lower Flint Creek	49,485	0.97	1.48	2.45	79%	0.05
Middle Flint Creek	48,657	1.32	1.53	2.85	81%	0.06
Upper Flint Creek	44,707	1.09	1.72	2.81	80%	0.06
Smart Creek	15,626	0.88	1.49	2.37	81%	0.15
Trout Creek	22,565	0.64	0.50	1.14	70%	0.05
Lower Willow Creek	9032	0.26	0.14	0.40	76%	0.04
N. F. Willow Creek	19,453	0.38	0.79	1.17	79%	0.06

Table 5-21. Estimated Sediment Loads From Roads With Application of BMPs, by Watershed

Watershed	Acres	Crossings Load	Parallel Load	Total Load	Percent Reduction	Load/1000 acres
S. F. Willow Creek	25,731	0.43	0.61	1.04	81%	0.04

5.5.2.5 Determining Allocations

Allocations for the reduction of sediment from roads in the Flint Creek TPA are presented as general percent reduction by watershed. It is expected that the maintenance of roads and ultimate achievement of the desired load is the responsibility of those individuals or entities who control and manage the roads. An illustration of road crossing ownership throughout the Flint Creek TPA is provided in **Table 5-22**. The true ownership, and therefore responsibility of maintenance, identified in **Table 5-22** is not confirmed, however the table provides an indication of the distribution of ownership by which to direct initial management activity priorities and investigations.

Table 5-22. Road Crossings By Ownership Based on Available GIS Information, By Watershed

Watershed	BLM	USFS	State of Montana	Private	Unattributed
Barnes Creek	-	2	-	26	1
Boulder Creek	1	69	-	4	-
Douglas Creek (North)	-	22	-	12	-
Douglas Creek (South)	1	-	-	19	1
Fred Burr Creek	-	-	-	9	-
Lower Flint Creek	-	14	3	62	-
Middle Flint Creek	10	31	-	70	1
Upper Flint Creek	-	47	-	35	4
Smart Creek	3	42	-	27	-
Trout Creek	-	-	9	32	-
Lower Willow Creek	-	-	-	20	-
North Fork Willow Creek	-	11	-	27	-
South Fork Lower Willow Creek	-	29	-	23	-

* Road crossings as identified through initial GIS analysis and does not account for 30% reduction due to "false-crossings". Crossings were identified based on adjacent land ownership; it is acknowledged that road ownership may not always equate to adjacent land ownership and therefore the ownership attribution may not be entirely accurate.

The management practices to achieve load reductions may be accomplished through a variety of measures; such as the installation of structural BMPs (drive through dips, culvert drains, settling basins, silt fence, etc), road surface improvement, reduction in road traffic levels (seasonal or permanent road closures), and timely road maintenance to reduce surface rutting. 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 watersheds 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. Complete TMDLs and allocations are presented in **Section 5.6**.

5.5.2.6 Assumptions and Considerations

- The sites assessed are representative of conditions throughout the Flint Creek TPA.

- The BMP reductions as simulated in WEPP represent the likely achievable reductions in sediment load that can be gained from BMP application throughout the watershed.
- Approximately 31% of the initially identified crossings and parallel segments either do not exist or do not contribute a quantifiable load to the streams of interest.
- BMPs may have already have been implemented on roads but have not been accounted for in the GIS information used in this analysis and therefore the reductions necessary by land owner may be less than described in this document.

5.5.3 Upland Sediment

Upland sediment is sediment that occurs across the landscape and is influenced by land use and/or vegetative cover. Sediment from the landscape may be entirely natural, or it may be increased by human activities such as timber harvest practices, farming or grazing practices, or clearing of land for development. When human activities increase levels of sediment, nutrients, metals, etc to levels that affect beneficial uses (**Section 3.0**), it may be described as a form of pollution. The term “nonpoint source pollution” is described as pollution that originates over many varied and diffuse sources, as opposed to pollution delivered directly from a specific point or outlet, such as an end of pipe or chimney stack. Typically, nonpoint source pollution is carried to streams and lakes through erosion via surface water (in the form of rainfall or snowmelt), groundwater, or wind. It is often difficult to accurately quantify pollutant loads from the landscape when so much variability may exist across a watershed with regard to weather, vegetation, land use practices, soil types, geology, riparian condition, etc. However, while many complex processes are intertwined that determine a pollutant load, models can be employed to represent the landscape and simulate natural processes to reasonably estimate sediment loads, identify where on the landscape the loads are coming from, and intimate how those loads could be reduced. In the Flint Creek watershed, a Universal Soil Loss Equation (USLE) model was used to quantify sediment loads from various land cover/land use types.

5.5.3.1 Quantifying Sediment from Upland Sources Using USLE

Upland sediment loading due to hillslope erosion was modeled using a GIS application of the USLE model. A sediment delivery ratio was incorporated in USLE to better simulate the relationship between downslope travel distance and ultimate delivery to the stream. In addition, riparian zone health was also accounted for in quantifying sediment loads from upland sources, since riparian zone health is susceptible to anthropogenic impacts and thus to land management decisions, and the effectiveness of healthy riparian zones as sediment filters has been quantified in the literature. This model provided an assessment of existing sediment loading from upland sources, an assessment of potential sediment loading through the application of BMPs and riparian improvement.

USLE uses five main factors by which to estimate soil erosion: R * K* LS * C * P, where:
R = rainfall/intensity
K = erodibility
LS = length/slope
C = vegetation cover
P = field practices

ArcGIS and available data sources were used to develop the appropriate USLE factor values to estimate upland sediment loading. Typically, the ability to modify change to vegetation cover or field practices are the only real ways to simulate landscape or land management alterations using USLE. As the P-Factor (field practices) generally relates to specific agricultural plots and at a scale much less than the watershed-scales DEQ deals with, the C-Factor is the main variable to represent existing conditions and the potential for improvement. The C-factor integrates a number of variables that influence erosion, including vegetative cover, plant litter, soil surface, and land management. Three primary variables are considered when determining the C-factor, including (1) canopy cover effects, (2) effects of low-growing vegetal cover, and (3) rooting structure. For the Flint Creek TPA, the 2001 National Land Cover Dataset, NRCS C-factor tables, and the assistance and input of local NRCS and USFS employees served as the basis for establishing the C-factors.

The riparian corridor quality assessment, used to modify sediment delivery to the stream, is based on the stream reach stratification results described earlier. Riparian corridors are referred to as having low (marginal/limited), moderate (some good, some marginal), or high (majority adequate for aquatic resources) quality and the buffering capacity of the riparian corridor is based on the percent condition for each stream of interest. The following subsections provide a summary of the upland sediment modeling efforts in the Flint Creek TPA. Expanded details of this effort are documented in the report, Flint Creek Watershed Sediment Assessment: Upland Sediment Assessment Modeling and BMP Effectiveness and Percent Reduction Potential, (Water & Environmental Technologies, P.C., 2010) and is included here as **Attachment B**.

5.5.3.2 Establishing the Total Allowable Load

From the model output, an average annual sediment load delivered to the stream is determined for each subwatershed, (or listed stream watershed). This sediment load represents the best estimation of current conditions (land use, land cover, riparian condition) and resultant sediment from upland sources.

To determine the total allowable load from upland sources, land use/land cover categories are modified (through an alteration to the C-Factor, or vegetative condition) and riparian condition categories improved to represent those changes on the landscape, and the USLE model is run again. The resultant sediment loads represent a desired condition where 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 mixed forest, shrub/scrub, grasslands/herbaceous, pasture/hay, and cultivated crops. For example, ground and canopy cover percentages for shrub/scrub and grassland/herbaceous land would increase 10% with the reduction of grazing pressure, while ground cover percentages for mixed forest would increase 5%. Ground cover percentages for pasture/hay and cultivated cropland would increase 10% and 20%, respectively, with the implementation of BMP practices designed to reduce erosion, such as conservation tillage or crop stripping. It is assumed that in the Flint Creek 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 Flint Creek TPA are presumed to be either negligible, or with little potential for altering the current management to reduce existing sediment loads. In addition, riparian corridor buffering efficiency was altered to reflect an increase from moderate quality riparian health to high quality and from areas with low quality riparian health to an improved moderate quality. (The riparian improvement scenario is based on a very broad assumption that there is some level of riparian improvement capable from areas designated as low or moderate. It is acknowledged however that there are certainly areas where the riparian corridor is at its potential, despite the fact that they may not appear to be high quality when reviewed through aerial photos. When developing implementation plans for a given watershed, a more thorough investigation of riparian condition should be conducted to identify where riparian improvement is possible, and to what degree.) Results are presented in **Table 5-23**.

Table 5-23. Upland Modeling Results

Watershed	Existing Condition (tons/year)	Land use/Land Cover BMP Implementation (tons/year)	Percent Change From Existing	Land Use/Land Cover BMPs and Riparian Improvement (tons/year)	Percent Change From Existing Condition
Barnes Creek	605	491	19%	265	56%
Boulder Creek	494	452	8%	279	44%
Douglas Creek (north)	535	446	17%	244	54%
Douglas Creek (P'burg)	58	50	13%	34	42%
Fred Burr Creek	61	57	8%	36	41%
Georgetown Lake	146	129	12%	74	49%
Lower Flint Creek	2276	1842	19%	948	58%
Lower Willow Creek	1121	900	20%	467	58%
Middle Flint Creek	3195	2592	19%	1334	58%
Princeton Gulch	124	110	11%	62	50%
Smart Creek	685	558	18%	305	55%
Trout Creek	1555	1224	21%	612	61%
Upper Flint Creek	179	147	18%	76	58%
Upper Willow Creek	2554	2098	18%	1212	53%

5.5.3.3 Determining Allocations

The upland sediment loads are estimations based on the land uses, land cover types, riparian conditions, and potential for improvements that exist within a watershed. The difference between the modeled existing condition and the modeled desired condition provides the amount of sediment that must be reduced to achieve acceptable sediment loads from upland sources. Because it is difficult to discretely quantify the sediment loads at the watershed scale, the percent reduction serves to best describe the degree of sediment load reduction necessary for each watershed. This value is then incorporated into each TMDL calculation. In the Flint Creek TPA, although a general percent reduction value is provided for the major source types, land use/land cover types and the associated percent reductions are provided to assist with future planning and prioritization or management activities. These values are provided in **Table 3-1** of **Attachment B**.

5.5.3.4 Assumptions and Considerations

As with any modeling effort, and especially when modeling at a watershed scale, there are a number of assumptions that must be accepted. For the Flint Creek TPA, the following points serve as some of the more significant considerations:

- The input variables used in the USLE calculations are representative of their respective land use conditions.
- The land management practices (grazing duration, hay cutting, etc) for certain land use categories that define the vegetative cover are relatively consistent and representative of practices throughout the watershed.
- The riparian condition as estimated through the aerial assessment is representative of on-the-ground conditions.
- The improvement scenarios to riparian condition and land management are reasonable and achievable.

- The USLE model provides an appropriate level of detail and is sufficiently accurate for developing upland sediment loads for TMDL purposes.
- The data sources used are reasonable and appropriate to characterize the watershed and parameterize the model.

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 load allocation 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 allocations and associated rationale behind the allocations are described in **Section 5.5** and **Attachments A and B, and Appendix E**. 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 F**.

Sediment from upland erosion in the following tables is represented as the sum of upland sediment load from each of the categorized land uses within that watershed. These land uses, by default, incorporate sediment loads influenced by both 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 load allocation.

A TMDL is determined by the sum of the Wasteload Allocation (WLA), Load Allocation (LA), and Margin of Safety (MOS). Wasteload Allocations 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. There are two permits in the Flint Creek watershed requiring a WLA: one on Smart Creek associated with the Black Pine Mine, and one on the upper segment of Flint Creek associated with the wastewater treatment plant for the town of Philipsburg. These permits and WLA’s are discussed in detail in their respective sections below. There are no WLA’s for Barnes Creek, Douglas Creek, and the lower segment of Flint Creek.

In addition to the TMDLs and allocations presented below, a sub-section is included for each stream entitled “Implications for Implementation”. These sections are provided to give additional information or suggestions on broad categories to begin efforts to address TMDLs. More detailed descriptions of specific implementation strategies and management practices are included in **Section 8.0**, however these descriptions to do not identify specific locations within any of the watersheds; only practices that may be used to address pollutants in the Flint watershed. As with any TMDL document, the analysis and resultant determinations contained herein are meant as the first steps toward achieving water quality goals. It is up to local land owners and resource managers to build upon the foundation of the TMDL and develop the proper strategies to address pollutants and meet water quality standards in the most appropriate, efficient and effective ways possible.

5.6.1 Barnes Creek

TMDL and allocations for Barnes Creek are presented in **Table 5-24**. Current estimated loads are presented as gross estimates which include natural and anthropogenic related loads. Sediment load allocations are estimated loads that are expected under all reasonable land, soil, and water conservation practices and natural conditions.

Table 5-24. Barnes Creek Sediment TMDL

Sources	Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion	409	186	55%
Roads	3	1	79%
Upland Load	605	265	56%
Total Sediment Load	1017	452	56%

The loads presented in **Table 5-24** above provide only general estimations of current loads and reductions needed from the three major source types in order to achieve the TMDL. For consistency in presentation, sediment loads have been rounded to the nearest ton/year. However, percent reduction values are based on the actual values determined through the source assessments (**Section 5.5**). Information from the source assessments and reach stratification provides insight into how and where to begin continued investigation and action to prioritize efforts to affect change and reduce sediment.

Implications for Implementation

An aerial assessment conducted on Barnes Creek during the stratification effort further characterizes the near stream conditions. Although only a qualitative observation, riparian condition was deemed 15% good, and 85% fair. Riparian vegetation composition was observed to be 15% mature coniferous, 31% shrubs, and 54% grasses. Typically riparian areas observed to be dominated by grasses often reflect less stable banks and higher sediment loads from bank erosion. These conditions also often reflect agricultural practices that may be limiting riparian health and condition. Adjacent land use was described as 14% forest, 40% range, 34% hay/pasture, and 12% rural residential. Aerial assessment attribution to bank influence identified 67% to grazing, irrigation, and other related human influence. Only 27% of the stream appeared to be without significant human influence, and roads made up the final 6%.

According to the loads in **Table 5-24**, roads in the Barnes watershed make up a relatively minor contribution to the overall sediment input to the stream. Of 29 identified crossings, 26 (90%) were designated as private or country roads. Although the load from roads is minor in comparison to other sources, a full inventory of Barnes roads and crossing conditions should be conducted to identify the most in need of improvement. Once identified, outreach should be developed to work with those responsible for road maintenance to reduce sediment loads and keep the load from roads to a minimum.

Upland loads in the Barnes watershed were identified as 45% grassland/herbaceous, 20% shrub/scrub, and 6% pasture/hay, for a total of 71% of land designated as having a potential for management improvement. According to the USLE model results, management changes alone through the improvement of vegetative cover could yield a 20% decrease in sediment. When coupled with riparian improvement, the predicted result is a 57% sediment load reduction from upland sources.

In summary, the Barnes watershed sediment loads appear to be most influenced by land management related to grazing and other agricultural practices, and the loss of riparian vegetation that is likely associated with those practices. As illustrated in the adjacent land use, almost a third of the watershed has range or hay/pasture. This watershed could see significant improvement through riparian restoration efforts, as well as review of upland land management practices, and changes where appropriate.

5.6.2 Douglas Creek (Philipsburg)

TMDL and allocations for Douglas Creek are presented in **Table 5-25**. Current estimated loads are presented as gross estimates which include natural and anthropogenic related loads. Sediment load allocations are estimated loads that are expected under all reasonable land, soil, and water conservation practices and natural conditions.

Table 5-25. Douglas Creek Sediment TMDL

Sources	Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion	132	74	44%
Roads	3	1	78%
Upland Load	58	34	41%
Total Sediment Load	193	109	44%

The loads presented in **Table 5-25** above provide only general estimations of current loads and reductions needed from the three major source types in order to achieve the TMDL. For consistency in presentation, sediment loads have been rounded to the nearest ton/year. However, percent reduction values are based on the actual values determined through the source assessments (**Section 5.5**). Information from the source assessments and reach stratification provides insight into how and where to begin continued investigation and action to prioritize efforts to affect change and reduce sediment.

Implications for Implementation

Aerial assessment on Douglas Creek conducted during the stratification further characterizes the near stream conditions. Although only a qualitative observation, riparian condition was designated as 15% good, 34% fair, and 51% poor. In addition, the riparian vegetation composition identified 30% as mature conifers, 16% shrubs, 3% grass, and over half identified as bare. Bare in this context refers to closely cropped vegetation or manicured lawns through the town of Philipsburg, in addition to the loss of riparian from mining practices and related disturbances upstream in the watershed. Attribution to bank erosion influence conducted during the aerial assessment identifies 20% to mining, 45% to transportation, 6% to forestry, and 28% natural. Review of adjacent land use describes 28% as forest, 24% as mine related, 25% as urban, and 13% roads. Limited access and road conditions limited visual observations on the upper watershed at the time of the field data collection, however the instability of banks and potential sediment load related to bare banks is probably a greater threat in the upper watershed due to the general terrain and steeper stream gradients there; as opposed to the lower section where the stream is essentially ditched and armored, inhibiting its ability to develop a natural morphology. The transportation influence on bank erosion refers to roads that impede or confine the channel, and therefore may exacerbate stream velocities and power resulting in increased erosion. As Douglas Creek has an unpaved road paralleling the stream through much of the upper watershed, and roads paralleling the stream throughout lower Douglas Creek, the 45% attribution to transportation seems reasonable.

Despite the high influence roads appear to have on channel form and stability, the sediment load from roads themselves is minimal in relation to the loads derived from bank erosion and upland sources. Nevertheless, these roads, particularly because of their proximity to Douglas Creek for much of its length, are a significant factor. Of 21 road crossings, 19 appear to occur on private or county roads. Much of that road length is in the upper watershed and as private road, may not be under the same standards of operation and maintenance. A full inventory of Douglas Creek roads and crossings should be conducted, especially above town, to identify the most in need of improvement and work with those responsible for road maintenance to reduce sediment loads and keep the load from roads to a minimum.

Upland land use in the Douglas Creek watershed was identified as 83% evergreen forest, 9% shrub/scrub, with small percentages of grassland, pasture, crop, and developed land. As a result, sediment loads derived using USLE could only be reduced by 14% through management improvements alone, with a maximum of 43% when coupled with riparian improvement.

In summary, Douglas Creek sediment loads appear to be most influenced by the present and historic practices related to mining and resource extraction in the upper watershed. Road development along the stream, and mining that occurred adjacent to and within the riparian corridor has disturbed and destabilized the banks, removed vegetation that would otherwise serve as a buffer or filter, and created direct conduits of sediment to the stream via the roads. However, the upper watershed is not the only source of sediment. In addition, the historic development of Philipsburg altered Douglas Creek's channel form and flow path and denuded much of the lower watershed's riparian vegetation. Years of manipulation and adaptation to the lower watershed's development has left the stream relatively stable here, however focus should be placed on improving riparian vegetation where appropriate, and investigating the road system to eliminate or reduce as many sediment paths to the stream as possible (the road source assessment focus on unpaved roads, where most of the roads through town are paved, and therefore their contribution unaccounted for). In the upper watershed, investigation and improvement of road conditions, and restablishment of riparian vegetation, particularly in known mine areas, should be a priority.

5.6.3 Flint Creek (Upper - Georgetown Lake to confluence with Boulder Creek)

Loads presented in **Table 5-26** include the sediment loads from all major contributing watersheds that flow into the upper segment of Flint Creek. These include Georgetown Lake, Trout Creek, Fred Burr Creek, and Douglas Creek (near Philipsburg), and the middle Flint watershed (from Fred Burr Creek to Boulder Creek). Current bank erosion and upland sediment loads include natural and human caused loads; load allocations for these two sources express the sediment load that can be expected with implementation of all reasonable land, soil, water conservation practices. The difference between the two is considered the controllable load, i.e., the human caused load.

Wasteload Allocation

Philipsburg's domestic wastewater treatment plant is a MPDES permitted point source authorized under permit #MT0031500. The plant is a two-cell facultative lagoon with no disinfection and a continuous discharge. It was built in 1961 and upgraded in the early 1990s. The plant discharges directly to Flint Creek via a single outfall location (at the end of ditch) and has a 300 foot mixing zone. With a maximum design flow of 0.16 million gallons per day (mgd), the WWTP serves 520 hookups (over 900 citizens) from the Town of Philipsburg (Houston Engineering, 2011).

The WLA for the Philipsburg treatment plant is based on the current load limit in its permit. This can be calculated using the facility design capacity of 0.160 mgd (0.25 cfs) and the 30-day average TSS permit concentration limit of 45 mg/l. This equates to 60 lbs/day, or 11.0 tons/year. Although the 7-day average value can be as high as 65 mg/l, the 30-day average TSS concentration of 45 mg/l provides a more representative account for calculating the acceptable yearly load.

The effect from this allowable permit discharge can be evaluated by calculating the potential increase in TSS loading within Flint Creek from the Philipsburg WWTP at design capacity. Flint Creek data from sampling completed by DEQ near the town of Philipsburg during 2007-2009 can be used to represent typical low flow conditions. Using a flow of 66.2 cfs (which is the lowest cfs recorded in the vicinity by DEQ during August) and an average TSS value for August measurements of about 9.9 mg/l; if the Philipsburg WWTP was discharging at design capacity (0.25 cfs) with a TSS concentration of 65 mg/l into Flint Creek when Flint Creek was flowing at 66.2 cfs, the result would be an increase in TSS concentration in Flint Creek from approximately 9.9 mg/l to 10.1 mg/l. Under this scenario, a 0.2 mg/l increase represents an acceptably low level that is not expected to cause harm to aquatic life nor is it expected to result in aesthetic concerns.

Based on the analysis above, it is concluded that the 11.0 tons/year load based on the existing permit is an acceptable value to use as the WLA for the Philipsburg wastewater treatment facility. This is also supported by the fact that the sediment TMDL focuses on inorganic material from watershed erosion processes, whereas the TSS load from the Philipsburg wastewater treatment facility is mainly organic material. The WLA applies to the upper segment of Flint Creek.

In addition to the concentration limitations on TSS described in the permit, the permit also called for a 65% removal requirement for TSS; whereby the arithmetic mean of the TSS for effluent samples collected in a period of 30 consecutive days shall not exceed 35% of the arithmetic mean of the values for influent samples collected at approximately the same times during the same period. This and any other conditions of the permit must still be met in addition to the WLA.

Table 5-26. Flint Creek (Upper) Sediment TMDL

Sources	Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion	3548	1116	69%
Roads	36	5	86%
Upland Load	5194	2166	58%
WLA – Philipsburg WWTP	11	11	0%
Total Sediment Load	8689	3299	62%

The loads presented in **Table 5-26** above provide only general estimations of current loads and reductions needed from the three major source types in order to achieve the TMDL. For consistency in presentation, sediment loads have been rounded to the nearest ton/year. However, percent reduction values are based on the actual values determined through the source assessments (**Section 5.5**). Information from the source assessments and reach stratification provides insight into how and where to begin continued investigation and action to prioritize efforts to affect change and reduce sediment.

Implications for Implementation
An aerial assessment conducted on upper Flint Creek during the stratification effort further characterizes the near stream conditions. Although only a qualitative observation, riparian condition was deemed 94% fair, and 6% poor. Riparian vegetation composition was observed to be 3% mature coniferous, 10% shrubs, 81% grasses, and 6% bare. Typically riparian areas observed to be dominated by grasses often reflect less stable banks and higher sediment loads from bank erosion. These conditions also often reflect agricultural practices that may be limiting riparian health and condition. Adjacent land use was described as 83% hay/pasture, with 7% as road, 2% as rural residential, 1% mining, and 8% as forest. 64% of possible influence on bank erosion in the upper Flint Creek mainstem was attributed to grazing and/or irrigation practices. Another 24% was attributed to the influence from roads. The remaining influence was presumed to be small percentages of mining or other human influences, and some naturally occurring bank erosion.

According to the loads in **Table 5-26**, roads in the upper Flint Creek watershed make up a relatively minor contribution to the overall sediment input to the stream. Of 198 identified crossings, 105 (53%) were designated as private or county roads, and 78 (39%) were within USFS property. The remaining road ownership was identified as BLM (5%) or unattributed (3%). Although the load from roads is minor in comparison to other sources, the analysis does indicate a potential for substantial improvement in sediment loads from roads. Reducing the loads from this source may improve discrete areas near and downstream of some of these sites, which may have a significant impact on fisheries or aquatic life as a whole. A full inventory of upper Flint Creek roads and crossing conditions should be conducted to identify those most in need of improvement. Once identified, outreach should be developed to work with those responsible for road maintenance to reduce sediment loads and keep the load from roads to a minimum.

Upland loads in the upper Flint watershed were identified as 17% grassland/herbaceous, 19% shrub/scrub, 6% pasture/hay, and 6% cultivated crops for a total of 48% of land designated as having a potential for management improvement. According to the USLE model results, management changes alone through the improvement of vegetative cover could yield a 20% decrease in sediment. When coupled with riparian improvement, the predicted result is a 59% sediment load reduction from upland sources.

It should be noted that the descriptions of stratification results, road, and upland load statistics are for the Flint Creek mainstem which includes some of its smaller contributing tributaries. The above summaries *do not* include Trout Creek, Douglas Creek (Philipsburg), or Fred Burr Creek. However these streams and their associated loads do factor into the TMDL and allocation calculations presented in **Table 5-26**. Immediate management activities to reduce sediment should focus on the Flint Creek mainstem and adjacent lands. Information above suggests that the predominance of agriculture and lack of good riparian quality should put focus on agricultural practices related to grazing and hay production and overall riparian condition. More detailed investigations of management practices and riparian health should be conducted to help prioritize areas where work can be done. Information related to Douglas Creek is described in detail in **Section 5.6.2**. Fred Burr Creek is a relatively low contributor of sediment in the context of the upper Flint Creek watershed, however roads in the Fred Burr watershed may be an issue and in general, road conditions and BMP implementation should be considered here as well. Trout Creek is dominated by agricultural land and when normalized by acreage, the estimated Trout Creek watershed sediment load is over 110 tons/1000 acres, more than any other watershed in the upper Flint Creek, including the upper Flint Creek valley watershed (which has an estimated contribution of 91 tons/1000 acres). Therefore, review of management practices and riparian condition in the upper Flint Creek watershed should include Trout Creek, although Trout Creek has not undergone full assessment and is not identified as impaired in this document.

5.6.4 Flint Creek (Lower – Boulder Creek to mouth)

Loads presented in **Table 5-27** include the sediment loads from all major contributing watersheds that flow into the lower segment of Flint Creek. These include Barnes Creek, Boulder Creek, Douglas Creek (near Hall), lower Willow Creek, and Smart Creek (Loads from upper Willow Creek were not included in **Table 5-27** calculations because they deposit in a reservoir that separates the two segments. It is assumed that these loads are trapped within the reservoir and do not contribute to the sediment load in lower Willow Creek.) Current bank erosion and upland sediment loads include natural and human caused loads; load allocations express the sediment load that can be expected under natural conditions, and/or implementation of all reasonable land, soil, water conservation practices. The difference between the two is the percent reduction in sediment load and is considered the controllable load, i.e., the human caused load.

Table 5-27. Flint Creek (Lower) Sediment TMDL

Sources	Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion	4221	1563	63%
Roads	46	9	80%
Upland Load	5840	2570	56%
Upper Flint Loads*	8689	3299	62%
Total Sediment Load	18808	7427	61%

*From **Table 5-26**

The loads presented in **Table 5-27** above provide only general estimations of current loads and reductions needed from the three major source types in order to achieve the TMDL. For consistency in presentation, sediment loads have been rounded to the nearest ton/year. However, percent reduction values are based on the actual values determined through the source assessments (**Section 5.5**). Information from the source assessments and reach stratification provides insight into how and where to begin continued investigation and action to prioritize efforts to affect change and reduce sediment.

Implications for Implementation

An aerial assessment conducted on lower Flint Creek during the stratification effort further characterizes the near stream conditions. Although only a qualitative observation, riparian condition was deemed 98% fair, and 2% poor. Riparian vegetation composition was observed to be 37% shrubs, 62% grasses, and 1% bare. Typically riparian areas observed to be dominated by grasses often reflect less stable banks and higher sediment loads from bank erosion. These conditions also often reflect agricultural practices that may be limiting riparian health and condition. Adjacent land use was described as 83% hay/pasture, with 8% described as range, and 9% as rural residential. 80% of possible influence on bank erosion on the mainstem of lower Flint Creek was attributed to grazing and/or irrigation practices. Another 9% was attributed to the influence from roads. The remaining influence was presumed to be small percentages of mining or other human influences, and some naturally occurring bank erosion.

According to the loads in **Table 5-27**, roads in the lower Flint Creek watershed make up a relatively minor contribution to the overall sediment input to the stream. Of 79 identified crossings, 62 (78%) were designated as private or county roads, and 14 (18%) were within USFS property. The remaining 4%

of road ownership was identified as occurring within State of Montana property. Although the load from roads is minor in comparison to other sources, the analysis does indicate a potential for substantial improvement in sediment loads from roads. Reducing the loads from this source may improve discrete areas near and downstream of some of these sites, which may have a significant impact on fisheries or aquatic life as a whole. A full inventory of lower Flint Creek roads and crossing conditions should be conducted to identify those most in need of improvement. Once identified, outreach should be developed to work with those responsible for road maintenance to reduce sediment loads and keep the load from roads to a minimum.

Upland loads in the lower Flint watershed were identified as 34% grassland/herbaceous, 18% shrub/scrub, 14% pasture/hay, and 17% cultivated crops for a total of 83% of land designated as having a potential for management improvement. According to the USLE model results, management changes alone through the improvement of vegetative cover could yield a 22% decrease in sediment. When coupled with riparian improvement, the predicted result is a 60% sediment load reduction from upland sources.

It should be noted that the descriptions of stratification results, road, and upland load statistics are for the mainstem of lower Flint Creek which includes some of its smaller contributing tributaries. The above summaries *do not* include Barnes Creek, Boulder Creek, Smart Creek, Douglas Creek (Hall), or Willow Creek. However these streams and their associated loads do factor into the TMDL and allocation calculations presented in **Table 5-27**. Immediate management activities to reduce sediment should focus on the Flint Creek mainstem and adjacent lands. Some of the statistics above (98% fair riparian condition, 83% hay/pasture adjacent land, 83% land use with management improvement potential) suggests that focus should be put on agricultural practices related to grazing and hay production and overall riparian condition. More detailed investigations of management practices and riparian health to help prioritize areas where work can be done should be conducted. Information related to Barnes Creek and Smart Creek are described in detail in **Sections 5.6.1** and **5.6.5** respectively. Estimates of sediment loads normalized by watershed acres consistently show a load of over just over 100 tons of sediment per 1000 acres for all of the major watersheds contributing to the lower Flint Creek, except for Boulder Creek, which has an estimated load of roughly 25 tons/1000 acres.

The sediment-related impairment listing for lower Flint Creek is identified as turbidity. This listing is based on data from a 2001 report which showed turbidity levels over 200 times that of similar streams at the time of that sampling event (April 3, 2001). Other information in the assessment file identifies significant sources of sediment from bank erosion, siltation, and riparian degradation. Although sediment does not appear specifically as a cause of impairment for the lower Flint Creek segment, analysis of recent data and supporting information within the original assessment file shows that sediment is indeed a problem in lower Flint Creek and the cause of the elevated turbidity due to increases in suspended sediment in the water column. Therefore a sediment TMDL is the justified approach to address turbidity. In developing the sediment TMDL, it is assumed that water quality problems such as turbidity or alteration in streamside littoral vegetative covers are also addressed since satisfying the sediment TMDL targets and sediment allocations will result in conditions where turbidity levels and streamside littoral vegetative covers are consistent with reference or naturally occurring conditions.

5.6.5 Smart Creek

TMDL and allocations for Smart Creek are presented in **Table 5-28**. Current estimated loads are presented as gross estimates which include natural and anthropogenic related loads. Sediment load allocations are estimated loads that are expected under all reasonable land, soil, and water conservation practices and natural conditions.

Wasteload Allocation

MPDES permit MTR300080 has been issued for Storm Water Discharges Associated with Mining and Oil and Gas Activities related to the ASARCO LLC Black Pine Mine, currently under the ownership of Montana Environmental Trust Group, LLC. Within that permit, two outfalls from the Combination Mine (Outfall 001, Outfall 003) were identified as discharging to an unnamed tributary to Smart Creek.

According to the General Permit For Storm Water Discharges Associated With Mining and With Oil and Gas Activities (Permit Number MTR300000) the following effluent limitations apply:

A. There shall be no discharge of process wastewater pollutants to surface waters.
B. A discharge of stormwater associated with mining or with oil and gas activity may occur based on water generated only through rainfall precipitation and snowmelt.
C. No discharge of stormwater associated with mining or with oil and gas activity shall cause or contribute to a violation of water quality standards.
D. Discharges of stormwater containing pollutants associated with mining or with oil and gas activity covered under this General Permit will be controlled through the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). Best Management Practices (BMPs) identified in the SWPPP must help eliminate or minimize the discharge of pollutants to surface waters.
E. New or increased stormwater discharges associated with mining or with oil and gas activity on or after April 29, 1993 shall not cause degradation as described in ARM 17.30.715(3) and 75-5-301(5)(c), MCA.

The SWPPP sets forth the procedures, methods, and equipment used to prevent the pollution of stormwater discharges from the facility. In addition, this SWPPP describes general practices used to reduce pollutants in stormwater discharges. According to the Black Pine Mine SWPPP, (ASARCO, LLC, 2011), the mine has been inactive and on standby status since the early 1990s. Therefore, there are no on-going operational activities that would contribute to stormwater runoff or stormwater pollution. However, recently completed and future reclamation-related construction activities have the potential to produce stormwater pollution sources; stormwater sampling data at the Combination Mine from sampling events on 4/12/06 and 3/30/07 returned Total Suspended Solids results of 19 mg/l, 764 mg/l, 2670 mg/l, 2870 mg/l. These results illustrate the elevated suspended solids that may occur from this site; although these same reclamation activities and stormwater BMPs have the potential to reduce sediment loading rates to Smart Creek through the eventual establishment of vegetative cover over previously disturbed areas.

According to **Attachment B** (Monitoring Parameter Benchmark Concentrations) within the general stormwater permit, the benchmark value for TSS is 100 mg/l. The SWPPP for the Black Pine Mine (Combination Mine site) provides information pertaining to site conditions. Based on this information, an area of approximately 12 acres drains the facility to Smart Creek. The annual average precipitation for this site is approximately 21 inches (PRISM data). Given the 12 acres of disturbed area, 21 inches of precipitation, and using the condition of the benchmark value (100 mg/l), the maximum allowable annual sediment load from this site would equate to approximately 2.8 tons/year. The WLA is provided because it is a requirement for permitted point sources (of the pollutant category of concern) but is not intended to add load limits to the permit; it is assumed that the WLA will be met by adherence to the General Permit requirements (MTR300000), which include a Stormwater Pollution Prevention Plan (SWPPP) with numerous BMPs and site stabilization before a permit can be terminated.

Table 5-28. Smart Creek Sediment TMDL

Sources	Current Estimated Load (Tons/Year)	Sediment Load Allocation (Tons/Year)	Sediment Load Allocation – Expressed as Percent Reduction
Bank Erosion	953	375	61%
Roads	13	2	81%
Upland Load	685	305	55%
WLA - Black Pine Mine	2.8	2.8	0%
Total Sediment Load	1654	685	59%

The loads presented in **Table 5-28** above provide only general estimations of current loads and reductions needed from the three major source types in order to achieve the TMDL. For consistency in presentation, sediment loads have been rounded to the nearest ton/year. However, percent reduction values are based on the actual values determined through the source assessments (**Section 5.5**). Information from the source assessments and reach stratification provides insight into how and where to begin continued investigation and action to prioritize efforts to affect change and reduce sediment.

Implications for Implementation

Aerial assessment on Smart Creek conducted during the stratification further characterizes the near stream conditions. Although only a qualitative observation, riparian condition was designated as 17% good and 83% fair. Riparian vegetation composition was classified as 51% mature conifers, 13% shrubs, and 36% grass. Adjacent land use is identified as 43% forest, 24% range, and 32% road. In viewing the aerial photos, influence on bank erosion was deemed to be 37% natural, 26% transportation, 23% grazing, with small contributions from forestry, irrigation and other agricultural related influences.

The percentages described above illustrate the fact that this watershed is split between forest in the upper watershed, and agriculture and cattle grazing in the lower, with grazing extending up into the forest as well. A road parallels the stream closely for much of its length and influences the stream, and this is reflected in the adjacent land use and attribution to bank erosion.

Although sediment loads from roads are relatively minor in comparison to the loads derived from bank erosion and upland loads, they are still a significant source, particularly in a watershed like Smart Creek where road and stream are within such close proximity for much of the stream length. A total of 72 crossings were identified through GIS analysis in the watershed, with 42 (58%) occurring on USFS land, 27 (38%) as private, and the remaining 3 on BLM land.

Land types in the Smart Creek watershed were identified as 11% grassland/herbaceous, 26% shrub/scrub, 1% pasture/hay, and 1% cultivated crops for a total of 39% of land designated as having a potential for management improvement; the remaining land use is identified as forest. According to the USLE model results, management changes alone through the improvement of vegetative cover could yield a 19% decrease in sediment. When coupled with riparian improvement, the predicted result is a 56% sediment load reduction from upland sources.

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 load allocations. TMDL development must also incorporate a margin of safety into the load allocation 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 margin of safety in the Flint Creek TPA tributary sediment TMDL development process.

5.7.1 Seasonality

All TMDL documents must consider the seasonal applicability of water quality standards as well as the seasonal variability of pollutant loads to the stream. Seasonality was addressed in several ways as described below.

- The applicable narrative water quality standards (**Appendix C**) are not seasonally dependant, although low flow conditions provide the best ability to measure harm to use based on the selected target parameters. The low flow or base flow condition represents the most practical time period for assessing substrate and habitat conditions, and also represents a time period when high fine sediment in riffles or pool tails will likely influence fish and aquatic life. Therefore, meeting targets during this time frame represents an adequate approach for determining standards attainment.
- The substrate and habitat target parameters within each stream are measured during summer or autumn low flow conditions consistent with the time of year when reference stream measurements are conducted. This time period also represents an opportunity to assess effects of the annual snow runoff and early spring rains, which is the typical time frame for sediment loading to occur.
- The DEQ sampling protocol for macroinvertebrates identifies a specific time period for collecting samples based on macroinvertebrate life cycles. This time period coincides with the low flow or base flow condition.
- All assessment modeling approaches are standard approaches that specifically incorporate the yearly hydrologic cycle specific to the Flint Creek watershed. The resulting loads are expressed as average yearly loading rates to fully assess loading throughout the year.
- Allocations are based on average yearly loading and the preferred TMDL expression is as an average yearly load reduction, consistent with the assessment methods.

5.7.2 Margin of Safety

Natural systems are inherently complex. Any approach used to quantify or define the relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty or error. To compensate for this uncertainty and ensure water quality standards are attained, a margin of safety is required as a component of each TMDL. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999). This plan incorporates an implicit MOS in a variety of ways:

- By using multiple targets to help verify beneficial-use support determinations and assess standards attainment after TMDL implementation. Conservative assumptions were used during target development (see **Section 5.4.1**).

- By using supplemental indicators, including biological indicators, to help verify beneficial-use support determinations and assess standards attainment after TMDL implementation. Conservative assumptions were used during supplemental indicator development (see **Section 5.4.1**).
- By using standards, targets, and TMDLs that address both coarse and fine sediment delivery.
- By using supplemental indicators that act as an early warning method to identify pollutant-loading threats, which may not otherwise be identified, if targets are not met. Conservative assumptions were used for the source assessment process, including erosion rates, sediment delivery ratio, and BMP effectiveness (see **Appendix E, and Attachments A and B**).
- By considering seasonality (discussed above).
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, targets, modeling assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development (discussed below and in **Sections 8 and 9**).
- By using naturally occurring sediment loads as described in ARM 17.30.602(17) (see **Appendix C**) to establish the TMDLs and allocations. This includes an allocation process that addresses all known human sediment causing activities, not just the significant sources.

5.7.3 Uncertainty and Adaptive Management

A degree of uncertainty is inherent in any study of watershed processes. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainty through adaptive management is a key component of TMDL implementation. The process of adaptive management is predicated on the premise that TMDLs, allocations and their supporting analyses are not static, but are processes that can be subject to periodic modification or adjustment as new information and relationships are better understood. Within the Flint Creek TPA, adaptive management for sediment TMDLs relies on continued monitoring of water quality and stream habitat conditions, continued assessment of impacts from human activities and natural conditions, and continued assessment of how beneficial uses, (particularly aquatic life), respond to changes in water quality and stream habitat conditions.

As noted in **Section 5.7.2**, adaptive management represents an important component of the implicit margin of safety. This document provides a framework to satisfy the MOS by including sections focused on TMDL implementation, monitoring and adaptive management (**Sections 8.0** and **9.0**). Furthermore, state law (ARM 75-5-703), requires monitoring to gauge progress toward meeting water quality standards and satisfying TMDL requirements. These TMDL implementation monitoring reviews represent an important component of adaptive management in Montana.

Perhaps the most significant uncertainties within this document involve the accuracy and representativeness of 1) field data and target development and 2) the accuracy and representativeness of the source assessments and associated load reductions. These uncertainties and approaches used to reduce uncertainty are discussed in following subsections.

5.7.3.1 Sediment and Habitat Data Collection and Target Development

Some of the uncertainties regarding accuracy and representativeness of the data and information used to characterize existing water quality conditions and develop water quality targets are discussed below.

Data Collection

The stream sampling approach used to characterize water quality is described within **Attachment A**. To control sampling variability and improve accuracy, the sampling was done by trained environmental professionals using a standard DEQ procedure developed for the purpose of sediment TMDL development (Montana Department of Environmental Quality, 2011). This procedure defines specific methods for each parameter, including sampling location and frequency to ensure proper representation and applicability of results. Prior to any sampling, a sampling and analysis plan (SAP) was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP, and was based on a stratification process described in **Attachment A**. The stratification work ensured that each stream included one or more sample sites representing a location where excess sediment loading or altered stream habitat could affect fish or aquatic life.

Even with the applied quality controls, a level of uncertainty regarding overall accuracy of collected data will exist. There is uncertainty regarding whether or not the appropriate sites were assessed and whether or not an adequate number of sites were evaluated for each stream. Also, there is the uncertainty of the representativeness of collecting data from one sampling season. These uncertainties are difficult to quantify and even more difficult to eliminate given resource limitations and occasional stream access problems.

Target Development

DEQ evaluated several data sets to ensure that the most representative information and most representative statistic was used to develop each target parameter consistent with the reference approach framework outlined in **Appendix D**. Using reference data is the preferred approach for target setting, however, some uncertainty is introduced because of differing protocols between the available reference data and DEQ data for the Flint Creek TPA. These differences were acknowledged within the target development discussion and taken into consideration during target setting. For each target parameter, DEQ stratified the Flint Creek watershed sample results and target data into similar categories, such as stream width or Rosgen stream type, to ensure that the target exceedance evaluations were based on appropriate comparison characteristics.

The established targets are meant to apply under median conditions of natural background and natural disturbance. It is recognized that under some natural conditions such as a large fire or flood event, it may be impossible to satisfy one or more of the targets until the stream and/or watershed recovers from the natural event. The goal, under these conditions, is to ensure that management activities are undertaken in a way that the achievement of targets is not significantly delayed in comparison to the natural recovery time. Also, human activity should not significantly increase the extent of water quality impacts from natural events. For example, extreme flood events can cause a naturally high level of sediment loading that could be significantly increased from a large number of road crossing or culvert failures.

Because sediment target values are based on statistical data percentiles, DEQ recognizes that it may be impossible to meet all targets for some streams even under normal levels of disturbance. On the other hand, some target values may underestimate the potential of a given stream and it may be appropriate to apply more protective targets upon further evaluation during adaptive management. It is important to recognize that the adaptive management approach provides the flexibility to refine targets as necessary to ensure protection of the resource and to adapt to new information concerning target achievability.

5.7.3.2 Source Assessments and Load Reduction Analyses

Each assessment method introduces uncertainties regarding the accuracy and representativeness of the sediment load estimates and percent load reduction analyses. For each source assessment, assumptions must be made to evaluate sediment loading and potential reductions at the watershed scale, and because of these uncertainties, conclusions may not be representative of existing conditions and achievable reductions at all locations within the watershed. Uncertainties are discussed independently for the three major source categories of bank erosion, upland erosion, and unpaved road crossings.

Bank Erosion

Bank erosion loads were initially quantified using the DEQ protocols (Montana Department of Environmental Quality, 2011) and the standard BEHI methodology as defined within **Attachment A**. Prior to any sampling, a SAP was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP, and was based on a stratification process described in **Attachment A**. The results were then extrapolated across the Flint Creek watershed as defined in **Attachment A** to provide an estimate of the relative bank erosion loading from various streams and associated stream reaches. Based on this process, the relative contribution from human versus natural sources as well as the potential for reduction with the implementation of riparian BMPs was estimated and used for TMDL allocations. Stratifying and assessing each unique reach type was not practical, therefore adding to uncertainty associated with the load extrapolation results.

There is additional uncertainty regarding the amount of bank erosion linked to human activities and the specific human sources, as well as the ability to reduce the human related bank erosion levels. This uncertainty is largely associated with historic disturbances, which are extremely difficult to identify the level to which they are still affecting streambank erosion, how much is associated with human sources, and what the dominant human sources are. Even if difficult to quantify, the linkages between human activity such as riparian clearing and bank erosion, are well established and these linkages clearly exist at different locations throughout the Flint Creek watershed. Evaluating bank erosion levels, particularly where best management practices have been applied along streams, is an important part of adaptive management that can help define the level of human-caused bank erosion as well as the relative impact that bank erosion has on water quality throughout the Flint Creek watershed.

Upland Erosion

A professional modeler determined upland erosion loads by applying a landscape soil loss equation (USLE) as defined in **Attachment B**. As with any model, there will be uncertainty in the model input parameters including uncertainties regarding land use, land cover and assumptions regarding existing levels of BMP application. For example, only one vegetative condition was assigned per land cover type (i.e., cannot reflect land management practices that change vegetative cover from one season to another), so an average condition is used for each scenario in the model.

The upland erosion model integrates sediment delivery based on riparian health, with riparian health evaluations linked to the stream stratification work discussed above. The potential to reduce sediment loading was based on modest land cover improvements to reduce the generation of eroded sediment particles in combination with riparian improvements. The uncertainty regarding existing erosion prevention land management practices and their ability to reduce erosion represents a level of uncertainty. Also, because the model is not spatial, the riparian health improvement was simulated through broad assumptions in riparian condition and filtering capacity, which are applied to the loads at the watershed scale. Although some uncertainty is introduced by simulating riparian improvements in this manner, the exercise was performed using the results of the model so that the pollutant removal capacity of the riparian areas could be simulated, and because the buffering capacity of riparian areas is used as a BMP for sediment TMDLs. Even with these uncertainties, the ability to reduce upland sediment erosion and delivery to nearby waterbodies is well documented in literature, the riparian buffer widths used are based on literature values, and the estimated reductions are consistent with literature values for riparian buffers.

Roads

The road sediment load was linked to unpaved road crossings and parallel segments. As described in **Appendix E**, the road sediment load was estimated via a standardized simple yearly model (WEPP:Roads). This model relies on a few basic input parameters that are easily measured in the field, as well as inclusion of precipitation data from local weather stations. A total of 38 crossings and 8 parallel segments were randomly selected for evaluation, representing about 5% of the total population of road crossings, and a much smaller percentage (1.5%) of parallel segments. The results from the 46 sites were extrapolated to the whole population of roads, stratified by climate station, road type, ownership, and ecoregion. The reduction potential for all road crossings was also based on data collected from the 46 sites taking into consideration existing BMP conditions. Random selection of the stratified sites was intended to capture a representative subset of the roads for existing conditions and level of BMP implementation, but some uncertainty is introduced because of the small sample size relative to the total number of road crossings. While an additional area of uncertainty, although the representation of parallel segments is small, modeling related to other TMDL projects has shown loading from parallel roads to be much smaller compared to crossings, and that based on field observations and model results in the Flint this appears to hold true.

SECTION 6.0 METALS TMDL COMPONENTS

This portion of the document focuses on metals as a cause of water quality impairments in the Flint Creek TMDL Planning Area. It addresses:

- Metals beneficial use impacts
- Stream segments of concern
- Water quality data and information sources
- Water quality targets and comparison to existing conditions for each impaired stream
- Metals sources
- Metals water quality data
- Evaluation of target attainment for individual metals parameters
- Metals total maximum daily loads and allocations
- Seasonality and margin of safety

6.1 MECHANISM OF EFFECTS OF EXCESS METALS TO 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, drinking water, and agriculture. Within aquatic ecosystems, elevated concentrations of heavy metals can have a toxic, carcinogenic, or bioconcentrating 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. The metals TMDLs provided are based upon protecting the most sensitive use a particular metal and thus protect all other uses. Depending upon the metal of concern, human health standards and aquatic life standards are the most sensitive use for the metals of concern in this document.

6.2 STREAM SEGMENTS OF CONCERN

A total of nine waterbody segments in the Flint TMDL Planning Area were listed as impaired due to metals-related causes on the 2012 Montana 303(d) List (**Table 6-1**). Additionally, Smart Creek and Royal Gold Creek were identified as needing metals TMDL for certain metals during source assessment for the Flint Creek. Eleven streams segments are provided TMDLs in this document. Because Douglas Creek near Hall is between metals listed waterbodies it was also considered for TMDL development but data was not conclusive and follow up monitoring may be needed for this stream. All 2012 303(d) listings are included in **Table 1-1** and the beneficial-use support status of listed segments are presented in **Table 3-1**. Metals-related listings include antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, and zinc. Sulfate is also listed as a cause of impairment in North Fork Douglas Creek. The sulfates are related to mining sources in North Fork Douglas Creek, and therefore this listing is addressed in conjunction with metals impairments.

Table 6-1. Metal and Sulfate Impairment Causes for the Flint TPA Addressed within this Document

Waterbody & Location Description	Waterbody ID	Impairment Cause	TMDL Document Resolution	Included in 2012 Integrated Report*
Upper Flint Creek Georgetown Lake to Boulder Creek confluence	MT76E003_011	Antimony	No TMDL Needed	Yes
		Arsenic	TMDL Completed	Yes
		Copper	TMDL Completed	Yes
		Cadmium	No TMDL Needed	Yes
		Lead	TMDL Completed	Yes
		Iron	Future Monitoring	No
		Mercury	TMDL Completed	Yes
Lower Flint Creek, Boulder Creek to mouth (Clark Fork R.)	MT76E003_012	Arsenic	TMDL Completed	Yes
		Cadmium	No TMDL Needed	Yes
		Copper	TMDL Completed	Yes
		Iron	TMDL Completed	Yes
		Lead	TMDL Completed	Yes
Barnes Creek, headwaters to mouth (Flint Cr.)	MT76E003_070	Iron	TMDL Completed	Yes
Boulder Creek, headwaters to mouth (Flint Cr.)	MT76E003_060	Arsenic	TMDL Completed	Yes
		Lead	TMDL Completed	Yes
		Mercury	TMDL Completed	Yes
		Zinc	TMDL Completed	Yes
		Copper	Future Monitoring	No
		Cadmium	Future Monitoring	No
Camp Creek, headwaters to mouth (Flint Cr.)	MT76E003_130	Arsenic	TMDL Completed	Yes
		Copper	TMDL Completed	Yes
		Cadmium	TMDL Completed	No
		Lead	TMDL Completed	Yes
		Zinc	TMDL Completed	Yes
Douglas Creek (Near Philipsburg), headwaters to mouth (Flint Cr.)	MT76E003_100	Arsenic	TMDL Completed	Yes
		Cadmium	TMDL Completed	Yes
		Copper	TMDL Completed	Yes
		Iron	TMDL Completed	Yes
		Lead	TMDL Completed	Yes
		Mercury	TMDL Completed	Yes
		Zinc	TMDL Completed	Yes
Douglas Creek (near Hall) Confluence of Middle and South Forks to mouth (Flint Creek) T9N, R13W	MT76E003_020	Cadmium	Future Monitoring	No
		Iron	Future Monitoring	No
North Fork Douglas Creek, Headwaters to mouth(Douglas Creek)	MT76E003_030	Arsenic	No TMDL Needed	Yes
		Cadmium	TMDL Completed	Yes
		Copper	TMDL Completed	Yes
		Zinc	TMDL Completed	Yes
		Lead	TMDL Completed	No
		Sulfates	No TMDL Needed	Yes

Table 6-1. Metal and Sulfate Impairment Causes for the Flint TPA Addressed within this Document

Waterbody & Location Description	Waterbody ID	Impairment Cause	TMDL Document Resolution	Included in 2012 Integrated Report*
Fred Burr Creek, Fred Burr Lake to mouth (Flint Cr.)	MT76E003_040	Arsenic	TMDL Completed	Yes
		Lead	TMDL Completed	Yes
		Mercury	TMDL Completed	Yes
		Copper	Future Monitoring	No
		Zinc	Future Monitoring	No
Royal Gold Creek (Headwaters to Mouth – Boulder River)	MT76E003_140	Cadmium	Future Monitoring	No
		Copper	TMDL Completed	No
		Lead	TMDL Completed	No
		Zinc	Future Monitoring	No
Smart Creek, headwaters to mouth (Flint Creek)	MT76E003_110	Arsenic	TMDL Completed	No
		Iron	TMDL Completed	No
South Fork Lower Willow Creek, headwaters to mouth (Lower Willow Creek)	MT76E003_050	Copper	TMDL Completed	Yes
		Lead	TMDL Completed	Yes
		Mercury	TMDL Completed	Yes
		Arsenic	TMDL Completed	No
		Antimony	TMDL Completed	No
		Cadmium	TMDL Completed	No

*Impairment causes not in the “2012 Water Quality Integrated Report” were recently identified and will be included in a future Integrated Report.

6.3 WATER QUALITY DATA AND INFORMATION SOURCES

Anthropogenic metals sources and associated water quality impacts in the Flint TMDL Planning Area are primarily the result of legacy mining impacts from abandoned and inactive hardrock and placer mines in the region. Predominant metals sources are those associated with historic mining activities and include metals derived from adits and seeps, metals-laden floodplain deposits, waste rock and tailings, and other ubiquitous sources associated with abandoned and inactive mining operations. Two sites are currently regulated by MPDES permits. The majority of existing data used in this report was obtained from the Montana DEQ Abandoned Mines Program, Montana Bureau of Mines and Geology, Montana DEQ permit compliance database, University of Montana, and Montana DEQ TMDL water quality sampling from 2007-2009.

Data used to assist in source characterization, target evaluation, loading analysis, and development of load allocations is derived from the aforementioned water quality investigations. Due to the availability and quality of recent data, unless specified otherwise, data from 2001 to present was considered in water quality analysis. In some cases where recent significant cleanup action has occurred, data previous to the cleanup action was not considered in analyses, and is discussed in the appropriate waterbody evaluation section. Data summaries for relevant water quality and sediment quality parameters are provided in **Section 6.4** for each metals impaired waterbody segment.

6.4 WATER QUALITY TARGETS AND COMPARISON TO EXISTING DATA

Water quality data described in **Section 6.3** was compiled and evaluated for attainment of water quality targets. **Section 6.4** presents the evaluation framework, metals water quality targets used in the evaluation, and metals targets attainment evaluations for each impaired waterbody given in **Table 6-1**.

6.4.1 Metals Evaluation Framework

Evaluating attainment of water quality standards for metals-related impairments, and subsequent determination of whether a TMDL is necessary for each waterbody segment involves three steps:

1. Evaluation of metals sources.

   Sources of metals in a watershed are both natural and anthropogenic. TMDLs are developed for waterbodies that are not meeting water standards, at least in part, due to human caused sources. Consequently, metals-impaired streams must demonstrate existence of significant anthropogenic metals sources to be appropriate candidates for TMDL development.

2. Development of numeric water quality targets that represent water quality conditions that are unimpaired for the pollutant of concern.

   A required component of TMDL plans is the establishment of numeric water quality criteria or *targets* that represent a condition that meets Montana's ambient water quality standards. Numeric targets are measurable water quality indicators that, either by themselves or in combination with others, reflect attainment of water quality criteria (narrative and numeric) or represent a water quality condition that is unimpaired for the pollutant of concern. Metals water quality targets are presented in **Section 6.4.2**.

3. Comparison of existing data with water quality targets to evaluate water quality target attainment and, consequently, determine whether a TMDL is necessary.

   Attainment of water quality targets is evaluated by comparing existing water quality data and information to established metals water quality targets. Where exceedances of water quality targets are documented, a TMDL is developed. If recent data indicates no impairment, the data is incorporated into 303(d) list files and the cause is removed from the list. If there are no recent target exceedances, but there is insufficient data to fully evaluate all seasonal flow conditions, then TMDL development may not be pursued within this document and further monitoring is recommended. TMDL determination is based on the assumption that natural levels of metals are below the chronic water quality criteria for aquatic life, and that single water quality samples represent a 96-hour average water quality condition.

6.4.2 Metals Water Quality Targets

Water quality targets for metals-related impairments in the Flint TMDL Planning Area consist of metals water quality targets, sediment quality targets and salinity targets. Metals water quality targets are based on numeric acute and chronic metals water quality criteria for the protection of aquatic life as defined in DEQ Circular, DEQ-7, while sediment quality targets are based on narrative criteria for toxins in sediment (**Appendix C**). Sulfate targets are based on general prohibitions and classification standards for B-1 waters given in **Appendix C.**

6.4.2.1 Metals Water Quality Criteria

For metals with numeric criteria, the most protective established state numeric water quality criteria as defined in Montana DEQ Circular DEQ-7 (Montana Department of Environmental Quality, 2008) is adopted as the water quality target. Numeric criteria apply to both human health and aquatic life protection. The numeric aquatic life criteria for most metals are dependent upon water hardness values: usually, as the hardness increases, the water quality criteria for a specific metal increase. Water quality criteria (acute and chronic aquatic life[1], human health HHC[2]) for each parameter of concern at a water hardness of 25 mg/L and 100mg/L are shown in **Table 6-2**. Acute and chronic toxicity aquatic life criteria are designed to protect aquatic life uses, while the human health standard is designed to protect drinking water uses.

If more than 10% of the samples exceed aquatic life standards, then a TMDL will be completed. If the exceedance rate is equal to or less than 10%, then a TMDL will not be written. In this case the TMDL document may recommend further monitoring if metals were found at low frequency. There are two exceptions to the 10% exceedance rate decisions: a) if **twice** the **acute** standard is exceeded in a sample, then the attainment decision is to list or to remain listed regardless of the percent exceedance by the data set or the data set size. b) If the 10% exceedance rate threshold is surpassed but no human caused metals sources are found in the drainage, then scientists and management will convene for a case by case review. When assessing recent data, no standard exceedances are allowed when assessing for human health. If any recently collected samples exceed human health criteria, the TMDL will be completed.

Table 6-2. Metals numeric water quality targets applicable to the Flint TMDL Planning Area

Metal of Concern	Aquatic Life Criteria (ug/L) at 25 mg/L Hardness		Aquatic Life Criteria (ug/L) at 100 mg/L Hardness		Human Health Criteria
	Acute	Chronic	Acute	Chronic	
Arsenic, TR*	340	150	340	150	10
Cadmium, TR	0.52	0.10	2.13	0.27	5
Copper, TR	3.79	2.85	14.00	9.33	1,300
Iron, TR	---	1,000	---	1,000	
Mercury, TR	1.70	0.91	1.70	0.91	0.05
Lead, TR	13.98	0.54	81.65	3.18	15
Antimony, TR	---	---	---	---	5.6
Zinc, TR	37.02	37.02	119.82	119.82	2,000

*TR = total recoverable

6.4.2.2 Metals Sediment Quality Criteria

Stream sediment data may also be indicative of impairment caused by elevated metals and are used as a supplementary indicator of impairment. In addition to directly impairing aquatic life that interacts with the elevated metals in the sediment, the elevated sediment values can also be an indicator of elevated concentrations of metals during runoff conditions. This can be a particularly important supplemental indicator when high flow data is lacking. The state of Montana does not currently have numeric water quality criteria for metals in stream sediment, however general water quality prohibitions (see **Appendix C**) state that *"state surface waters must be free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life".*

The National Oceanic and Atmospheric Administration (NOAA) has developed Screening Quick Reference Tables for stream sediment quality, and provides concentration guidelines for metals in freshwater sediments. Screening criteria concentrations come from a variety of studies and investigations, and are expressed in Probable Effects Levels (PEL). PELs represent the sediment

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[1] No surface or ground water concentration shall exceed these values more than once in three years, or alternatively, a similar exceedance rate. Any single acute exceedance greater than two times the criteria justifies a TMDL.

[2] No surface or ground water shall exceed these values.

concentration above which toxic effects to aquatic life frequently occur, and are calculated as the geometric mean of the 50th percentile concentration of the toxic effects data set and the 85th percentile of the no-effect data set (Buchman, 1999).

Table 6-3 contains the PEL values (in parts per million) for parameters of concern in the Flint TMDL Planning Area.

Table 6-3. Screening level criteria for sediment metals concentrations

Metal of Concern	PEL (mg/kg)
Antimony	--
Arsenic	17.0
Cadmium	3.53
Copper	197
Iron	4% content
Lead	91.3
Mercury	0.486
Nickel	36.0
Silver	--
Zinc	315

PELs provide a screening tool that may assist in identification of toxic metals concentrations in stream sediments, and can be used to assist in impairment determinations and metals source assessment where water chemistry data is limited. PEL values are therefore adopted as supplemental targets that are used to evaluate whether streams are "*free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life*" **(Appendix C).** Where in-stream water quality data exceeds water quality targets, sediment quality data provide supporting information, but are not necessary to verify impairment. Where water quality data is limited or does not show exceedances of water quality targets, sediment quality data may demonstrate impairment due to high levels of metals toxicity in stream sediments.

6.4.2.3 Sulfate Criteria

A recent review of sulfate aquatic toxicity studies indicates sulfate toxicity is related to overall hardness (**Appendix C**). Using toxicity studies from 9 different species and a typical reference hardness range sometimes dipping into the lowest hardness category (25-50 mg/L) for sulfate toxicity effects, a target criteria of 129 ug/L sulfates is used for comparing sulfate data. Human drinking water and agricultural uses are generally higher than the targets that will be used to protect aquatic life which apply in the Flint Creek Watershed. A random 10% exceedance rate is allowed when comparing data to the chronic sulfate target.

6.4.3 Metals Target Attainment Evaluation

For each waterbody segment listed on the 2012 303(d) List for metals (**Table 6-1**), recent water quality and sediment data is evaluated relative to the water quality targets to make a TMDL development determination. Many current metals impairment listings are based on data collected by the DEQ Abandoned Mines Bureau in 1993 and 1994. For all impaired streams in the Flint TPA, substantial data has been collected since this initial effort, and the new data (mostly from 2007-2009) forms the basis for the metals target attainment evaluations below. Montana's 2014 "Integrated Water Quality Report" will reflect an update of impairment decisions using the 2007-2009 metals data.

6.4.3.1 Barnes Creek (MT76E003_070)

Barnes Creek originates at mid range elevations along the northwestern edge of the Flint Range. Forest composes about 15% of the watershed and the remainder is native rangeland and irrigated hay pastures. Barnes Creek flows into Flint Creek between Hall and Drummond. A livestock confinement area is located on Barnes Creek near where it enters the Flint Creek Valley. Only one known abandoned mine is located in the watershed, it is located high on the divide between Dunkleberg Creek and Barnes Creek Watersheds. Summit Mine produced small amounts of silver and lead (**Appendix A, Figure A-18**). Yet, it is far from a stream and there is no adit discharge. Iron is the only metal of concern found during this TMDL project and the only metal identified as a cause of impairment on the 2012 303(d) List.

Of 16 water samples collected from Barnes Creek, exceedance of iron chronic aquatic life criteria is 81% (**Table 6-4**). Four groundwater samples from the area are all well below iron levels found in the stream. Because no known iron deposits and no known significant mining sources are present, the TMDL will focus on controlling erosion. Iron is likely associated with soil erosion from the landscape. A single sample of stream sediment was collected in 2007 near the confluence with Flint Creek. The sample contained 11,200 mg/kg iron. Iron and TSS loading are correlated, indicating iron is primarily associated with sediment (**Figure 6-1**).

Table 6-4. Barnes Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Iron
# Samples	16
Min	150
Max	6420
Median	2061
# Acute Exceedances	NA
Acute Exceedance Rate	NA
# Chronic Exceedances	12
Chronic Exceedance Rate	81%
# Human Health Exceedances	NA
Human Health Exceedance Rate	NA

*all units in ug/L, Total Recoverable fraction

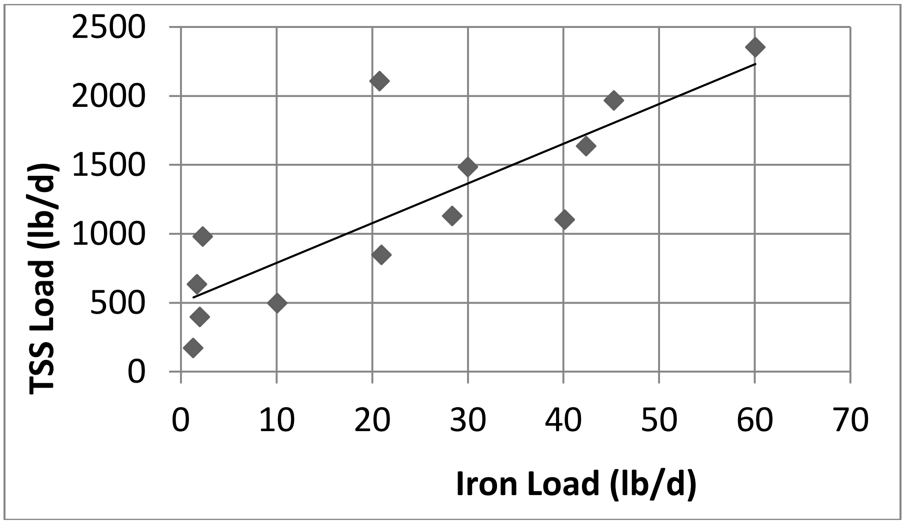

Figure 6-1. Iron and TSS loading in Barnes Creek.

Only one known mine is located in the watershed, it is located above the headwaters sample location (**Appendix A**, **Figure A-18**). In Barnes Creek, Iron and TSS levels are the highest downstream of Gaskill Creek confluence and remain elevated in the lower reaches of the stream (**Figure 6-2**). An inter-basin water transfer from Douglas Creek may also contribute to erosion, iron, and streamflow within Gaskill Creek. Limited iron data available for Douglas Creek indicate iron may be slightly elevated in water diverted from Douglas Creek watershed. Median iron concentrations in Douglas Creek were 230 ug/L while the median iron condition in Barnes Creek was 1715 ug/L. Therefore, it appears that most of the iron is being generated in Barnes Creek watershed in or near the Gaskill Creek area, although data suggests there are also sources above Gaskill Creek. The Gaskill Creek source area could be caused by erosion from irrigation water transport or from infiltration and reemergence of irrigation water in iron rich soils and geology.

An iron TMDL is provided, but controlling iron concentrations in Barnes Creek should focus on reduction of upland, road, irrigation network, and streambank erosion rates. It appears that iron is not derived from mining, but from soils and erosion in the watershed. Sediment sources are reviewed and sediment allocations are provided in the Barnes Creek sediment TMDL (**Section 5.6.1**).

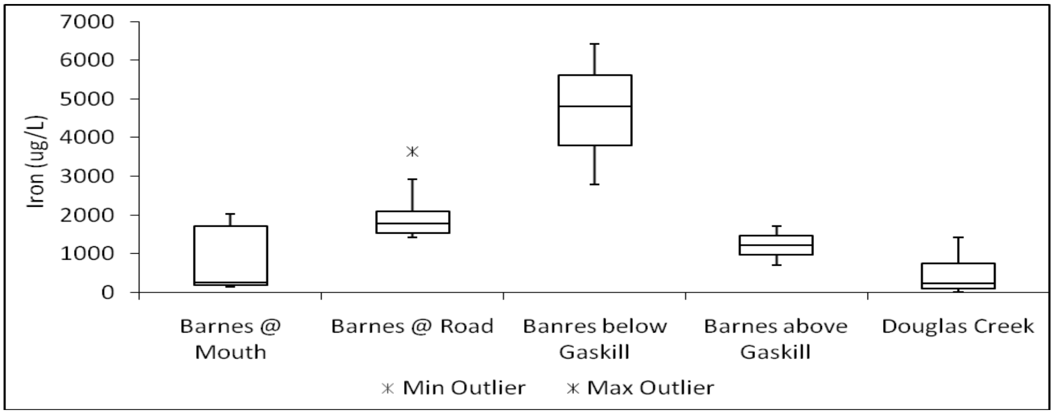

Figure 6-2. Iron concentrations at Barnes Creek sites and in Douglas Creek.

6.4.3.2 Boulder Creek (MT76E003_070)

Boulder Creek drains a large area of the Flint Range (**Appendix A, Figure A-18**). Most of the watershed is composed of mid to high elevation conifer forest. Boulder Creek enters Flint Creek at Maxville and is a significant contributor of water to Flint Creek (**Appendix A**, **Figure A-18**). Boulder Creek is on the 2012 303(d) List as being impaired for metals: arsenic, lead, zinc and mercury. Data compilation, collection and analysis indicate arsenic, lead, zinc and mercury TMDLs are necessary.

Metals Sources

Anthropogenic metals sources in the Boulder Creek watershed are comprised primarily of abandoned mining activity from the Maxville District. Many abandoned mines, waste piles, and mills have been identified in Boulder Creek's watershed. Three of these are identified in Montana's list of priority abandoned mine cleanup sites. Waste rock and tailings, by-products of mining and milling processes, are present in the valley bottoms in various locations. Also, numerous mine adits discharge to the local streams either directly or through groundwater flow.

Mining-related metals sources in these areas have been documented through a variety of investigations in support of mine site investigation and remediation activities, and sampling studies have documented heavy metal impacts from pervasive mining waste affecting soil, groundwater, surface water and stream sediments. Most of this limited mine reclamation related sampling was completed in the early 1990s. Additional stream water quality and adit sampling was completed from 2007-2009 by DEQ in support of this TMDL effort (**Table 6-5**). **Figure A-19** (**Appendix A)** shows the spatial extent of historic mining activity and mine wastes in the watershed.

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets. Due to the availability of recently-collected water quality data in the watershed, data used for this evaluation was comprised of recent 2007-2009 synoptic high and low flow sampling data collected by Montana DEQ for the TMDL project, except for mercury. Mercury samples were collected by Montana Bureau of Mines and Geology and Montana DEQ's abandoned mines program in the late 1990s. **Figure A-19** (**Appendix A)** shows the location of these sampling stations on Boulder Creek and its tributaries. Data collected along Boulder Creek was used to evaluate attainment of metals water quality targets **(Table 6-5** and **6-6**).

Table 6-5. Boulder Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Copper	Lead	Zinc	Mercury
# Samples	22	30	30	29	9
Min	<1	<0.5	<0.5	<3	<0.02
Max	2	3.2	46	56	0.10
Median	<1	<0.5	<0.5	<5	0.10
# Acute Exceedances	0	0	6	0	0
Acute Exceedance Rate	0%	0%	20%	0	0%
# Chronic Exceedances	0	1	11	1	0
Chronic Exceedance Rate	0%	3%	37%	3%	0%
# Human Health Exceedances	0	0	0	0	5
Chronic Exceedance Rate	0%	0%	0%	0%	55%

Table 6-6. Boulder Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Copper	Lead	Zinc
# Samples	4	4	4	4
Min	24	76	114	537
Max	62	2110	289	20200
Median	35	92	225	649
PEL Value	17	197	91	315
# Samples>PEL	4	1	4	4
PEL Exceedance Rate	100%	25%	100%	100%
Max PEL Exceedance Magnitude	360%	1071%	317%	6412%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Boulder Creek is listed as impaired for arsenic on the 2012 303(d) List. This listing was originally based upon older sampling results from the late 1970s and a sample from 1990. Recent data collection, from 2007-2009 indicated no samples exceeded the human health criteria. Yet, all arsenic concentrations in stream sediments were higher than sediment targets with one sample at 3.6 times the sediment target threshold. Arsenic appears to harm aquatic life via sediment toxicity. Since mining sources are prevalent and need cleanup for other metals, arsenic sediment concentrations should be reduced by mining reclamation activities. Therefore, an arsenic TMDL is provided for Boulder Creek.

Cadmium

Boulder Creek is not currently listed for cadmium. During the initial TMDL monitoring event which collected full metals analysis, cadmium was found in the sediment and therefore DEQ continued to collect water samples during 2007-2009 along the length of Boulder Creek (**Appendix B**). No water samples were above the water quality standards yet cadmium concentrations in 75% of stream sediment samples exceeded PEL values established as supplemental indicators of impairment. Because cadmium is not listed and no cadmium water column targets were exceeded, no TMDL will be provided at this time. Cadmium should continue to be monitored if metals sampling occurs in this watershed associated with mine cleanup activities.

Copper

Boulder Creek is not currently listed for copper. During the initial TMDL monitoring event which collected full metals analysis, sediment copper levels were found above the PEL, therefore copper monitoring continued during the TMDL monitoring. Of 30 water quality samples collected from 2007-2009 along the length of Boulder Creek, only 1 exceeded the chronic aquatic life criteria (a 3% exceedance rate). Copper concentrations in only one out of four stream sediment samples exceeded PEL value established as supplemental indicators of impairment. Therefore, a copper TMDL will not be provided at this time because aquatic life threshold exceedance rates were less than 10%. Copper should be included in the metals monitoring suite when future monitoring occurs.

Lead

Boulder Creek is listed as impaired for lead on the 2012 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 30 samples collected from 2007-2009 along the length of the stream, six exceeded the acute aquatic life criteria (a 20% exceedance rate) and 11 (37%) exceeded the chronic aquatic life criteria. Likewise lead concentrations in all stream sediment samples exceeded sediment PEL values. Consequently, lead target exceedances are confirmed and a lead TMDL is provided for Boulder Creek.

Zinc

Boulder Creek is listed as impaired for zinc on the 2012 303(d) List. Of 29 samples collected from 2007-2009 along the length of the stream, one exceeded the chronic aquatic life criteria (a 3% exceedance rate) and no samples exceeded the acute aquatic life criteria. All four sediment samples exceeded zinc PEL values with the highest sediment concentration at 64 times the PEL. Zinc likely exerts toxicity to aquatic life and fish via contact with the sediment or interstitial water. Additionally, sources of zinc are documented in the TMDL source assessment monitoring and include: Bluebird and Mountain Lion mine adit discharges, Nonpareil waste rock and Royal Gold Mill tailings in Royal Gold Creek. Target exceedances are confirmed and a zinc TMDL is provided for Boulder Creek.

Mercury

Boulder Creek is listed as impaired for mercury on the 2012 303(d) List. Water quality data collected during the early 1990s, indicated ten (71%) out of 14 samples exceeded the human health criteria and two samples (14%) exceeded chronic aquatic life standards. Mercury appears to impact human health and likely impacts aquatic life. A mercury TMDL will be provided.

6.4.3.2 Camp Creek (MT76E003_130)

Camp Creek is about 3miles in length and extends from its headwaters to Philipsburg. It flows under Phillipsburg and reemerges from buried pipe east of MT HWY 1 and then flows into an irrigation canal or Flint Creek depending upon the season (**Appendix A**, **Figure A-20**). Camp Creek is on the 2012 303(d) List as being impaired for metals: Arsenic, copper, lead, and zinc. TMDLs will be written for arsenic, cadmium, copper, lead and zinc.

Metals Sources

Human caused metals sources in the Camp Creek watershed are comprised primarily of abandoned or inactive mines. A number of abandoned mines and mills in the district have adit-discharges or large volumes of tailings, waste rock and mine spoils which are directly impacting Camp Creek (**Appendix A**, **Figure A-20**). Some of the larger abandoned mine adits, mills, and spoil piles include: True Fissure, Scratch All, Thomas McKay, Minerals Processing Mill and others. Forty known mine, mill, or waste sites are identified in the Montana Bureau of Mines and Geology abandoned mine inventory. Additionally, a cyanide heap leach pad is present in the headwaters area above the ghost town of Tower. This pad was run under a small miners exclusion from state regulations and began to flow over the pad liner during 2011 due to inactivity at the site. The small miners exclusion status for this cyanide heap leach pad was closed due to inactivity and non-renewal of the exclusion status.

Data from Camp Creek was used to evaluate attainment of metals water quality targets. Data included 19 water quality samples and three stream sediment samples collected from several stations along the length of Camp Creek during 2007 to 2009. A summary of relevant water quality and sediment data is provided in **Table 6-7** and **6-8**.

Table 6-7. Camp Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper**	Lead	Zinc
# Samples	19	15	19	19	19
Min	5	<0.1	<1.0	<0.5	<10
Max	16	3.51	16	40.5	2110
Median	7	0.2	2	2.5	50
# Acute Exceedances	0	0	1	1	3
Acute Exceedance Rate	0%	0%	5%	5%	16%
# Chronic Exceedances	0	3	1	3	3
Chronic Exceedance Rate	0%	20%	5%	16%	16%
# Human Health Exceedances	4	0	0	3	1
Human Exceedance Rate	21%	0%	0%	16%	5%

*all units in ug/L, Total Recoverable fraction

** See text for further discussion about copper spatial considerations.

Table 6-8. Camp Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Zinc
# Samples	3	3	3	3	3
Min	34.3	2.46	61.8	189	646
Max	246	10.4	247	800	4940
Median	189	9.88	72.8	750	4410
PEL Value	17	3.5	197	91	315
# Samples>PEL	3	2	1	3	3
PEL Exceedance Rate	100%	66%	33%	100%	100%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Camp Creek is listed as impaired for arsenic on the 2012 303(d) List based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Four of 19 recent water quality samples exceeded the human health criteria for arsenic, and 100% of stream sediment samples exceeded PEL targets for arsenic. Due to human health criteria exceedances and high levels of arsenic in stream sediments, an arsenic TMDL is developed for Camp Creek.

Cadmium

Camp Creek was not listed as impaired for cadmium on the 2012 303(d) List. Evaluation of data collected since the initial impairment listing verifies that cadmium likely exerts toxicity upon aquatic life and fish. Of 15 samples collected since 2007 along the length of Camp Creek, no concentrations exceeded the acute aquatic life criteria and three samples exceeded the chronic aquatic life criteria. Likewise cadmium concentrations in two out of three sediment samples collected greatly exceeded PEL values established as indicators of impairment. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for Camp Creek. The 303(d) listing status for cadmium will be formally evaluated by DEQ in the future.

Copper

Camp Creek is listed as impaired for copper on the 2012 303(d) List, and the copper listing is based primarily on sediment chemistry data collected by the DEQ during 2005. For purposes of this evaluation, two reaches of this segment are used. An upper and lower reach were used to segregate data due to different sources of metals. Sites 3 and 4 are located in the upper reach (**Appendix A**). When looking at data from these sites, the copper acute aquatic life exceedance rate is 10% in this upper reach. Likewise a sediment copper concentration exceeded the PEL value established as a sediment quality target. Consequently, copper target exceedances are confirmed near mine sources and a copper TMDL is developed for Camp Creek.

Lead

Camp Creek is listed as impaired for lead on the 2012 303(d) List, and is based primarily on sediment metal contamination found during a 2005 sampling event. Evaluation of data collected since the initial impairment listing verifies lead problems. Of 19 samples collected since 2007, one exceeded the acute aquatic life criteria, three (15%) exceeded the chronic aquatic life criteria and human health standards. Likewise lead concentration in all stream sediment samples greatly exceeded PEL values established as indicators of potential aquatic life impairment. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Camp Creek.

Zinc

Camp Creek is listed as impaired for zinc on the 2012 303(d) List; the listing is based primarily on sediment zinc data collected by the DEQ during 2005. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 19 samples collected since 2007, three (15%) exceeded the acute and chronic aquatic life criteria and one sample exceeds the human health standard. Likewise zinc concentration in all stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Due to exceedances of all applicable zinc targets, a zinc TMDL is developed for Camp Creek.

6.4.3.3 Douglas Creek (near Philipsburg) MT76E003_100

Douglas Creek originates in the Flint Range and flows east about six miles to its confluence with Flint Creek (**Appendix A**, **Figure A-20**). Douglas Creek is on the 2012 303(d) List as being impaired for metals: arsenic, cadmium, copper, iron, lead, mercury and zinc. TMDLs will be completed for each of these metals.

Metals Sources

Human caused metals sources in the Douglas Creek watershed are comprised primarily of abandoned mining and milling activities. Although, the Contact Mill currently has a MPDES groundwater permit, which is not to be confused with a NPDES permit. Major mining activity occurred in the District in the late 19th century through the early 20th century. Large scale mining ceased in the 1940's but mines operated sporadically and intermittently since then. The major abandoned mining influences are Granite Mountain and Bimetalic mines near the ghost town of Granite, along with Wagner, Little Gem, Trout and Algonquin mines in the Frost Creek watershed. The associated wasterock and mill tailings from these and other local mines are now deposited along the Douglas Creek valley (**Appendix A**, **Figure A-20**). EPA recently reported results from Superfund Program preliminary site investigation monitoring that further characterizes sources of metals in the watershed (United States Environmental Protection Agency and Hogan, 2010). This effort is investigating this area to determine if it should be included on a National Priority List (NPL) or 'Superfund' site.

Metals water quality and sediment data were used to evaluate attainment of water quality targets. Data used for this evaluation consisted of recent (2007 to 2009) synoptic high and low flow sampling data. Sediment metals data from 1993-2007 is used. **Figure A-20** (**Appendix A**) shows the location of these sampling stations and abandoned mine sources on Douglas Creek and its tributaries. A summary of relevant water quality and sediment data is given in **Table 6-9** and **6-10**.

Table 6-9. Douglas Creek (near Philipsburg) Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc
# Samples	13	11	13	13	13	3	13
Min	<3	<0.08	<1	40	<0.5	0.11	<10
Max	155	2.77	12	1,950	40.2	0.25	1970
Median	56	0.27	2	430	0.70	0.17	180
# Acute Exceedances	0	1	1	NA	1	0	8
Acute Exceedance Rate	0%	9%	8%	NA	0%	0%	62%
# Chronic Exceedances	8	8	3	2	5	0	8
Chronic Exceedance Rate	62%	73%	23%	15%	38%	0%	62%
# Human Health Exceedance	8	0	0	NA	3	3	1
Human Health Exceedance Rate	62%	0%	0%	NA	23%	100%	8%

*all units in ug/L, Total Recoverable fraction

Table 6-10. Douglas Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc
# Samples	7	7	5	4	5	5	7
Min	<1	<0.2	<5	12,300	<5	2.32	<5
Max	4,860	9.98	253	60,900	535	22.5	5,680
Median	1,770	3.3	95.1	15,950	403	3.84	672
PEL Value	17	3.53	197	40,000	91	0.486	315
# Samples>PEL	6	2	1	1	4	5	6

Table 6-10. Douglas Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Zinc
PEL Exceedance Rate	86%	29%	20%	25%	80%	100%	86%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Douglas Creek is listed as impaired for arsenic on the 2012 303(d) List based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Eight of 13 recent (2007-2009) water quality samples exceeded the human health criteria for arsenic, and 100% of stream sediment samples exceeded PEL targets for arsenic which were downstream of human sources. The only site with arsenic sediment and water concentrations below the target concentrations was above known mining sources. Due to human health criteria exceedances, known human caused sources, and high levels of arsenic in stream sediments, an arsenic TMDL is developed for Douglas Creek.

Cadmium

Douglas Creek is listed as impaired for cadmium on the 2012 303(d) List based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies that cadmium conditions negatively affect aquatic life. Of 13 samples collected since 2007 along the length of Douglas Creek, 1 (9%) exceeded the acute aquatic life criteria, and 8 (73%) exceeded the chronic aquatic life criteria. Also, cadmium concentration in two of seven stream sediment samples collected exceed PEL values established as sediment targets. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for Douglas Creek.

Copper

Douglas Creek is listed as impaired for copper on the 2012 303(d) List, which is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies a copper problem. Of 13 samples collected since 2007 along the length of Douglas Creek, 1 (8%) exceeded the acute aquatic life criteria and 3 (23%) exceeded the chronic aquatic life criteria. Likewise copper concentrations in 1 of 5 stream sediment samples exceeded PEL values established as a sediment target. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for Douglas Creek.

Iron

Douglas Creek is listed as impaired for iron on the 2012 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this decision. Of 13 samples collected since 2007 along the length of Douglas Creek, two (15%) exceeded the acute aquatic life criteria and one was almost double the criteria. Iron concentrations in one of five stream sediment samples exceeded toxicity guidance values which were based upon 4% iron content. Consequently, iron target exceedances are confirmed and an iron TMDL is developed for Douglas Creek.

Lead

Douglas Creek is listed as impaired for lead on the 2012 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this decision. Of 13 samples collected since 2007 along the length of

Douglas Creek, one sample exceeded the acute aquatic life criteria but was less than double this value and 5 (38%) exceeded the chronic aquatic life criteria. Likewise lead concentration in all four stream sediment samples downstream of sources greatly exceeded PEL values established as sediment targets. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Douglas Creek.

Mercury

Douglas Creek is listed as impaired for mercury on the 2012 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of this data indicates a mercury problem. Of 3 samples, there were no acute or chronic aquatic life criteria exceedances but human health criteria were exceeded in all samples. Likewise, mercury concentrations in all 5 stream sediment samples collected greatly exceeded PEL values established as sediment targets. Due to exceedances of human health standards and high levels of mercury in stream sediments, a mercury TMDL is developed for Douglas Creek.

Zinc

Douglas Creek is listed as impaired for zinc on the 2012 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies zinc contamination. Of 12 samples, 8 (62%) exceeded the acute aquatic life criteria. Likewise, zinc concentrations in all 6 stream sediment samples collected from downstream of source areas greatly exceeded PEL values established as sediment targets. Due to exceedances of acute aquatic life criteria, a zinc TMDL is developed for Douglas Creek.

6.4.3.4 Douglas Creek (near Hall) MT76E003_020

Douglas Creek is originates in the Flint Range and flows east to its confluence with Flint Creek (**Appendix A**, **Figure A-18 and A-19**). Douglas Creek currently is not listed for any metals related impairment causes on the 2012 303(d) List. Monitoring occurred because North Fork Douglas Creek, a tributary to Douglas Creek, and Flint Creek (a downstream waterbody) were both listed for metals impairment. Limited data was collected and indicates potential cadmium and iron problems. Available data is not definitive about metals impairment because exceedance rates are low and sample sizes are low. Future monitoring should occur on this stream, especially downstream of the North Fork confluence. Alternatively, it appears most metals loading comes from the North Fork of Douglas Creek and metals TMDLs will be completed for this tributary. If abandoned mine sources in the North Fork of Douglas Creek are cleaned up, metal loading to Douglas Creek will be lowered. No TMDLs will be completed for Douglas Creek near Hall at this time. Future metals monitoring of this waterbody should be pursued if water quality monitoring occurs in the vicinity.

6.4.3.5 North Fork Douglas Creek (near Hall) MT76E003_030

North Fork Douglas Creek originates in the Flint Range and flows southeast about three miles to its confluence with Douglas Creek (**Appendix A**, **Figure A-18**). North Fork Douglas Creek is on the 2012 303(d) List as being impaired for metals: arsenic, cadmium, copper, zinc and sulfates. TMDLs will be completed for each of these metals except for arsenic. Additionally, a lead TMDL will be completed. Sulfate conditions do not likely inhibit aquatic life and a sulfate TMDL will not be pursued.

Metals Sources

Human caused metals sources in the NF Douglas Creek watershed are comprised of abandoned or inactive mines. A number of abandoned mines and mills in the district have adit-discharges or large volumes of tailings, waste rock and mine spoils which are directly impacting NF Douglas Creek

(**Appendix A**, **Figure A-18**). Some of the larger abandoned mine adits, mills, and spoil piles include: Homestake, Kirkindal/Koski, Shamrock and Wasa mines. Most of these are located in the headwaters area; the stream originates from a highly contaminated adit.

Data from NF Douglas Creek was used to evaluate attainment of metals water quality targets. Data included 15 water quality samples and two stream sediment samples collected from several stations along the length of NF Douglas Creek from 2007 to 2009. Sulfate samples consist of 13 collections over five monitoring events. A summary of relevant water quality and sediment data is given in **Table 6-11** and **6-12**.

Table 6-11. North Fork Douglas Creek (by Hall) Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Zinc	Sulfate
# Samples	15	12	15	15	15	13
Min	<3	1.42	2.00	<0.5	132	19
Max	10.00	107	646.00	8.30	9880	180
Median	<3.00	7.81	18.00	<0.5	1070	30
# Acute Exceedances	0	8	6	0	13	NA
Acute Exceedance Rate	0%	67%	40%	0%	87%	NA
# Chronic Exceedances	0	12	8	2	13	1
Chronic Exceedance Rate	0%	100%	53%	13%	87%	7%
# Human Health Exceedance	0	0	0	0	0	NA
Human Health Exceedance Rate	0%	0%	0%	0%	0%	NA

Table 6-12. North Fork Douglas Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Zinc	Mercury	Zinc
# Samples	2	4	4	4	4	5	7
Min	15.5	3.43	124	32.1	308	2.32	<5
Max	29.2	54.4	973	221	8720	22.5	5,680
Median	22.35	13.7	498.5	83	2188	3.84	672
PEL Value	17	3.5	197	91	315	0.486	315
# Samples>PEL	1	4	2	2	3	5	6
PEL Exceedance Rate	50%	100%	50%	50%	75%	100%	86%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Sulfate

North Fork Douglas Creek is listed as impaired for sulfate on the 2012 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of available data and review of new sulfate toxicity studies conducted since the initial impairment listing disputes this decision. Of 13 samples collected since 2007 along the length of Douglas Creek, one (7%) exceeded the chronic aquatic life criteria. Consequently, sulfate target exceedances are below the allowed exceedance rate threshold of 10% for chronic toxicity and a sulfate TMDL is not needed for NF Douglas Creek. The 303(d) listing status of this stream will be updated to reflect the new sulfate data.

Arsenic

North Fork Douglas Creek is listed as impaired for arsenic on the 2012 303(d) List based primarily on 1970s data. No recent (1990-2009) water quality samples exceeded the human health criteria for arsenic but one sample was at the standard. Arsenic sediment concentrations were slightly elevated at a site just downstream of Wasa Mine. An arsenic TMDL will not be developed for NF Douglas Creek, although future metals monitoring in the stream should include arsenic analysis to track conditions. The listing status of this stream will be updated to reflect the new arsenic data.

Cadmium

North Fork Douglas Creek is listed as impaired for cadmium on the 2012 303(d) List based primarily on data collected in the late 1970s. Evaluation of data collected since the initial impairment listing verifies that cadmium conditions negatively affect aquatic life. Of 15 water samples collected since 2007 along the length of NF Douglas Creek, 8 (67%) exceeded the acute aquatic life criteria, and all exceeded the chronic aquatic life criteria. Also, cadmium concentration in all stream sediment samples collected exceed PEL values established as sediment targets. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for NF Douglas Creek.

Copper

North Fork Douglas Creek is listed as impaired for copper on the 2012 303(d) List, which is based primarily on data collected in the late 1970s. Evaluation of data collected since the initial impairment listing verifies a copper problem. Of 15 water samples collected since 2007 along the length of NF Douglas Creek, 6 (40%) exceeded the acute aquatic life criteria and 8 (53%) exceeded the chronic aquatic life criteria. Also, copper concentrations in 2 of 4 stream sediment samples exceeded PEL values established as a sediment target. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for NF Douglas Creek.

Lead

North Fork Douglas Creek is not currently listed as impaired for lead on the 2012 303(d) List. Evaluation of new data collected during the TMDL project verifies lead conditions are likely to affect aquatic life. Of 15 water samples collected since 2007 along the length of NF Douglas Creek, two (13%) exceeded the chronic aquatic life criteria. Likewise, lead concentration in two of four stream sediment samples exceeded PEL values established as sediment targets. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for NF Douglas Creek. The 303(d) listing status for lead will be formally evaluated by DEQ in the future.

Zinc

North Fork Douglas Creek is listed as impaired for zinc on the 2012 303(d) List, and is based primarily on data collected in the late 1970s. Evaluation of data collected since the initial impairment listing verifies zinc conditions are likely to affect aquatic life. Of 15 samples, 13 (87%) exceeded the acute aquatic life criteria. Likewise, zinc concentration in 3 of 4 stream sediment samples collected from downstream of source areas exceeded PEL values established as sediment targets. Due to target exceedances, a zinc TMDL is developed for NF Douglas Creek.

6.4.3.6 Fred Burr Creek MT76E003_040

Fred Burr Creek originates in the Flint Range and flows east about 10 miles to its confluence with Flint Creek (**Appendix A**, **Figure A-20**). The town of Phillipsburg draws drinking water from Fred Burr Reservoir near the headwaters. Fred Burr Creek is on the 2012 303(d) List as being impaired for metals: arsenic, lead and mercury. TMDLs will be completed for each of these metals.

The only known human caused metals source in the Fred Burr Creek watershed is an abandoned mill site, Rumsey Mill (**Appendix A, Figure A-20**). The mill used a pan amalgamation method of ore extraction which employed large quantities of mercury to isolate silver. A landowner of the site developed the stream bottom area for fish and wildlife ponds and potential subdivision in the later half of the 1990s without permits or proper government review. The land developer did not comply with state and federal investigation and was eventually sent to jail. The EPA CERCLA program published an ecological risk assessment of the Rumsey site in 1999 after the developer moved mine tailings, mechanically altered Fred Burr Creek, created ponds within tailings areas, and disturbed contaminated soils.

Data from Fred Burr Creek was used to evaluate attainment of metals water quality targets. Data includes 11 water quality samples and two stream sediment samples collected from several stations along the length of Fred Burr Creek from 2007 to 2009. EPA CERCLA data and Montana DEQ enforcement action data from the late 1990s is also used for the mercury and sediment metals summaries. A summary of relevant water quality and sediment data is provided in **Table 6-13** and **6-14**.

Table 6-13. Fred Burr Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Lead	Mercury
# Samples	11	11	10
Min	<1.00	<0.50	<0.02
Max	85.00	8.20	10.60
Median	14.00	-0.50	0.46
# Acute Exceedances	0	0	0
Acute Exceedance Rate	0%	0%	0%
# Chronic Exceedances	0	5	5
Chronic Exceedance Rate	0%	45%	50%
# Human Health Exceedance	6	0	6
Human Health Exceedance Rate	55%	0%	60%

Table 6-14. Fred Burr Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Lead	Mercury
# Samples	7	7	6
Min	8.4	4.6	<0.060
Max	3270	674	6.5
Median	69.4	45.6	3.550
PEL Value	17	91.3	0.486
# Samples>PEL	6	2	4
PEL Exceedance Rate	86%	29%	67%

*All units in mg/kg dry weight

Table 6-15. Fred Burr Creek Mercury Fish Tissue Concentrations (1974)

	Mercury (ug/g)
# Samples	33
Min	<0.010
Max	0.670
Median	0.270

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Fred Burr Creek is listed as impaired for arsenic on the 2012 303(d) List based primarily on 1990s data. Evaluation of data collected since the initial impairment listing verifies this decision. Of 11 water samples collected since 2007 along the length of Fred Burr Creek, six (55%) samples exceeded the human health standard. Likewise, arsenic concentrations in six stream sediment samples exceed PEL values established as sediment targets. Consequently, arsenic target exceedances are confirmed and a arsenic TMDL is developed for Fred Burr Creek.

Lead

Fred Burr Creek is listed as impaired for lead on the 2012 303(d) List, and is based primarily on data collected in the late 1990s. Evaluation of data collected since the initial impairment listing verifies this decision. Of 11 water samples collected since 2007 along the length of Fred Burr Creek, five (45%) samples exceeded the chronic aquatic life criteria. Likewise, lead concentration in two stream sediment samples greatly exceeded PEL values established as sediment targets. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Fred Burr Creek.

Mercury

Fred Burr Creek is listed as impaired for mercury on the 2012 303(d) List, and is based primarily on data collected in the late 1970s and late 1990s. Evaluation of this data verifies mercury contamination. Of 10 stream water samples, five (50%) exceeded the chronic aquatic life criteria and six (60%) exceeded the human health standard. Likewise, mercury concentration in 4 of 6 stream sediment samples collected exceed PEL values established as sediment targets. Results from a 1974 University of Montana fish tissue analysis are quite dated but add evidence there is a mercury problem (**Table 6-15**). Due to exceedances of chronic aquatic life criteria and human health standards, a mercury TMDL is developed for Fred Burr Creek.

Zinc and Copper

Fred Burr Creek is not currently listed for zinc or copper. Fred Burr Creek zinc and copper conditions were monitored during this project to inform source assessment efforts for Flint Creek. Results indicate that Rumsey Mill area is a source of these metals. Only one copper water quality monitoring result (<10%) was above the chronic aquatic life standard threshold while no zinc water quality results were above the any standard threshold. Both zinc and copper were found in sediment samples at slightly above the PEL. The results do not clearly indicate if these metals are affecting aquatic life. Zinc and copper should be considered during future metals monitoring efforts of the area to assure they stay at or below current levels.

6.4.3.7 Princeton Gulch MT76E003_090

Princeton Gulch originates in the Flint Range and flows southwest about four miles to its confluence with Boulder Creek (**Appendix A, Figure A-19**). Princeton Gulch is not currently listed for any metals on the 2012 303(d) List. It was included in source assessment monitoring for the Boulder Creek metals TMDLs because of mining sources. Cadmium monitoring should continue in this watershed when metal monitoring occurs in this area as there was one out of seven samples that exceeded the chronic aquatic life standard threshold. More data is needed to determine impairment.

Human caused metals sources in the Princeton Gulch watershed are comprised of abandoned or inactive mines. Although there are no priority abandoned mines, mills or spoil piles in Princeton Gulch, there are a number of abandoned mines in the watershed. (**Appendix A, Figure A-19**). These include: Moonlight, Mountain lion, East Mountain lion, upper mountain lion, Princeton, Sunset, Thursday-Friday, and Mayward mines.

6.4.3.8 Royal Gold Creek MT76E003_140

Royal Gold Creek originates in the Flint Range and flows southeast about three miles to its confluence with Boulder Creek (**Appendix A**, **Figure A-19**). Royal Gold Creek is not currently on the 2012 303(d) List as being impaired for metals. It was included in source assessment monitoring for the Boulder Creek metals TMDLs because of mining sources. Cadmium and zinc data indicate there may be a problem, yet too little evidence exists to make an assessment if these metals exert toxicity to fish and aquatic life. Yet, enough evidence exists to support the need for copper and lead TMDLs for Royal Gold Creek.

Metals Sources

Human caused metals sources in the Royal Gold Creek watershed are comprised of abandoned or inactive mines. A number of abandoned mines and mills in the district have adit-discharges or large volumes of tailings, waste rock and mine spoils which affect water quality in Royal Gold Creek (**Appendix A, Figure A-19**). Some of the larger abandoned mine adits, mills, and spoil piles include: Starlight (little queen), Royal Gold mill tailings, Port Royal, Sunday, and others.

Recent TMDL source assessment data for Boulder Creek was used to evaluate attainment of metals water quality targets in Royal Gold Creek. Data included 4 water quality samples and one stream sediment sample collected from several stations along the length of Royal Gold Creek from 2007 to 2009. A summary of relevant water quality data is given in **Table 6-16**. These metals were found to be above water quality standards: non-reported metals were below standards.

Table 6-16. Royal Gold Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Cadmium	Copper	Lead	Zinc
# Samples	4	4	4	4
Min	<0.08	2	0.9	20
Max	0.19	9	9.4	50
Median	0.06	4	4.5	25.00
# Acute Exceedances	0	2	2	0
Acute Exceedance Rate	25%	50%	50%	0%
# Chronic Exceedances	1	2	4	1
Chronic Exceedance Rate	25%	50%	100%	25%
# Human Health Exceedance	0	0	0	0
Human Health Exceedance Rate	0%	0%	0%	0%

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

<u>Cadmium</u>

Royal Gold Creek is not currently identified as impaired for cadmium on the 2012 303(d) List. Of 4 water samples collected since 2007 along the length of the stream, no samples exceeded the acute and one (25%) exceed chronic aquatic life criteria. Cadmium data indicate there may be a problem, yet too little evidence exists to make an assessment if these metals exert toxicity to fish and aquatic life. Cadmium sampling should continue in this watershed.

Copper

Royal Gold Creek is not currently identified as impaired for copper on the 2012 303(d) List. Evaluation of TMDL source assessment data collected during 2007-2009 indicate Royal Gold Creek is in need of a copper TMDL. Of 4 water samples collected since 2007 along the length of the stream, two (50%) exceeded both the acute and chronic aquatic life criteria. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for Royal Gold Creek. The 303(d) listing status for copper will be formally evaluated by DEQ in the future.

Lead

Royal Gold Creek is not currently identified as impaired for lead on the 2012 303(d) List. Evaluation of TMDL source assessment data collected during 2007-2009 indicate Royal Gold Creek is in need of a lead TMDL. Of 4 water samples collected since 2007 along the length of the stream, two (50%) exceeded the acute and all (100%) exceed the chronic aquatic life criteria. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Royal Gold Creek. The 303(d) listing status for will be formally evaluated by DEQ in the future.

Zinc

Royal Gold Creek is not currently identified as impaired for zinc on the 2012 303(d) List. Of 4 water samples collected since 2007 along the length of the stream, no samples exceeded the acute and one (25%) exceed chronic aquatic life criteria. Cadmium data indicate there may be a problem, yet too little evidence exists to make an assessment if these metals exert toxicity to fish and aquatic life. Zinc sampling should continue in this watershed.

6.4.3.9 Smart Creek MT76E003_110

Smart Creek originates in the John Long Mountains and flows northeast about 11 miles to its confluence with Flint Creek (**Appendix A, Figure A-21**). Smart Creek is not currently on the 2012 303(d) List as being impaired for any metals. This stream was included in source assessment monitoring for the Flint Creek metals TMDLs because of abandoned mining sources present in the watershed. Arsenic and iron levels warrant TMDLs for Smart Creek.

Future 303(d) assessment should include copper, zinc and cadmium monitoring in the upper reach of the segment. A limited amount of data associated with Black Pine Mine indicate there may be copper, zinc and cadmium levels in a tributary to Smart Creek which could limit fish and aquatic life growth in the upper reaches of Smart Creek. Data collected by the confluence of Flint Creek did not indicate any exceedances of copper, zinc and cadmium standards. Further zinc and cadmium data collection should continue with the Black Pine Mine reclamation efforts.

Metals Sources

Human caused metals sources in the Smart Creek watershed are comprised mostly of abandoned or inactive mines. A number of abandoned mines and mills in the district have tailings, waste rock and mine spoils which are directly impacting Smart Creek (**Appendix A, Figure A-21**). Some of the larger abandoned mine adits, mills, and spoil piles include: Black Pine, Sunrise/Queen Mill, Douglas Mine/Mill and other various small shafts and placer mines. Montana received settlement funds for cleanup of Black Pine Mine and DEQ recently began investigations to base the site cleanup upon.

Recent TMDL source assessment data for Flint Creek was used to evaluate attainment of metals water quality targets in Smart Creek. Data included seven water quality samples and one stream sediment sample collected during 2007 to 2009 from a single site on Smart Creek near the confluence with Flint

Creek. A summary of relevant water quality data is given in **Table 6-17**. Relevant sediment data is summarized in text.

Table 6-17. Smart Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Iron
# Samples	7	7
Min	4.00	20
Max	19	2190
Median	12	330
# Acute Exceedances	0	2
Acute Exceedance Rate	0%	29%
# Chronic Exceedances	0	NA
Chronic Exceedance Rate	0%	NA
# Human Health Exceedance	4	0
Human Health Exceedance Rate	57%	0%

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Smart Creek is not currently identified as impaired for arsenic on the 2012 303(d) List. Evaluation of TMDL source assessment data collected during 2007-2009 indicate Smart Creek is in need of an arsenic TMDL. Of seven water samples collected since 2007 along the length of the stream, four (57%) exceeded human health standards. Consequently, arsenic target exceedances are confirmed and an arsenic TMDL is developed for Smart Creek. The 303(d) listing status for arsenic will be formally evaluated by DEQ in the future.

Iron

Smart Creek is not currently identified as impaired for iron on the 2012 303(d) List. Evaluation of TMDL source assessment data collected during 2007-2009 indicate Smart Creek is in need of a iron TMDL. Of seven water samples collected since 2007 along the length of the stream, two (29%) exceeded the acute aquatic life criteria. Consequently, iron target exceedances are confirmed and an iron TMDL is developed for Smart Creek. The 303(d) listing status for iron will be formally evaluated by DEQ in the future.

6.4.3.10 South Fork Lower Willow Creek MT76E003_050

South Fork Lower Willow Creek originates in the John Long Mountains and flows north about thirteen miles to its terminus at Willow Creek Reservoir (**Appendix A, Figure A-21**). South Fork Lower Willow Creek is on the 2012 303(d) List as being impaired for metals: copper, lead and mercury. TMDLs will be completed for each of these listed metals and also for arsenic, cadmium and antimony.

Metals Sources

Human caused metals sources in the South Fork Lower Willow Creek watershed are comprised of abandoned or inactive mines. A number of abandoned mines and mills in the district have large volumes of tailings, waste rock and mine spoils which are directly impacting South Fork Lower Willow Creek (**Appendix A, Figure A-21**). The larger abandoned mine adits, mills, and spoil piles include: Combination, Combination II and Black Pine Mine. Most of these are located in the headwaters area.

Data from South Fork Lower Willow Creek was used to evaluate attainment of metals water quality targets. Data included 15 water quality samples and two stream sediment samples collected from several stations along the length of South Fork Lower Willow Creek from 2007 to 2009. A summary of relevant water quality data is given in **Table 6-18**. Sediment metals analysis indicate mine waste has migrated along the whole segment of South Fork Lower Willow Creek during past floods.

Table 6-18. South Fork Lower Willow Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Antimony	Arsenic	Cadmium	Copper	Mercury	Lead
# Samples	25	25	20	25	7	25
Min	5	3	0.08	<1	0.04	0.5
Max	21	35	0.21	48	0.13	39.7
Median	8	4	0.12	17	0.10	2.7
# Acute Exceedances	0	0	0	21	0	21
Acute Exceedance Rate	0%	0%	0%	84%	0%	84%
# Chronic Exceedances	0	8	13	21	0	2
Chronic Exceedance Rate	0%	32%	65%	84%	0%	8%
# Human Health Exceedance	11	3	0	0	5	2
Human Health Exceedance Rate	44%	12%	0%	0%	71%	8%

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Antimony

South Fork Lower Willow Creek is not listed as impaired for antimony on the 2012 303(d) List. Evaluation of data collected since the initial impairment listing verifies that antimony conditions may negatively affect human health. Of 25 water samples collected since 2007 along the length of South Fork Lower Willow Creek, 11 (44%) exceeded the human health standard. Consequently, antimony target exceedances are confirmed and an antimony TMDL is developed for South Fork Lower Willow Creek. The 303(d) listing status for antimony will be formally evaluated by DEQ in the future.

Arsenic

South Fork Lower Willow Creek is not listed as impaired for arsenic on the 2012 303(d) List. Evaluation of data collected since the initial impairment listing verifies that arsenic conditions may negatively affect human health. Of 25 water samples collected since 2007 along the length of South Fork Lower Willow Creek, 8 (32%) exceeded the chronic aquatic life criteria, and three (12%) exceeded the human health standard. Also, arsenic concentrations in both stream sediment samples collected greatly exceed PEL values established as sediment targets. Consequently, arsenic target exceedances are confirmed and an arsenic TMDL is developed for South Fork Lower Willow Creek. The 303(d) listing status for arsenic will be formally evaluated by DEQ in the future.

Cadmium

South Fork Lower Willow Creek is not listed as impaired for cadmium on the 2012 303(d) List. Evaluation of data collected since the initial impairment listing verifies that cadmium conditions negatively affect aquatic life. Of 25 water samples collected since 2007 along the length of South Fork Lower Willow Creek, 6 (24%) exceeded the acute aquatic life criteria, and 18 (72%) exceeded the chronic aquatic life criteria. Also, cadmium concentrations in both stream sediment samples collected greatly exceed PEL values established as sediment targets. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for South Fork Lower Willow Creek. The 303(d) listing status for cadmium will be formally evaluated by DEQ in the future.

Copper
South Fork Lower Willow Creek is listed as impaired for copper on the 2012 303(d) List, which is based primarily on historic data. Evaluation of data collected since the initial impairment listing verifies a copper problem. Of 25 water samples collected since 2007 along the length of South Fork Lower Willow Creek, 21 (84%) exceeded the acute and chronic aquatic life criteria. Also, copper concentrations in both stream sediment samples greatly exceeded PEL values established as a sediment target. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for South Fork Lower Willow Creek.

Lead
South Fork Lower Willow Creek is listed as impaired for lead on the 2012 303(d) List, and is based primarily on historic data. Evaluation of data collected since the initial impairment listing verifies this decision. Of 25 water samples collected since 2007 along the length of South Fork Lower Willow Creek, 21 (84%) exceeded the chronic aquatic life criteria. Two (8%) samples exceeded acute aquatic life and human health standards. Likewise, lead concentrations in both stream sediment samples exceeded PEL values established as sediment targets. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for South Fork Lower Willow Creek.

Mercury
South Fork Lower Willow Creek is listed as impaired for mercury on the 2012 303(d) List, and is based primarily on data collected in the early 1990s. Evaluation of this data verifies mercury contamination. Of seven samples, five (71%) exceeded the human health standard. Likewise, mercury concentration in 6 of 7 stream sediment samples greatly exceeded PEL values established as sediment targets. The greatest PEL exceedance was 107 times the PEL. Due to exceedances of human health standards and high sediment concentrations, and known human sources, a mercury TMDL is developed for South Fork Lower Willow Creek.

6.4.3.11 Upper Flint Creek MT76E003_011

Flint Creek flows out of Georgetown Lake toward the north. The upper segment of Flint Creek flows past Philipsburg and ends at the Boulder Creek confluence near Maxville (**Appendix A, Figure A-22**). The lower segment of Flint Creek continues to the Clark Fork River. Upper Flint Creek is on the 2012 303(d) List as being impaired for metals: antimony, arsenic, cadmium, copper, lead and mercury. TMDLs will be completed for each of these metals except antimony and cadmium.

Metals Sources
Human caused metals sources in the Upper Flint Creek watershed are comprised of abandoned or inactive mines. A number of abandoned mines and mills in the district have adit-discharges or large volumes of tailings, most of these are located on tributaries, although a couple sites of interest are located directly on Flint Creek (**Appendix A, Figure A-22**). Londonderry adit is located near Flint Creek upstream of Maxville, and an old mill site is located near Flint Creek downstream of Philipsburg. An active MPDES groundwater permitted milling facility is located in the Douglas Creek (near Philipsburg) area. Most of the historic and abandoned mining sources are located near Philipsburg or Maxville although there was historic mining activity in other areas of the watershed including the North Fork Flint Creek. Additionally, Philipsburg's WWTP effluent and storm sewer systems appear to provide some metals loading.

Data from Upper Flint Creek was used to evaluate attainment of metals water quality targets. Data included 20-34 water quality samples depending upon the metal, and five stream sediment samples collected from several locations along the length of Upper Flint Creek. Most of this data ranges from 2007 to 2009. Mercury data is the exception; all mercury data was collected during the 1970s. A summary of relevant water quality, sediment, and fish tissue data is provided in **Table 6-19** through **6-21**.

Table 6-19. Upper Flint Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Antimony	Arsenic	Cadmium	Copper	Lead	Mercury
# Samples	34	28	20	31	28	10
Min	0	<3	<0.08	<1	<0.5	<0.01
Max	0	46	0.09	13	37	1.3
Median	0	11.5	<0.08	2	3.6	0.4
# Acute Exceedances	0	0	0	2	0	0
Acute Exceedance Rate	0	0%	0%	6%	0%	0%
# Chronic Exceedances	0	0	0	2	12	0
Chronic Exceedance Rate	0%	0%	0%	6%	43%	0%
# Human Health Exceedance	0	14	0	0	2	5
Human Health Exceedance Rate	0%	50%	0%	0%	7%	50%

Table 6-20. Upper Flint Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Mercury
# Samples	5	5	5	5	No Data
Min	87.3	-0.5	25.7	77.3	
Max	415	4.29	763	493	
Median	228	2.04	91.5	324	
PEL Value	17	3.5	197	91	
# Samples>PEL	5	1	1	4	
PEL Exceedance Rate	100%	20%	20%	80%	

*All units in mg/kg dry weight
**No PEL for Antimony

Table 6-21. Upper Flint Creek Mercury Fish Tissue Concentrations (1974)

	Mercury (ug/g)
# Samples	16
Min	<0.01
Max	0.22
Median	0.06

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Antimony

Upper Flint Creek is listed as impaired for antimony on the 2012 303(d) List based primarily on 1991-1992 data. Evaluation of data collected from 2007-2009 disputes this decision. Of 34 water samples collected since 2007 along the length of Flint Creek, no samples exceeded the human health or aquatic life standards. Antimony concentrations in stream sediment are irrelevant because there are no PEL values established as sediment targets due to antimony's low toxicity to aquatic animals. As a result, antimony conditions are blow standards and a TMDL will not be pursued for upper Flint Creek. The 303(d) listing status for antimony will be formally evaluated by DEQ in the future.

Arsenic
Upper Flint Creek is listed as impaired for arsenic on the 2012 303(d) List based primarily on 1990s data. Evaluation of data collected since the initial impairment listing verifies this decision. Of 28 water samples collected since 2007 along the length of Flint Creek, 14 (50%) samples exceeded the human health standard. Likewise, arsenic concentrations in five stream sediment samples exceed PEL values established as sediment targets. Consequently, arsenic target exceedances are confirmed and an arsenic TMDL is developed for upper Flint Creek.

Lead
Upper Flint Creek is listed as impaired for lead on the 2012 303(d) List, and is based primarily on data collected in the late 1990s. Evaluation of data collected since the initial impairment listing verifies this decision. Of 28 water samples collected since 2007 along the length of Upper Flint Creek, 12 (43%) samples exceeded the chronic and two (6%) exceed acute aquatic life criteria. Likewise, lead concentration in four of five stream sediment samples exceeded PEL values established as sediment targets. Consequently, lead target exceedances are confirmed, human sources are present, and a lead TMDL is developed for Upper Flint Creek.

Cadmium
Upper Flint Creek is listed as impaired for cadmium on the 2012 303(d) List, and is based primarily on data collected in the late 1990s. Evaluation of data collected since the initial impairment does not support this decision. Of 20 water samples collected since 2007 along the length of Upper Flint Creek, no samples exceeded the chronic or acute aquatic life criteria. No human health standards are exceeded. Consequently, a cadmium TMDL is not needed for Upper Flint Creek. The 303(d) listing status will be formally evaluated by DEQ in the future.

Copper
Upper Flint Creek is listed as impaired for copper on the 2012 303(d) List, and is based primarily on data collected in the late 1990s, most of the 1990s data was collected near Maxville area in association with a Londonderry Adit investigation. Evaluation of data collected since the initial impairment listing verifies two acute and chronic exceedances out of 31 samples (6%). Yet, both of these samples were collected downstream of Londonderry Adit. A copper concentration in one of five stream sediment samples exceeded PEL values established as sediment targets. Consequently, copper target exceedances are confirmed near a mining area at the lower end of this river segment, human sources are present, and a copper TMDL is developed for Upper Flint Creek.

Mercury
Upper Flint Creek is listed as impaired for mercury on the 2012 303(d) List, and is based primarily on data collected in the late 1970s. Evaluation of this data along with data collected by MBMG and DEQs PAM program during 1992-1995 near Maxville, verifies mercury contamination. Of ten stream water samples, five (50%) exceeded the human health standard. Results from a 1974 University of Montana fish tissue analysis add evidence that mercury levels are elevated (**Table 6-15**). Due to exceedances of human health standards, a mercury TMDL is developed for Upper Flint Creek.

6.4.3.12 Lower Flint Creek MT76E003_012

The lower segment of Flint Creek continues from the confluence of the Boulder River to the Clark Fork River (**Appendix A, Figure A-22**). Lower Flint Creek is on the 2012 303(d) List as being impaired for metals: arsenic, cadmium, copper, lead and iron. TMDLs will be completed for each of these metals except for cadmium. Minimal data indicates mercury should be monitored in the future although this segment is not currently listed for this pollutant.

Metals Sources

Human caused metals sources in the Flint Creek watershed are comprised of abandoned or inactive mines. A number of abandoned mines and mills in the district have adit-discharges or large volumes of tailings. Most of the mining areas are located on tributaries or areas adjacent to Flint Creek above Maxville (**Appendix A, Figure A-22**). Londonderry adit is located near Flint Creek upstream of Maxville, and an old mill site is located near Flint Creek downstream of Philipsburg. An active MPDES groundwater permitted milling facility is located in the Douglas Creek (near Philipsburg) area. Most of the historic and abandoned mining sources are located near Philipsburg or Maxville, or in Smart, Willow, and Boulder Creek Watersheds. Additionally, Philipsburg's WWTP effluent and stormsewer system appear to provide some metals loading.

The 303(d) metals listings are based upon USGS and other temporally dispersed data from 1971-2003. More recent data from the Flint Creek TMDL project was used to evaluate attainment of metals water quality targets. Data included 16-19 water quality samples depending upon the metal, and five stream sediment samples collected from several locations along the length of Lower Flint Creek. Most of this data ranges from 2007 to 2009. Historic data was reviewed and also supports conclusions made from the recent review of TMDL project data. A summary of relevant water quality and sediment data is provided in **Table 6-22** and **6-23**.

Table 6-22. Lower Flint Creek Metals Water Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead
# Samples	19	12	19	19	19
Min	6	<0.08	1	50	0.5
Max	28	0.19	10	1250	28.3
Median	13	<0.08	3	340	5.7
# Acute Exceedances	0	0	0	NA	0
Acute Exceedance Rate	0%	0%	0%	NA	0%
# Chronic Exceedances	0	0	7	3	11
Chronic Exceedance Rate	0%	0%	37%	16%	58%
# Human Health Exceedance	14	0	0	NA	2
Human Health Exceedance Rate	74%	0%	0%	NA	11%

Table 6-23. Lower Flint Creek Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead
# Samples	4	4	4	4	4
Min	66.9	2.03	44	9610	122
Max	415	4.29	143	11500	493
Median	239.5	2.655	83.4	10425	283
PEL Value	17	3.5	197	4%	91
# Samples>PEL	4	1	0	0	4
PEL Exceedance Rate	100%	25%	0%	0%	100%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Lower Flint Creek is listed as impaired for arsenic on the 2012 303(d) List based primarily on 1990s and earlier data. Evaluation of data collected since the initial impairment listing verifies this decision. Of 19 water samples collected since 2007 along the length of Flint Creek, 14 (74%) samples exceeded the human health standard. Likewise, arsenic concentrations in all four stream sediment samples exceed PEL values established as sediment targets. Consequently, arsenic target exceedances are confirmed and an arsenic TMDL is developed for lower Flint Creek.

Cadmium

Lower Flint Creek is listed as impaired for cadmium on the 2012 303(d) List, and is based primarily on data collected in the late 1990s and early 2000s. Evaluation of data collected since the initial impairment listing contradicts the listing based on older data. Of 12 water samples collected since 2007 along the length of Lower Flint Creek, no samples exceeded the chronic or acute aquatic life criteria. Cadmium concentration in one of four stream sediment samples exceeded PEL values established as secondary sediment targets. Consequently, a cadmium TMDL is not needed for Lower Flint Creek but future metals monitoring should verify static or improving cadmium conditions. The 303(d) listing status for cadmium will be formally evaluated by DEQ in the future.

Copper

Lower Flint Creek is listed as impaired for copper on the 2012 303(d) List, and is based primarily on data collected in the late 1990s and early 2000s. Evaluation of data collected since the initial impairment listing verifies a copper problem. Seven chronic exceedances out of 19 samples (37%) were detected. No copper concentrations in stream sediment samples exceeded PEL values established as sediment targets. Copper target exceedances are confirmed, human sources are present, and a copper TMDL is developed for Lower Flint Creek.

Iron

Lower Flint Creek is listed as impaired for iron on the 2012 303(d) List, and is based primarily on data collected in the late 1990 and early 2000s. Evaluation of data collected since the initial impairment listing verifies an iron problem. Three chronic aquatic life exceedances out of 19 (16%) samples were detected. No iron concentrations in stream sediment samples exceeded values established as sediment targets. Iron target exceedances are confirmed, human sources are present, and an iron TMDL is developed for Lower Flint Creek.

Lead

A USGS report indicates Flint Creek contributes 17% of the Clark Fork River’s lead load at Turah Bridge based upon early 1990s data. Lower Flint Creek is listed as impaired for lead on the 2012 303(d) List, and is based primarily on data collected in the late 1990s and early 2000s. Evaluation of data collected since the initial impairment listing verifies this decision. Of 19 water samples collected since 2007 along the length of Lower Flint Creek, 11 (16%) samples exceed the chronic aquatic life criteria and two exceed human health standards. Likewise, lead concentration in all four stream sediment samples exceeded PEL values established as sediment targets. Consequently, lead target exceedances are confirmed, human sources are present, and a lead TMDL is developed for Lower Flint Creek.

Mercury

Lower Flint Creek is not currently listed as impaired by mercury on the 2012 303(d) List. Recent fish and aquatic insect tissue analysis indicates a potential mercury water quality problem. Montana FWP has provided a fish consumption advisory for Flint Creek. MSU research indicates high levels of mercury in aquatic insects. Future water quality and sediment metals monitoring in this area should include mercury for analysis in Lower Flint Creek.

6.4.4 Metals Target Attainment Evaluation and TMDL Development Summary

Nine individual stream segments were listed as impaired for metals-related impairments in the Flint Creek TMDL Planning Area. Review of metals target exceedances verified most metals impairments on the 2012 303(d) List, however target exceedances could not be verified for listed metals on some stream segments. Likewise, several streams exhibited target exceedances for metals that do not appear on the 2012 303(d) List. Metals TMDLs will be completed for two streams not currently identified as impaired for metals. Metals TMDLs for 11 stream segments will be provided in **Section 6.5**. Data from this project will be incorporated into the 303(d) list for their inclusion in a future Integrated Water Quality Report for Montana. **Table 6-1** presents a summary of existing metals impairment causes and metals for which target exceedances were confirmed and for which TMDLs are prepared.

A total of 42 metals TMDLs are identified in this document. TMDLs and allocations for these segments and metals are provided in the following section. Although elevated levels of sulfate are present in North Fork Douglas from historic mining activity, this TMDL was not pursued because sulfates are not at levels likely to cause harm to the most sensitive uses.

6.5 METALS TMDLS AND ALLOCATIONS

6.5.1 Metals TMDLs

As summarized in **Table 5-23**, metals total maximum daily loads are presented herein for impaired waterbodies in the Flint TMDL Planning Area. A Total Maximum Daily Load (TMDL) is a calculation of the maximum pollutant load a waterbody can receive while maintaining water quality standards. The total maximum daily load is based on the most stringent applicable water quality criteria provided in **Section 6.4.2.1**, the 25th percentile of seasonal water hardness if applicable, and the stream flow. With most metals, the chronic aquatic life criteria, which depend upon hardness, will be used to calculate the TMDL. Under high hardness conditions however, the human health criteria for lead may apply). In the case of arsenic and mercury, the human health criteria will be used for the basis of the TMDLs, as it is the most stringent standard. Where aquatic life criteria are variable based on hardness, TMDLs at a water hardness of 25 mg/L and 400 mg/L are shown. TMDLs based on human health criteria are included in the graphs where appropriate.

Because stream flow and hardness vary seasonally, the TMDL is expressed not as a static value, but as an equation. The TMDL under a specific flow condition is calculated using the following formula:

TMDL = (X) (Y) (k)

TMDL= Total Maximum Daily Load in lbs/day
X= lowest applicable metals water quality target in ug/L
Y= streamflow in cubic feet per second
k = conversion factor of 0.0054

The TMDL equation and curves apply to all metals TMDLs within this document and provide a graphical reference for illustrating TMDLs for applicable metals under variable flow and hardness conditions. If a TMDL is based upon the chronic aquatic life standard, the lowest applicable metals water quality target is based upon a 25th percentile hardness value for a seasonal data set. Metals TMDLs will apply to any point along the continuum of the waterbody, with some exceptions for mixing zones, and therefore protect uses along the entire stream.

6.5.2 Metals Allocations

Metals TMDLs are allocated to point (wasteload) and nonpoint (load) sources. The TMDL is comprised of the sum of all significant point and nonpoint metals sources (natural and anthropogenic), plus a margin of safety that accounts for uncertainties in loading and receiving water analyses. In addition to metals load allocations, the TMDL must also take into account the seasonal variability of metals loads and adaptive management strategies in order to address uncertainties inherent in environmental analyses.

These elements are combined in the following equation:

TMDL = ∑WLA + ∑LA + MOS

WLA = Wasteload Allocation or the portion of the TMDL allocated to metals point sources.
LA = Load Allocation or the portion of the TMDL allocated to nonpoint metals sources and natural background
MOS = Margin of Safety or an accounting of uncertainty about the relationship between metals loads and receiving water quality.

Within the Flint TMDL Planning Area, significant metals sources are primarily those derived from historic and abandoned mining activity over the past one hundred and fifty years. Mining sources are prevalent at several locations throughout the affected watersheds. An in-depth assessment of metals sources is not conducted herein. Rather, loading estimates from these known sources are provided using data and information gleaned from aforementioned investigations, and form the basis for metals load allocations and load reductions necessary to meet water quality criteria. Aside from metals sources associated with mining activity and municipal sources, other sources of metals are not believed to be a significant source contributing to water quality impairment and appear to be within naturally-occurring concentrations.

Metals source load allocations are provided for the following source categories:

- Naturally occurring metals sources
- Abandoned mining sources
- Permitted NPDES point-source discharges

Naturally occurring metals sources

Naturally occurring sources will be provided a load allocation (LA) in lbs/day based on naturally occurring metals concentrations and streamflow. Naturally occurring metals sources occur naturally within a watershed. As defined in ARM 17.30.602, naturally occurring sources also include *"those sources from developed areas where all reasonable land, soil and water conservation practices have been applied."* Within the Flint Creek TMDL Planning Area, naturally-occurring metals concentrations are established by using in-stream data upstream of mining sources or from locally unimpacted watersheds where metals sources are limited to those associated with natural background and low-level development.

Within the Flint Creek TMDL Planning Area, naturally-occurring metals concentrations were estimated from 14-16 samples collected in the watershed in areas representing naturally occurring conditions for metals during both high and low flow conditions. All samples were taken upstream of developed mining lands and represent water quality conditions where "all reasonable land and soil water conservation practices have been applied." From this data set, the 75th percentile metals concentration was chosen as an estimation of naturally-occurring metals concentration. In many cases, non-detects were recorded for most metals; for purposes of data analysis half the lowest detection limit was substituted for the result value. **Table 6-24** shows estimates of naturally occurring metals concentration in the Flint Creek TMDL Planning Area. Because local reference data was not available, a statewide data set was used for mercury using only recently collected, ultra low level detection limits. These metal concentrations are used to calculate load allocations to naturally occurring metals sources for impaired waterbodies.

Table 6-24. Naturally occurring metals concentrations in the Flint TMDL Planning Area

Metal	Number of Samples	Concentration (ug/L)
Arsenic	16	1.5
Antimony	16	1.5
Cadmium	16	0.04
Copper	16	0.5
Iron	14	330
Lead	16	0.25
Mercury	168 (statewide)	0.0025
Zinc	16	5.0

Abandoned mining sources

Abandoned mining sources include a variety of discrete sources associated with historic abandoned mining activity and are typically categorized as adits, seeps, tailings piles, floodplain deposits, and other associated mining waste. Given the pervasive nature of abandoned mining activity in most of the affected watersheds, the sum of all abandoned mining sources contributing to a waterbody segment are treated as a composite non-permitted point source, and a composite wasteload allocation is provided for these non-permitted point sources. Composite wasteloads to abandoned mining sources are calculated as the difference between the TMDL and the load allocation to naturally occurring sources plus any wasteloads to permitted discharges.

Permitted NPDES point-source discharges

MPDES discharges permitted by the DEQ are also provided a wasteload allocation. One individual municipal wastewater MPDES permit exists within the Flint TMDL Planning Area: Permit MT0031500 (Town of Philipsburg). The permitted facility is a lagoon system that discharges to Flint Creek. Also, a permitted mining related stormwater permit is active for the Black Pine Mine area as the State of Montana begins a cleanup process after settlement with ASARCO. As the two NPDES point-sources in the watershed with reasonable potential for metals loading, both permitted sources will be provided wasteload allocations. The wasteload allocation under a specific discharge flow is calculated using the following formula:

$$\mathbf{WLA_{NPDES} = (X)\ (Y)\ (k)}$$

WLA= Wasteload Allocation to NPDES- permitted discharges in pounds per day
X= lowest applicable metals water quality target in ug/L for a specific in-stream hardness value
Y= wastewater treatment plant discharge flow (not design flow) in gallons per day
k = conversion factor of 0.00834

Essentially the WLA is based on meeting the lowest applicable metals standard concentration within the discharger's effluent. This approach is consistent with the reasonable assurance approach defined within **Section 4.4.**

The example wasteload allocation numbers provided in tables within the following sections should not strictly be used for permit writing because they are only applicable to a given set of flow and point source discharge conditions. In an effort to coordinate potential permit based WLAs to the TMDL derived WLAs, DEQ found that both efforts provided similar outcomes for providing wasteload allocations even though they are based upon different processes.

6.5.3 Allocations by Waterbody Segment

In the sections that follow, a loading summary and source load allocations are provided for each pollutant-waterbody combination for which a TMDL is prepared (see **Table 5-23**). Loading summaries are based on the sample data used for evaluation of metals targets in **Section 5.4.3**. For each metal, water quality sample data are used to calculate metals loading estimates and the required percent load reduction to achieve the TMDL for each metal during high flow and low flow conditions. Load estimations and allocations are based on a limited data set and are assumed to approximate general metals loading during high and low flow conditions.

The example loads provided for existing conditions, TMDLs, LAs, and WLAs provided for both high flow and low flow conditions are based upon the following assumptions:

1. The 25th percentile of in-stream seasonal hardness results are used for determining hardness based standards and associated TMDLs, LAs, and WLAs.
2. TMDL examples use seasonal average stream flow condition as basis for TMDL load examples. Permits may need to use 7Q10 or other statistics for deriving numeric WLAs consistent with the WLA equations given in this TMDL.
3. Existing condition load summaries use the 90th percentile of the data set to compare to TMDLs based upon chronic aquatic life standard thresholds. This compares to a 10% random exceedance rate, which is allowed for under DEQ duration and frequency considerations of chronic aquatic life thresholds.
4. Existing condition load summaries use the maximum concentration of a data set to compare to TMDLs based upon human health standards. This compares to a condition where no exceedances of these thresholds should occur within recent data sets (<10 years old).
5. The existing condition and TMDL examples provided in the following metals TMDL sections are located at the most contaminated location that was monitored for each metal.

6.5.3.1 Barnes Creek MT41U002_010

There are no known mining related iron sources in Barnes Creek watershed. There are also no permitted point-sources in the watershed. Iron load allocations consist of a composite load allocation to agricultural sources that increase soil erosion or potentially leach iron from soils due to irrigation, and a load allocation to naturally-occurring iron sources. A margin of safety (MOS) is implicit in this allocation approach, through a variety of conservative assumptions (see **Section 6.6**). The iron TMDL for Barnes Creek is therefore the sum of the LA to agricultural sources and the LA to naturally-occurring sources:

$TMDL_{Barnes} = LA_{nat} + LA_{ag}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
LA_{ag} = Composite load allocation to all agricultural sources in the watershed

Table 6-25 summarizes metals TMDLs and load allocations for Barnes Creek. Percent reduction values are the necessary load reduction to meet the TMDL and water quality standards. The Barnes Creek sediment TMDL has detailed allocations for sediment sources in the watershed (**Section 5.6.1**). Sediment sources in Barnes Creek watershed are mutual with the iron sources. It appears that iron is mostly derived from erosion within the watershed.

Table 6-25. Barnes Creek: Metals TMDLs and Allocation Example

Metal	Flow	TMDL	LA_{nat}	LA_{ag}	Existing Load	Percent Reduction
Iron	High flow	11.1	3.67	7.47	49.6	77.6%
	Low flow	9.11	3.00	6.11	42.8	78.7%

Example TMDL calculations based upon: Hardness = irrelevant, Discharge: HF = 2.1cfs, LF = 1.7cfs
*loads reported in lb/day

TMDL and allocation examples provided in **Table 6-25** are calculated from iron and flow data collected from the middle reach of Barnes Creek between Gaskill Creek and county road 512. This area has the highest iron concentrations. Gaskill Creek area appears to be a large source of iron and suspended sediment. Irrigation removes take water, suspended sediment and iron from Barnes Creek at the road and groundwater continues to dilute iron and suspended sediment conditions below the road. Significant reductions are necessary during both high and low flow to meet the iron TMDL and water quality targets. This is because even at low flow, Barnes Creek is turbid.

6.5.3.2 Boulder Creek (MT76E003_070)

Abandoned mine sources in the Boulder Creek watershed are responsible for significant metals loading to the creek. Abandoned mills, lodes, and placer mining in the watershed are generally pervasive. Three priority abandoned mines are located in and near Royal Gold Creek, a tributary to Boulder Creek. Significant metal sources may include: Bluebird Mine, Mountain Lion Mine, Starlight Mine, Swamp Gulch Mill, Brooklyn Mill, Port Royal Tailings, NonPareil and potentially others. As there are no permitted point-sources in the watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. Also, metals TMDLs will be completed for Princeton Gulch and Royal Gold Creek, both tributaries to Boulder Creek. A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for Boulder Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{Boulder} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

Example metals TMDLs and allocations for Boulder Creek are calculated at the confluence with Flint Creek for typical high and low flow water quality conditions. The TMDL, LA and WLAs are equations provided in **Section 6.5.1 and 6.5.2**. **Table 6-26** provides an example of metals TMDLs and load allocations for Boulder Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 6-26. Boulder Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	15.7	2.37	13.35	4.71	NA*
	Low flow	1.41	0.212	1.20	0.282	NA*
Lead	High flow	1.27	0.393	0.873	3.61	65.0%
	Low flow	0.349	0.0353	0.313	0.0353	NA
Mercury	High flow	0.0705	0.00393	0.0670	0.109951	28.6%
	Low flow	0.00785	0.000353	0.00749	0.0141	50%
Zinc	High flow	75.4	7.85	67.6	15.7	NA%*
	Low flow	14.2	0.705	13.6	7.85	NA%*

Example TMDL calculations based upon: Hardness = HF = 34, LF = 82, Discharge: HF = 292.5cfs, LF = 26.3cfs
*loads reported in lb/day

Lead and mercury appear as the most pervasive metals in Boulder Creek, usually during high flow, springtime conditions. Arsenic and zinc appear to mostly be transported via sediment and likely exert toxicity to benthic fish and aquatic life. Because there may be cumulative interactions between toxicity of these metals, and the abandoned mine sources are the same as other metals, TMDLs are provided for arsenic and zinc. Sediment metals levels will likely be reduced if mining reclamation reduces influence of mine waste piles on water quality in this watershed.

6.5.3.3 Camp Creek (MT76E003_130)

Abandoned mine sources in the Camp Creek watershed are responsible for significant metals loading to the creek. Abandoned mills, waste piles, lodes, and placer mining in the watershed are generally pervasive. The stream originates slightly downstream from a cyanide heap leach pad which has a grandfathered small miners exclusion. During 2011, the lined pad began to overflow. Just downstream, a number of priority abandoned mine sites affect water quality. The stream enters a canyon between the abandoned mine sites and the town of Philipsburg, yet due to historic mining, the stream almost completely infiltrates into loosely compacted mine waste and soils and then it reemerges above the town of Philipsburg. Camp Creek then flows into Philipsburg's storm runoff system and reemerges near MT HWY 1. Abandoned mine influences also occur within Philipsburg city limits where spoils from Hope Mill are scattered. Significant metal sources likely include: Trout, True Fissure, Thomas McKay, Scratch All, Hope Mill, and Hobo T. Hayes mines, with a possibility of many other historic mining sources that could contribute metals. EPA recently reported results from Superfund Program preliminary site investigation monitoring that further characterizes sources of metals in the Camp Creek watershed (United States Environmental Protection Agency and Hogan, 2010).

As there are no permitted point-sources in the watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. As a side note, metals are likely infiltrating into Philipsburg wastewater collection system from groundwater in the area. Metals also appear to be infiltrating from groundwater into the city stormwater collection system and ultimately into Camp Creek. A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for Camp Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{Camp} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

The TMDL, LA and WLAs are equations provided in **Section 6.5.1 and 6.5.2**. The example metals TMDLs and allocations for Camp Creek are calculated for the area above Philipsburg for typical high and low flow water quality conditions because this area had the highest metals contamination. **Table 6-27** provides an example of metals TMDLs and load allocations for Camp Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 6-27. Camp Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	0.0171	0.00257	0.0146	0.0274	37.5%
	Low flow	0.0143	0.00215	0.0122	0.0186	23.1%
Cadmium	High flow	0.000265	0.0000685	0.000196	0.00511	94.8%
	Low flow	0.000383	0.0000573	0.000326	0.00185	79.2%
Copper	High flow	0.00838	0.000857	0.00753	0.00358	NA
	Low flow	0.0153	0.000716	0.0146	0.0212	60.5%
Lead	High flow	0.00787	0.00162	0.00625	0.207	96.2%
	Low flow	0.00447	0.000358	0.00412	0.00580	22.8%
Zinc	High flow	0.409	0.0323	0.376	2.33	82.4%
	Low flow	0.170	0.00716	0.162	1.63	89.6%

Example TMDL calculations based upon: Hardness = HF = 47, LF = 98, Discharge: HF = 1.2cfs, LF = 0.27cfs
*loads reported in lb/day

In Camp Creek above Philipsburg, most metals loads are above TMDLs during both high and low flow conditions. This is understandable given the extent of mining-related soil and water quality contamination in the upper Camp Creek watershed. Metals conditions generally continue to be problematic near and below Philipsburg, but are not as pervasive.

6.5.3.4 Douglas Creek (near Philipsburg) MT76E003_100

Human caused metals sources in Douglas Creek watershed are comprised primarily of abandoned mining activity. Montana's abandoned mine cleanup program has identified eight priority abandoned mines in the watershed. A couple of these are near the ghost town of Granite: BiMetalic/Old Red and Granite Mountain. Others are located in or near Frost Creek, a tributary to Douglas Creek: Algonquin, Little Gem, Trout, Wegnar #2. Still others are located on the Douglas Creek valley bottom: Douglas Creek waste areas and extensive waste from Bi-Metallic Mill (**Appendix A, Figure A-18**). The Granite Drain, a drain system under the mines near Granite, and an associated aqueduct, moves metal laden water from most of the shafts under Granite Mountain to Douglas Creek near the lowest Douglas Creek Waste area.

Contact Mill continues to operate sporadically, yet does not discharge to Douglas Creek or its tributaries. Groundwater monitoring near this operation will occur beginning 2011 to assure this potential source meets conditions in adherence to the combined WLA. The facility has two tailings impoundments, one of which is located in Douglas Creek watershed. Montana DEQ identifies that the ponds are not lined and likely discharge to groundwater, while the operators contend the ponds have self sealed through metals processing activities.

Remedial investigation of the watershed was initiated during the summer of 2011 under the EPA Superfund program. Extensive investigation of mine waste location and characterization is underway through this process. EPA recently reported results from Superfund Program preliminary site investigation monitoring that further characterizes sources of metals in the Douglas Creek watershed (United States Environmental Protection Agency and Hogan, 2010).

State efforts of mine waste cleanup activities include a 2000 Montana DEQ completed a reclamation project on both of the Douglas Creek Tailings piles by placing them in lined repositories and covering them with a geomembrane. This effort also moved the stream to flow around the repositories. Historic Bi-Metallic Mill tailings cover an area of about 600,000 sf and may have been partially reclaimed in the 1980s as a condition of the original Contact Mill MPDES groundwater discharge permit. Little information can be found about this reclamation effort. The stream enters a wooden flume for diversion around a portion of the Bi-Metallic Mill tailings.

As there are no NPDES permitted point-sources, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for upper Douglas Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{Douglas} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

The TMDL, LA and WLAs are equations provided in **Section 6.5.1 and 6.5.2. Table 6-28** provides examples of metals TMDLs and load allocations for Douglas Creek, calculated from a location just upstream of the abandoned Bi-Metallic Mill because this site had the highest metals contamination.

Table 6-28. Douglas Creek (near Philipsburg): Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	0.222	0.0333	0.189	2.65	91.6%
	Low flow	0.0987	0.0148	0.0839	1.53	93.5%
Cadmium	High flow	0.00650	0.000889	0.00561	0.0453	85.7%
	Low flow	0.00149	0.000347	0.00114	0.0143	89.6%
Copper	High flow	0.227	0.0111	0.216	0.187	NA
	Low flow	0.0478	0.00434	0.0435	0.0971	50.8%
Iron	High flow	22.2	7.24	14.9	30.2	26.4%
	Low flow	9.95	3.26	6.69	10.1	2.53%
Lead	High flow	0.0808	0.00516	0.0752	0.183	55.9%
	Low flow	0.0126	0.00217	0.0104	0.314	96.0%
Mercury*	High flow	0.00111	0.0000556	0.00106	0.00556	80%
	Low flow	0.000434	0.0000217	0.000412	0.00217	80%
Zinc	High flow	0.227	0.0111	0.216	0.187	NA
	Low flow	0.0478	0.00434	0.0435	0.0971	50.8%

Example TMDL calculations based upon: Hardness: HF = 54, LF = 111, Discharge: HF = 4.14cfs, LF = 1.84cfs
*For the mercury example TMDL and WLAs, the chemistry samples were collected on different dates than discharge samples.
*all loads reported in lb/day

In Douglas Creek just upstream of the Bi-Metallic Mill, most metals loads are above TMDLs during both high and low flow conditions. This is understandable given the extent of mining-related soil and water quality contamination in the watershed. It appears that the Granite Drain is a very large source of most metals in this watershed even though its contribution of discharge ranges from 5-20% of the water when compared to monitoring sites in the lower watershed (**Table 6-29**). Metals conditions generally continue to be problematic near and below Philipsburg. As stated earlier, the EPA superfund program is assessing metal sources in the watershed, and results could be used for further prioritization of reclamation activities.

Table 6-29. Load contribution of metals from Granite Drain to Lower Douglas Creek just upstream of the abandoned Bi-Metallic Mill

	Arsenic	Cadmium	Copper	Lead	Iron	Zinc
Low Flow	47%	26%	10%	0.35%	84%	142%
High Flow	27%	5%	2%	0.67%	15%	10%

*all loads reported in lb/day

6.5.3.5 North Fork Douglas Creek – near Hall (MT76E003_130)

Abandoned mine sources in the North Fork Douglas Creek watershed are responsible for significant metals loading to the creek. Abandoned mills, waste piles, lodes, and placer mining in the headwaters are extensive. The stream originates from an adit with very high metals concentrations and collects more water in an area with extensive mine waste and other adits. As the stream continues down-gradient, water quality only slightly improves as few abandoned mine sources are present in any other areas of the watershed (**Appendix A, Figure A-18**). A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for North Fork Douglas Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{NFDC} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

The TMDL, LA and WLAs are equations provided in **Section 6.5.1 and 6.5.2**. The example metals TMDLs and allocations for North Fork Douglas Creek are calculated for the headwaters area for typical high and low flow water quality conditions because this area had the highest metals contamination. **Table 6-30** provides an example of metals TMDLs and load allocations for North Fork Douglas Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 6-30. North Fork Douglas Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Cadmium	High flow	0.00262	0.000404	0.00221	0.719	99.6%
	Low flow	0.00141	0.000195	0.00122	0.167	99.2%
Copper	High flow	0.0896	0.00505	0.0846	3.80	97.6%
	Low flow	0.0493	0.00243	0.0468	0.160	69.1%
Lead	High flow	0.0298	0.00253	0.0273	0.0535	44.3%
	Low flow	0.0175	0.00122	0.0163	0.00355	NA
Zinc	High flow	1.15	0.0505	1.10	65.6	98.2%
	Low flow	0.632	0.0243	0.607	16.1	96.1%

Example TMDL calculations based upon: Hardness: HF =94, LF = 110, Discharge: HF = 1.88cfs, LF = 0.90cfs
*all loads reported in lb/day

In North Fork Douglas Creek most metals loads are above TMDLs during both high and low flow conditions. This is understandable given the extent of mining-related soil and water quality contamination in the upper reaches of North Fork Douglas Creek headwaters. Metals conditions generally continue to be problematic along the whole stream.

6.5.3.6 Fred Burr Creek (MT76E003_040)

An abandoned mill in the middle reach of Fred Burr Creek is the primary source of metals loads to the creek (**Appendix A, Figure A-20**). The DEQ abandoned mine program assessed metal sources on this property during the 1990s. EPA recently reported results from Superfund Program preliminary site investigation monitoring that further characterizes sources of metals in the Fred Burr Creek watershed (United States Environmental Protection Agency and Hogan, 2010).

The WLA for abandoned mining activities in the watershed can almost entirely be applied to this site. A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for Fred Burr Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{FBC} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

The TMDL, LA and WLAs are equations provided in **Section 6.5.1 and 6.5.2**. The example metals TMDLs and allocations for Fred Burr Creek are calculated using data from a site near the confluence with Flint Creek for typical high and low flow water quality conditions. This area had the highest metals contamination. **Table 6-31** provides an example of metals TMDLs and load allocations for Fred Burr Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 6-31. Fred Burr Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	4.46	0.669	3.79	11.6	61.5%
	Low flow	0.104	0.0156	0.0882	0.882	88.2%
Lead	High flow	0.243	0.112	0.132	3.56	93.2%
	Low flow	0.00566	0.00260	0.00306	0.00976	42.0%
Mercury	High flow	0.0223	0.00112	0.0212	4.73	99.5%
	Low flow	0.000519	0.0000260	0.000493	.00332	84.3%

Example TMDL calculations based upon: Hardness: HF =25 LF = 25, Discharge: HF = 83.1cfs, LF = 1.9cfs
*all loads reported in lb/day

In Fred Bur Creek, a limited number of metals are in need of TMDLs because human caused sources are from milling activity, not metals extraction from the earth. Metals problems occur at both high and low flow conditions and originate from Rumsey Mill site and associated sediment contamination along the stream.

6.5.3.7 Royal Gold Creek (MT76E003_040)

Royal Gold Mill tailings are the largest source of metal loading in Royal Gold Creek (**Appendix A, Figure A-20**). The WLA for abandoned mining activities in the watershed can almost entirely be applied to this site. A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for Royal Gold Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{RGC} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

The TMDL, LA and WLAs are equations provided in **Section 6.5.1 and 6.5.2**. The example metals TMDLs and allocations for Royal Gold Creek are calculated using data from a site near the confluence with Boulder Creek for typical high and low flow water quality conditions. **Table 6-32** provides an example of metals TMDLs and load allocations for Royal Gold Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 6-32. Royal Gold Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Copper	High flow	0.1455	0.0255	0.120	0.444	67.2%
	Low flow	0.0218	0.00382	0.0180	0.0153	NA
Lead	High flow	0.0278	0.0128	0.0150	0.444	93.7%
	Low flow	0.00417	0.00191	0.00226	0.0153	72.7%

Example TMDL calculations based upon: Hardness: HF =94, LF = 110, Discharge: HF = 1.88cfs, LF = 0.90cfs
*all loads reported in lb/day

In Royal Gold Creek, a limited number of samples were collected, copper and lead very apparently need load reductions to meet standards and are in need of TMDLs because human caused sources are from milling and mining activity. Other metals should be included in any further sampling in this watershed.

6.5.3.8 Smart Creek (MT76E003_110)

The Black Pine Mine is located in the headwaters of Smart Creek. Montana DEQ is beginning a cleanup effort for this mine after a settlement agreement with ASARCO; preliminary investigations are currently underway. There is a mining related stormwater permit for the Black Pine mine area. Also, a hardrock mine permit is in place for the Black Pine mine, yet no water quality discharge permit, other than the stormwater permit, is associated with this mine. Other various abandoned mines are scattered across the watershed including one priority abandoned mine (**Appendix A, Figure A-21**). A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for Smart Creek are therefore the sum of the WLA to abandoned mines plus the Black Pine Mine stormwater WLA and the LA to naturally-occurring sources:

$TMDL_{Smart} = LA_{nat} + WLA_{abmine} + WLA_{BPMsw}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

WLA_{BPsw} = Wasteload allocation to Black Pine Mine stormwater

The TMDL, LA and WLAs equations are provided in **Section 6.5.1 and 6.5.2**. The example metals TMDLs for Smart Creek are calculated using data from a site near the confluence with Flint Creek for typical high and low flow water quality conditions. This location was the only monitoring site assessed during this TMDL project because it was originally included as a source assessment location for the Flint Creek TMDL. Metals problems were found in Smart Creek, therefore TMDLs are prepared but with less source assessment data than other streams in the TPA. **Table 6-33** provides an example of metals TMDLs and load allocations for Smart Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Black Pine mine shafts contain acid mine drainage which is likely seeping into adjacent groundwater and emerging in local springs. Local seeps and springs are being pumped back into the mine shafts to contain metals contamination. DEQ is currently investigating a cleanup strategy for this source. An environmental trust group holds a hardrock permit for this area, yet no industrial wastewater NPDES discharge permit is associated with this source. Since no active mining is occurring, there is no industrial process wastewater NPDES discharge permit, and a cleanup effort is underway, this area will be combined with all other areas of abandoned mines for a composite WLA to all abandoned mines in the watershed. Although, the NPDES stormwater permitted area is provided an individual WLA. The combined abandoned mine WLA approach assumes that water quality standards are met in Smart Creek down gradient of the Black Pine Mine area.

Wasteload Allocation

MPDES permit MTR300080 has been issued for Storm Water Discharges Associated with Mining and Oil and Gas Activities related to the ASARCO LLC Black Pine Mine, currently under the ownership of Montana Environmental Trust Group, LLC. Within that permit, two outfalls from the Combination Mine (Outfall 001, Outfall 003) were identified as discharging to an unnamed tributary to Smart Creek.

According to the General Permit For Storm Water Discharges Associated With Mining and With Oil and Gas Activities (Permit Number MTR300000) the following effluent limitations apply:

A. There shall be no discharge of process wastewater pollutants to surface waters.
B. A discharge of storm water associated with mining or with oil and gas activity may occur based on water generated only through rainfall precipitation and snowmelt.
C. No discharge of storm water associated with mining or with oil and gas activity shall cause or contribute to a violation of water quality standards.
D. Discharges of storm water containing pollutants associated with mining or with oil and gas activity covered under this General Permit will be controlled through the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). Best Management Practices (BMPs) identified in the SWPPP must help eliminate or minimize the discharge of pollutants to surface waters.
E. New or increased storm water discharges associated with mining or with oil and gas activity on or after April 29, 1993 shall not cause degradation as described in ARM 17.30.715(3) and 75-5-301(5)(c), MCA.

The arsenic drinking water and the iron chronic aquatic life standards are used for the basis of a stormwater wasteload allocation. Because the permit indicates no runoff may contribute to water quality standards exceedances, the permitting process should meet the WLA for the TMDL. The State of Montana is currently planning a mine waste cleanup for this source area. Runoff conditions during the cleanup may exceed water quality standards even with all reasonable stormwater practices in place. Therefore, the WLA to permit MTR300080 should not be applied until after the mine waste cleanup is completed according to consent decree Case No. 05-21207 of the Southern District of the Texas Corus Christy Bankruptcy Court.

Table 6-33 provides estimates of the WLAs for this area. An equation provided in **Section 6.5.2** provides the actual WLA. The assumptions behind the example WLA in **Table 6-33** include a 1 inch rainfall event with 100% runoff from the twelve acres of barren land from this site draining to the unnamed tributary of Smart Creek. In reality, detention basins are present but a rainstorm of a larger magnitude may occur. The WLA assumes average daily runoff conditions meet arsenic and iron standards. An implementation approach for meeting wasteload allocations is provided in **Section 8.5.7**.

Table 6-33. Smart Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{BPsw}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	0.288	0.0433	0.0272	0.218	0.548	47.4%
	Low flow	0.255	0.0383	0.0272	0.190	0.357	28.6%
Iron	High flow	28.8	9.52	2.72	16.6	61.7	52.8%
	Low flow	25.5	8.42	2.72	14.4	9.31	NA

Example TMDL calculations based upon: Hardness: irrelevant, Discharge: HF = 5.4cfs, LF = 4.8cfs
*all loads reported in lb/day

Permit data indicates that zinc, copper, iron and arsenic samples should be collected in Smart Creek downstream of the unnamed tributaries influenced by Black Pine Mine. If standards cannot be met in this area after remediation is completed and time is provided for remediation activities to take effect, site specific standards may be needed. Yet, the goal of the cleanup should consider meeting existing water quality standards.

6.5.3.9 South Fork Lower Willow Creek (MT76E003_050)

The predominant source of metals in South Fork Lower Willow Creek is Black Pine Mine and associated tailings from mills that processed ore from this mine (**Appendix A, Figure A-21**). Other small scattered abandoned mines are present throughout the watershed. Now, contaminated sediments originating from these sources are present throughout most of South Fork Lower Willow Creek. There is a mining related stormwater permit for the Black Pine mine area. A margin of safety (MOS) is implicitly applied through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for South Fork Lower Willow Creek are therefore the sum of the WLA to abandoned mines plus the Black Pine Mine stormwater WLA and the LA to naturally-occurring sources:

$TMDL_{SFLWC} = LA_{nat} + WLA_{abmine} + WLA_{StormBPM}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed
$WLA_{StormBPM}$ = Wasteload allocation to Black Pine Mine stormwater

The TMDL, LA and WLAs are equations provided in **Sections 6.5.1 and 6.5.2**. The example metals TMDLs and allocations for SF Lower Willow Creek are calculated using data from a site near the confluence with Willow Creek Reservoir for typical high and low flow water quality conditions. This area had the highest metals contamination. **Table 6-34** provides an example of metals TMDLs and load allocations for South Fork Lower Willow Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Black Pine mine shafts contain acid mine drainage which is likely seeping into adjacent groundwater and emerging in local springs. Local seeps and springs are being pumped back into the mine shafts to contain metals contamination. DEQ is currently investigating a cleanup strategy for this source. An environmental trust group holds a hardrock permit for this area, yet no industrial wastewater NPDES discharge permit is associated with this source. Since no active mining is occurring, there is no industrial process wastewater NPDES discharge permit, and a cleanup effort is underway, this area will be combined with all other areas of abandoned mines for a composite WLA to all abandoned mines in the watershed. Although, the NPDES stormwater permitted area associated with Black Pine Mine is provided an individual WLA. The combined abandoned mine WLA approach assumes that water quality standards are met along all reaches of South Fork Lower Willow Creek.

Wasteload Allocation

MPDES permit MTR300080 has been issued for Storm Water Discharges Associated with Mining and Oil and Gas Activities related to the ASARCO LLC Black Pine Mine, currently under the ownership of Montana Environmental Trust Group, LLC. Within that permit, one outfall from the Tim Smith Drainage (Outfall 002) is identified as discharging to a tributary of South Fork Lower Willow Creek.

According to the General Permit For Storm Water Discharges Associated With Mining and With Oil and Gas Activities (Permit Number MTR300000) the following effluent limitations apply:

A. There shall be no discharge of process wastewater pollutants to surface waters.
B. A discharge of storm water associated with mining or with oil and gas activity may occur based on water generated only through rainfall precipitation and snowmelt.
C. No discharge of storm water associated with mining or with oil and gas activity shall cause or contribute to a violation of water quality standards.
D. Discharges of storm water containing pollutants associated with mining or with oil and gas activity covered under this General Permit will be controlled through the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). Best Management Practices (BMPs) identified in the SWPPP must help eliminate or minimize the discharge of pollutants to surface waters.
E. New or increased storm water discharges associated with mining or with oil and gas activity on or after April 29, 1993 shall not cause degradation as described in ARM 17.30.715(3) and 75-5-301(5)(c), MCA.

The arsenic and mercury drinking water and the iron, antimony, cadmium, copper and lead chronic aquatic life standards are used for the basis of a stormwater wasteload allocation. There has been no observed runoff from the 1.98 acres of disturbed area in the Tim Smith drainage (outfall 02), therefore no data exists for this location. Because the permit indicates no runoff may contribute to water quality standards exceedances, the permitting process should meet the WLA for the TMDL. The State of Montana is currently planning a mine waste cleanup action for this source area. Runoff conditions during the cleanup may exceed water quality standards even with all reasonable stormwater practices in place. Therefore, the WLA to permit MTR300080 should not be applied until after the mine waste cleanup is completed according to consent decree Case No. 05-21207 of the Southern District of the Texas Corpus Christy Bankruptcy Court.

Table 6-34 provides estimates of the WLAs for the stormwater permit area. An equation provided in S**ection 6.5.2** provides the actual WLA. The assumptions behind the example WLA in **Table 6-34** include a 1 inch rainfall event with 100% runoff from the 1.98 acres of barren land from this site draining to Tim Smith Gulch, a tributary of South Fork Lower Willow Creek. The WLA assumes average daily runoff conditions meet the most restrictive metals standards. An implementation approach for meeting wasteload allocations is provided in **Section 8.5.7**.

Table 6-34. South Fork Lower Willow Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	$WLA_{StormBPM}$	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	4.16	0.625	0.00449	3.53	3.33	NA
	Low flow	0.061	0.00900	0.00449	0.0475	0.212	71.4%

Table 6-34. South Fork Lower Willow Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	$WLA_{StormBPM}$	WLA_{abmine}	Existing Load	Percent Reduction
Antimony	High flow	2.33	0.625	0.00251	1.70	8.75	73.3%
	Low flow	0.0340	0.00900	0.00251	0.0225	0.103	67.1%
Cadmium	High flow	0.0403	0.0166	0.0000449	0.0237	0.0566	28.7%
	Low flow	0.0007	0.000200	0.0000449	0.000451	0.000900	36.2%
Copper	High flow	1.188	0.208	0.00128	0.979	18.5	93.6%
	Low flow	0.017	0.003	0.00128	0.0127	0.181	90.4%
Lead	High flow	0.227	0.104	0.000244	0.123	14.6	98.44%
	Low flow	0.003	0.00100	0.000244	0.00176	0.0460	92.87%
Mercury	High flow	0.0197	0.00112	0.0000224	0.0186	0.0333	61.5%
	Low flow	0.000303	0.0000151	0.0000224	0.000265	.000789	37.5%

Example TMDL calculations based upon: Hardness: HF =25, LF = 25 , Discharge: HF = 77.6cfs, LF = 1.13cfs
*all loads reported in lb/day

In South Fork Lower Willow Creek at its confluence with Willow Creek Reservoir, all metals loads are above TMDLs during both high and low flow conditions except for arsenic. Arsenic appears to be problematic only during low flow conditions. This is understandable given the extent of mining-related soil and water quality contamination in the watershed. Metals conditions generally continue to be problematic along most of the stream. As stated earlier, the DEQ remediation program is assessing metal sources associated with Black Pine Mine and results could be used for further prioritization of reclamation activities.

6.5.3.10 Upper Flint Creek (MT76E003_011)

Human caused metals sources in the Upper Flint Creek watershed (above Boulder Creek) are comprised primarily of abandoned mines and mills around Philipsburg in Camp, Douglas and Fred Burr creek watersheds (**Appendix A, Figure A-22)**. Also, another large source appears to come from abandoned mines near Maxwell. Other abandoned mines are scattered across the landscape yet are smaller sources. The contact mill continues operation periodically yet does not have a surface water effluent. Although the city of Philipsburg contributes very small loads compared to other sources, current wastewater effluent conditions contribute to copper, mercury and lead water quality standard exceedances.

The town of Philipsburg operates a permitted wastewater treatment lagoon facility that discharges to Flint Creek (MPDES Permit No. MT0031500) for which metals wasteload allocations are provided. Wasteload allocations to permitted discharges in the Planning Area are calculated using the formula in **Section 6.5.2** and the chronic aquatic life standard for copper and lead along with the arsenic and mercury human health standard are applied in this case. The example numeric Philipsburg WLAs provided in **Table 6-35** are estimated using effluent discharge data from 2007-2010 and the lowest standard threshold for each metal. An implementation approach for meeting wasteload allocations is provided in **Section 8.5.7**.

Metals load allocations consist of a composite wasteload allocation to abandoned mining sources, a wasteload allocation to the city of Philipsburg wastewater treatment facility, and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for upper Flint Creek are therefore the sum of the two wasteload allocations and the load allocation to naturally-occurring sources:

$TMDL_{UFlint} = LA_{nat} + WLA_{abmine} + WLA_{Pburg}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all non-permitted abandoned mining sources in the watershed
WLA_{Pburg} = Wasteload allocation to City of Philipsburg permitted wastewater treatment facility

Because water hardness, flows and metals concentrations are variable throughout the seasons, the example loads and TMDLs presented herein represent loading conditions calculated from high and low flow sampling events. Actual TMDLs and allocations are variable equations presented in **Sections 6.5.1 and 6.5.2** and are dependent upon streamflow and water quality conditions. **Table 6-35** provides example metals TMDLs and load allocations for upper Flint Creek, calculated based on flows and metals concentrations measured at the downstream end of the segment. The Philipsburg WLA examples are based upon end of pipe concentrations that would meet human health or chronic aquatic life standards end of the pipe.

Table 6-35. Upper Flint Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	WLA_{Pberg}	Existing Load	Percent Reduction
Arsenic	High flow	13.6	2.042	11.6	0.00942	62.62	78.3%
	Low flow	9.40	1.41	7.98	0.00767	15.036	37.5%
Copper	High flow	9.33	0.681	8.65	0.0065	17.56	46.8%
	Low flow	6.08	0.470	5.60	0.005	3.57	NA
Lead	High flow	2.74	0.340	2.40	0.00189	49.7	94.5%
	Low flow	3.91	0.235	3.67	0.00315	7.55	48.2%
Mercury	High flow	0.0681	0.0034	0.0647	0.0000471	0.681	90%
	Low flow	0.0470	0.00235	0.0446	0.0000384	1.22	96%

Example TMDL calculations based upon: Hardness: HF = 69.8, LF = 124 , Discharge: HF = 253cfs, LF = 175cfs
*all loads reported in lb/day

Variable metals load reductions are needed for Upper Flint Creek depending upon the metal and season. This is understandable given the variable extent and location of mining-related soil and water quality contamination in the watershed. If loads from abandoned mines in Douglas, Fred Burr, Camp Creek and near Philipsburg and Maxville are reduced to conditions that meet standards along with minor load reductions of copper, mercury and lead from the Philipsburg WWTP, TMDLs would likely be met. Metals conditions are generally high beginning near Fred Burr Creek Confluence and continue to the lower end of the segment.

6.5.3.11 Lower Flint Creek (MT76E003_012)

Human caused metals sources in the Flint Creek watershed are comprised of abandoned mines and mills around Philipsburg in Camp, Douglas and Fred Burr creeks, Londonderry Mine, Black Pine Mine, and abandoned mines and mills in Smart, Douglas, Lower Willow Creek and Boulder Creek Watersheds (**Appendix A, Figure A-22**). Erosion from agriculture, grazing and irrigation systems may be a significant source of iron in the lower Flint Creek Valley, Lower Willow Creek, and Barnes Creek. Other abandoned mines are scattered across the landscape yet are smaller sources. The contact mill continues operation periodically yet does not have a surface water effluent. Although the city of Philipsburg contributes very small loads compared to other sources, current wastewater effluent conditions contribute to copper and lead water quality standard exceedances.

The town of Philipsburg operates a permitted wastewater treatment lagoon facility that discharges to Upper Flint Creek (MPDES Permit No. MT0031500) for which metals wasteload allocations are provided. Wasteload allocations to permitted discharges in the Planning Area are calculated using the formula in **Section 6.5.2** and the chronic aquatic life standard for iron, copper, and lead along with the arsenic human health standard are applied in this case. Because iron conditions in Philipsburg's effluent do not have reasonable potential for contribution to iron impairment and loading from this source is less than 0.5 % of the TMDL, iron monitoring beyond one yearly sample is not necessary for TMDL implementation and TMDL WLA tracking purposes. The example numeric Philipsburg WLAs provided in **Table 6-36** are estimated using effluent discharge data from 2007-2010 and the lowest standard threshold for each metal. An implementation approach for meeting wasteload allocations is provided in **Section 8.5.7**.

Metals load allocations consist of a composite wasteload allocation to abandoned or diffuse mining sources, a wasteload allocation to the city of Philipsburg wastewater treatment facility, a wasteload allocation to Black Pine Mine Stormwater Runoff, and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 6.6**). Metals TMDLs for Lower Flint Creek are therefore the sum of the two wasteload allocations and the load allocation to naturally-occurring sources:

$TMDL_{LFlint} = LA_{nat} + WLA_{abmine} + WLA_{Pberg} + WLA_{BPMsw}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all non-permitted abandoned mining sources in the watershed
WLA_{Pberg} = Wasteload allocation to City of Philipsburg permitted wastewater treatment facility
WLA_{BPMsw} = Black Pine Mine stormwater wasteload allocation

Because water hardness, flows and metals concentrations are variable throughout the seasons, the example loads and TMDLs presented herein represent loading conditions calculated from high and low flow sampling events. Actual TMDLs and allocations are variable equations presented in **Sections 6.5.1 and 6.5.2** and are dependent upon streamflow and water quality conditions. **Table 6-36** provides example metals TMDLs and load allocations for Lower Flint Creek, calculated based on flows and metals concentrations measured at the downstream end of the segment. The Philipsburg WLA examples are based upon end of pipe concentrations that would meet human health or chronic aquatic life standards end of the pipe.

Table 6-36. Lower Flint Creek: Metals TMDLs and Allocation Examples

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	WLA_{BPMsw}	WLA_{Pberg}	Existing Load	Percent Reduction
Arsenic	High	26.0	3.90	22.1	0.0375	0.00942	72.9	64.3%
	Low	3.21	0.481	2.68	0.0375	0.00767	3.53	9.1%
Copper	High	15.7	1.30	14.4	0.00273	0.0065	24.7	36.5%
	Low	2.15	0.160	1.98	0.00273	0.0050	0.834	NA
Iron	High	2,602	859	1,739	3.17	0.942	2,960	12.1%
	Low	321	106	211	3.17	0.767	102	NA
Lead	High	4.32	0.650	3.64	0.0274	0.00189	69.5	93.8%
	Low	1.42	0.0800	1.31	0.0274	0.00315	1.56	9.0%

Example TMDL calculations based upon: Hardness: HF =60, LF = 130 , Discharge: HF = 485cfs, LF = 59.8cfs
*all loads reported in lb/day

Variable metals load reductions are needed for the lower segment of Flint Creek depending upon the metal and season. This is understandable given the variable extent and location of mining-related soil and water quality contamination in the watershed. If loads from abandoned mines in Camp, Douglas and Fred Burr creeks, Londonderry Mine, Black Pine Mine, and abandoned mines and mills in Smart, Douglas, Lower Willow Creek and Boulder Creek watersheds are reduced to conditions that meet standards along with minor load reductions of copper, mercury and lead from the Philipsburg WWTP, TMDLs would likely be met. Metals conditions are generally high along the whole segment.

6.6 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 load allocations. TMDL development must also incorporate a margin of safety into the load allocation 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 a margin of safety in the Flint TPA metal TMDL development process.

6.6.1 Seasonality

Seasonality addresses the need to ensure year round beneficial-use support. Seasonality was considered for assessing loading conditions and for developing water quality targets, TMDLs, and allocation schemes. For metals TMDLs, seasonality is critical due to varying metals loading pathways and varying water hardness during high and low flow conditions. Loading pathways associated with overland flow and erosion of metals-contaminated soils and wastes tend to be the major cause of elevated metals concentrations during high flows, with the highest concentrations and metals loading typically occurring during the rising limb of the hydrograph. Loading pathways associated with groundwater transport and/or adit discharges tend to be the major cause of elevated metals concentrations during low or base flow conditions. Hardness tends to be lower during higher flow conditions, thus leading to lower water quality standards for some metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals concentrations and loading conditions are evaluated for both high flow and low flow conditions.
- Metals TMDLs incorporate stream flow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target attainment developed to address seasonal water quality extremes associated with loading and hardness variations.
- Example targets, TMDLs and load reduction needs are developed for high and low flow conditions.

6.6.2 Margin of Safety

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

- Target attainment, refinement of load allocations, and, in some cases, impairment validations 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.

- Chronic aquatic life criteria were used to calculate a daily load limit rather than a 96-hour load limit
- Sediment metals concentration criteria were used as secondary indicators.

6.7 UNCERTAINTY AND ADAPTIVE MANAGEMENT

Uncertainties in the accuracy of field data, applicable target values, source assessments, 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 better understanding of impairment conditions and the processes that affect impairment. This process of adaptive management is predicated on the premise that 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, as a result of additional monitoring and source refinement additional WLAs may be necessary for abandoned mines that are found to be discrete sources and the allocations and margin of safety may be modified. Components may be changed to improve ways of achieving and measuring success. A remediation and monitoring framework is closely linked to the adaptive management process, and is addressed in **Section 8.0**.

The water quality targets and associated metals TMDLs developed for the Flint TPAs are based on future attainment of water quality standards. In order to achieve attainment, all significant sources of metal 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 water quality targets may not be possible due to the potential presence of unalterable human-caused sources. For this reason, an adaptive management approach is adopted for all metals targets described within this document. Under this adaptive management approach, all metals identified in this plan as requiring TMDLs will ultimately fall into one of the three categories identified below:

- Implementation of remediation and restoration activities resulting in full attainment of restoration targets for all parameters;
- Implementation of remediation and 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 associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant 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, EPA Superfund Program, 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. This includes consideration of appropriate evaluation of cleanup options, actual cleanup planning and design, as well as the appropriate performance and maintenance of the cleanup activities. Where NPDES permitted point sources are involved, the DEQ Permitting Program will also be involved. Determinations on the performance of all aspects of restoration activities, or lack thereof, will then be used along with available in-stream 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 EPA, 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, construction/maintenance, and future development may result in short term increase 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 impact to the least amount possible.

7.0 OTHER IDENTIFIED ISSUES OR CONCERNS

7.1 NON-POLLUTANT LISTINGS

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 the Flint Creek TPA may appear on the 303(d) list but may not always require TMDL development for a pollutant, but do have non-pollutant listings such as "alteration in streamside or littoral vegetation covers" that could be linked to a pollutant. These habitat related non-pollutant causes are often associated with sediment issues, or potential sediment issues, or may be having a deleterious effect on a beneficial use without a clearly defined quantitative measurement or direct linkage to a pollutant to describe that impact. Nevertheless, the issues associated with these streams are still important to consider when attempting to improve water quality conditions in individual streams, and the Flint Creek watershed as a whole. In some cases, pollutant and *non-pollutant* causes are listed for 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** presents the *non-pollutant* listings in the Flint Creek TPA, and notes those streams listed that do not have any associated pollutant listings.

Table 7-1. Waterbody segments in the Flint Creek TPA with non-pollutant listings related to the 2012 303(d) List pollutants of concern addressed in this document

Waterbody ID	Stream Segment	2012 Probable Causes of Impairment
MT76E003_060	**Boulder Creek*,** headwaters to the mouth (Flint Creek)	*Physical substrate habitat alterations*
MT76E003_130	**Camp Creek*,** headwaters to terminus, T7N R14W S25	*Alteration in streamside or littoral vegetation covers; Fish-passage barrier*
MT76E003_020	**Douglas Creek*,** confluence of Middle and South Fork to the mouth (Flint Creek), T9N R13W S10	*Physical substrate habitat alterations*
MT76E003_100	**Douglas Creek,** headwaters to where stream ends, T7N R14W S25	*Physical substrate habitat alterations*
MT76E003_011	**Flint Creek,** Georgetown Lake to confluence with Boulder Creek	*Alteration in streamside or littoral vegetation covers; Low flow alterations*
MT76E003_012	**Flint Creek,** Boulder Creek to mouth (Clark Fork River)	*Alteration in streamside or littoral vegetation covers*
MT76E003_040	**Fred Burr Creek*,** Fred Burr Lake to mouth (Flint Creek)	*Alteration in streamside or littoral vegetation covers*
MT76E003_030	**North Fork Douglas Creek*,** headwaters to mouth (Middle Fork Douglas Creek)	*Alteration in streamside or littoral vegetation covers*
MT76E003_090	**Princeton Gulch*,** headwaters to mouth (Boulder Creek)	*Physical substrate habitat alterations*
MT76E003_110	**Smart Creek,** headwaters to mouth (Flint Creek), T9N R13W S21	*Alteration in streamside or littoral vegetation covers*

* Streams listed for *non-pollutants* only, and have no associated sediment pollutant listings.

7.2 NON-POLLUTANT CAUSES OF IMPAIRMENT DESCRIPTIONS

Non-pollutant listings are often used as a probable cause of impairment when available data at the time of assessment does not necessarily provide a direct quantifiable linkage to a specific pollutant; however non-pollutant sources or indicators do indicate impairment. In some cases the pollutant and non-pollutant categories are linked and appear together in the cause listings; however a non-pollutant category may appear independent of a pollutant listing. The following discussion provides some rationale for the application of the identified non-pollutant causes to a waterbody, and thereby provides additional insight into possible factors in need of additional investigation or remediation.

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 loads, and the resultant lack of canopy cover can lead to increased water temperatures.

In cases where a sediment TMDL has been developed for a stream that also has alteration in streamside or littoral vegetation covers listed as a cause, the recommendations and allocations described within the TMDL will usually address the alteration cause as well. For those streams that are only listed for an alteration cause and have no sediment TMDL, the targets and implementation recommendations for TMDL streams in the watershed provide the general guidance to address habitat alterations.

Physical Substrate Habitat Alterations
Physical substrate habitat alterations generally describe cases where the stream channel has been physically altered or manipulated, such as through the straightening of the channel or from anthropogenically influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or through placer mine operations.

In cases where a sediment TMDL has been developed for a stream that also has physical substrate habitat alterations listed as a cause, the recommendations and allocations described within the TMDL will usually address the alteration cause as well. For those streams that are only listed for an alteration cause and have no sediment TMDL, the targets and implementation recommendations for TMDL streams in the watershed provide the general guidance to address habitat alterations.

Fish Passage Barrier
Fish passage barriers, in the context of a probable cause of impairment, refer to those barriers created by humans that impede the movement of fish within their natural habitat and range. Barriers such as dams, diversion structures, or mis-sized or improperly installed culverts that prohibit fish passage to or from areas critical to the various life stages of fish can be deemed a cause of impairment to the Fishes beneficial use. Exceptions to this include the reasonable operation of dams that have been constructed prior to July 1, 1971, which are defined as 'natural' under MCA 75-5-306(2) (reasonable operations as evaluated by Montana DEQ). In addition, fish passage barriers installed or maintained as a management strategy by resource professionals may be exempted as well. For instance, a fish passage barrier that

prohibits an undesirable fish species from intermingling with a desired species (such as a native population of westslope cutthroat) when the result of their intermingling would negatively affect the desired species would be an acceptable method for protecting a beneficial use. These cases are only acceptable when developed solely or in conjunction with ecosystem or fish management professionals.

In the context of Camp Creek, the fish passage barrier cause was assigned due to extreme habitat alterations in the watershed resulting in areas where the creek goes dry or subsurface. In this instance, addressing habitat alterations in Camp Creek via the recommendations within this document for sediment and habitat impairment should also address the fish passage barrier cause.

Low Flow Alterations

Streams are typically listed for low flow alterations when irrigation withdrawal management or dam operations lead to base flows that are too low to support all the beneficial uses designated for that stream. This could result in dry channels or extreme low flow conditions that do not support fish and aquatic life. It could also result in lower flow conditions which absorb thermal radiation more readily and increase stream temperatures, which in turn creates dissolved oxygen conditions too low to support some species of fish. It should be noted that while Montana law states that TMDLs cannot impact Montana water rights and thereby affect the allowable flows at various times of the year, the identification of low flow alterations as a probable source of impairment does not violate state or federal regulations or guidance related to stream assessment and water quality impairment determination. Subsequent to the identification of low flow alterations as a probable cause of impairment, it is up to local users, agencies, and entities to investigate water management options, and improve flows through water and land management if possible.

7.3 MONITORING AND BMPS FOR POLLUTION AFFECTED STREAMS

Streams listed for *non-pollutant* as opposed to a pollutant should not be overlooked when developing watershed management plans. Attempts should be made to collect additional information where data is minimal and the linkage between probable cause, non-pollutant listing, and affects to the beneficial uses are not well defined. As part of Flint Creek watershed TMDL development, some of the streams listed in **Table 7-1** were included in sediment and habitat investigations. In some cases the data collected was not enough to warrant TMDL development, but still may have warrant future monitoring or implementation. Information from that data collection effort is included in **Attachment A** and includes data for Boulder Creek, Douglas Creek (near Hall), Fred Burr Creek, North Fork Douglas Creek, and Trout Creek, in addition to the TMDL addressed streams. The restoration and monitoring strategies that follow in **Sections 8** and **9** are presented to address pollutant and issues for the Flint Creek TPA, are equally applicable to streams listed for the above non-pollutant categories.

8.0 FRAMEWORK WATER QUALITY RESTORATION STRATEGY

8.1 SUMMARY OF RESTORATION STRATEGY

This section provides a framework strategy for water quality restoration in the Flint Creek watershed, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document. This section identifies which activities will contribute the most reduction in pollutants for each TMDL.

This section should assist stakeholders in developing a more detailed adaptive Watershed Restoration Plan (WRP) in the future. The locally-developed WRP will likely provide more detailed information about restoration goals and spatial considerations within the watershed. The WRP may also encompass broader goals than the focused water quality restoration strategy outlined in this document. The intent of the WRP is to serve as a locally organized “road map” for watershed activities, sequences of projects, prioritizing types of projects, and funding sources towards achieving local watershed goals, including water quality improvements. Within this plan, the local stakeholders would identify and prioritize streams, tasks, resources, and schedules for applying Best Management Practices (BMPs). As restoration experiences and results are assessed through watershed monitoring, this strategy could be adapted and revised by stakeholders based on new information and ongoing improvements.

8.2 ROLE OF DEQ, OTHER AGENCIES, AND 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 Granite Conservation District, USFS, USFWS, NRCS, DNRC, FWP, EPA, and DEQ. Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include Granite Headwaters Watershed Group, Montana Water Trust, Montana Water Center, University of Montana Watershed Health Clinic, Clark Fork Coalition, Watershed Restoration Coalition of the Upper Clark Fork, Montana Bureau of Mines and Geology, Montana Aquatic Resources Services (MARS), and MSU Extension Water Quality Program.

8.3 WATERSHED RESTORATION GOALS

This TMDL document provides information to achieve the following water quality goals:

- Provide technical guidance for full recovery of aquatic life beneficial uses to all impaired streams within the Flint Creek TPA by improving pollutant and non-pollutant related water quality conditions. This technical guidance is provided by the TMDL components in the document which include:
    - water quality targets,

  - pollutant source assessments, and
  - general restoration guidance which should meet the TMDL allocations.
- Assess watershed restoration activities to address significant pollutant sources.

A WRP is a locally-derived plan that can be more dynamic and detailed than the TMDL document. It can be refined as activities progress and address more goals than those included in this TMDL document. The following elements may be included in a stakeholder-derived WRP in the future:

- Design for implementing restoration projects to protect water conditions so that all streams and aquatic resources in the watershed maintain good water quality with an emphasis on waters with TMDLs completed.
- More detailed cost/benefit analysis and spatial considerations for water quality improvement projects.
- An approach for future BMP installment and efficiency results tracking.
- Strategies for stakeholder outreach to inform and educate about restoration approaches, benefits and funding assistance.
- Inclusion of other various watershed health goals and local watershed issues (such as weed control initiatives, wetland restoration, etc).

Specific water quality goals for the various pollutants are detailed in **Sections 5 and 6.** These goals include water quality and habitat targets as a measure for long-term effectiveness monitoring. These targets specify satisfactory conditions to ensure protection and/or recovery of beneficial uses of waterbodies in the Flint Creek TPA. It is presumed that the meeting of all water quality and habitat targets will signal the achievement of water quality goals for a given stream. **Section 9** identifies a general monitoring strategy and recommendations designed to track post-implementation water quality conditions and measure restoration successes.

8.4 OVERVIEW OF MANAGEMENT RECOMMENDATIONS

TMDLs were completed for 5 waterbody segments for sediments, and 11 waterbody segments for metals. Other streams in the watershed may be in need of restoration or pollutant reduction, but insufficient information about them precludes TMDL formation at this time. The following sub-sections describe some generalized recommendations for implementing projects to achieve the TMDL. Details specific to each stream, and therefore which of the following strategies may be most appropriate, are found within **Section 5**.

8.4.1 Sediment Restoration Approach

Streamside riparian and wetland vegetation restoration and long term riparian area and wetland management are vital restoration practices that must be implemented across the watershed to achieve the sediment TMDLs. Native streamside riparian and wetland vegetation provides root mass which hold streambanks together. Suitable root mass density ultimately slows bank erosion. Riparian and wetland vegetation filters pollutants from upland runoff. Therefore, improving riparian and wetland vegetation will decrease bank erosion by improving streambank stability and will also reduce pollutant delivery from upland sources. Sediment is also deposited more heavily in healthy riparian zones and wetland areas during flooding because water velocities slow in these areas enough for excess sediment to settle out.

Riparian and wetland disturbance has occurred throughout the Flint Creek TPA as a result of many influencing factors. Riparian timber harvest and the conversion of forest and valley bottoms for agriculture, livestock production, and residential development have all had varying degrees of impact, depending on the drainage. Restoration recommendations involve the promotion of riparian and wetland recovery through improved grazing and land management (including the timing and duration of grazing, the development of multi-pasture systems that include riparian pastures, and the development of off-site watering areas), application of timber harvest best management practices, and floodplain and streambank stabilization and revegetation efforts where necessary. In general, natural recovery of disturbed systems is preferred however it is acknowledged that existing conditions may not readily allow for unassisted recovery in some areas where disturbance has occurred. Active vegetation planting and bank or stream channel reshaping may increase costs, but may be a reasonable and relatively cost effective restoration approach, depending on the site. When stream channel restoration work is needed because of altered stream channels, cost increases and projects should be assessed on a case by case basis. The implementation of BMPs should aim to prevent the availability, transport, and delivery of a pollutant through the most natural or natural-like means possible. Appropriate BMPs will differ by location and are recommended to be included and prioritized as part of a comprehensive watershed scale plan (e.g. WRP).

Although roads may be a small source of sediment at the watershed scale, sediment derived from roads may cause significant localized impact in some stream reaches. Restoration approaches for unpaved roads near streams should be to divert water off of roads and ditches before it enters the stream. The diverted water should be routed through natural healthy vegetation, which will act as filter zones for the sediment laden runoff before it enters streams. Sediment loads from culvert failure and culvert caused scour were not assessed by the TMDL source assessment, but should be considered in road sediment restoration approaches.

Assistance from resource professionals from various local, state, and federal agencies or non-profit groups is widely available in the Flint Creek TPA. In particular, the Granite Conservation District in Philipsburg and the NRCS are two resources that are valuable aids for assisting with investigating, developing, and implementing measures to improve conditions in the Flint Creek watershed.

8.4.2 Metals Restoration Approach

This section outlines strategies for addressing metals loading sources in need of restoration activities within the Flint Creek TPA. The restoration strategies focus on regulatory mechanisms and/or programs applicable to the controllable source types present within the watershed; which, for the most part, are associated with historic mining and mining legacy issues. Potential metals loading sources associated with abandoned mines include discharging mine adits and mine waste materials on-site and in-channel. The goal of the metals restoration plan is to limit the input of metals to stream channels from priority abandoned mine sites and other identified sources of metals impairments. For most of the mining-related sources, additional analysis will likely be required to identify site specific metals delivery pathways and to develop mitigation plans.

Because Superfund/CERCLA clean-up goals do not always correspond to Montana water quality standards, additional remediation may be necessary to meet metals TMDLs. However, after all planned remediation work is complete, effectiveness and trends monitoring should be conducted to determine if additional measures are needed to meet the TMDLs and to assess if target attainment may not be achievable for all metals.

Goals and objectives for future restoration work include the following:

- Prevent soluble metal contaminants or metals contaminated solid materials in the waste rock and tailings materials/sediments from migrating into adjacent surface waters to the extent practicable.
- Reduce or eliminate concentrated runoff and discharges that generate sediment and/or heavy metals contamination to adjacent surface waters and groundwater to the extent practical.
- Identify, prioritize, and select response and restoration actions based on a comprehensive source assessment and streamlined risk analysis of areas affected by historical mining.

8.4.3 Pollution Restoration Approach

Although TMDL development is not required for pollution listings, they are frequently linked to pollutants, and addressing pollution sources is an important component of TMDL implementation. Pollution listings within the Flint Creek TPA are described in **Section 7**. Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Therefore, if restoration goals within the Flint Creek TPA are not also addressing pollution impairments, additional pollution-related BMP implementation should be considered.

8.5 RESTORATION APPROACHES BY SOURCE

Generalized management recommendations are outlined below for the major sources of human caused pollutant loads in the Flint Creek TPA: grazing, upland sources, riparian and wetland vegetation removal, irrigation, and roads. Applying BMPs are the core of the sediment reduction strategy, but are only part of a watershed restoration strategy. Restoration activities may also address other current pollution-causing uses and management practices. In some cases, efforts beyond implementing new BMPs may be required to address key sediment sources. In these cases, BMPs are usually identified as a first effort and an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve water quality standards. Monitoring is also an important part of the restoration process. Monitoring recommendations are outlined in **Section 9.0**.

8.5.1 Agriculture Sources

Reduction of sediment from upland agricultural sources can be done by limiting the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil and runoff before it enters a waterbody. The main BMP recommendations for the Flint Creek watersheds are riparian buffers, wetland restoration, and vegetated filter strips, where appropriate. These methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept pollutants. Filter strips and buffers are even more effective for reducing upland agricultural related sediment when used in conjunction with BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, and stripcropping (although currently there is very little cropping activity that occurs in the Flint Creek watershed). Additional BMP information, design standards and effectiveness, and details on the suggested BMPs can be obtained from your local USDA Agricultural Service Center and in Montana's NPS Management Plan (Montana Department of Environmental Quality, 2012).

An additional benefit of reducing sediment input to the stream is a decrease in sediment-bound nutrients. Although this document focuses only on sediment and metals, nutrient TMDLs will be completed for the Flint Creek watershed in the future. Reductions in sediment loads may help address some nutrient related problems. Nutrient management considers the amount, source, placement, form, and timing of plant nutrients and soil amendments. Conservation plans should include the following information (NRCS MT 590-1):

- Field maps and soil maps
- Planned crop rotation or sequence
- Results of soil, water, plant, and organic materials sample analysis
- Realistic expected yields
- Sources of all nutrients to be applied
- A detailed nutrient budget
- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns
- Location of designated sensitive areas
- Guidelines for operation and maintenance

8.5.3.1 Grazing

Development of riparian grazing management plans should be a goal for any landowner in the watershed who operates livestock and does not currently have such plans. Private land owners may be assisted by state, county, federal, and local conservation groups to establish and implement appropriate grazing management plans. Note that riparian grazing management does not necessary eliminate all grazing in riparian corridors. Nevertheless, in some areas, a more restrictive management strategy may be necessary for a period of time in order to accelerate re-establishment of a riparian community with the most desirable species composition and structure.

Every livestock grazing operation should have a grazing management plan. The plan should at least include the following elements:

- A map of the operation showing fields, riparian and wetland areas, winter feeding areas, water sources, animal shelters, etc
- The number and type of livestock
- Realistic estimates of forage needs and forage availability
- The size and productivity of each grazing unit (pasture/field/allotment)
- The duration and time of grazing
- Practices that will prevent overgrazing and allow for appropriate regrowth
- Practices that will protect riparian and wetland areas and associated water quality
- Procedures for monitoring forage use on an ongoing basis

Reducing grazing pressure in riparian and wetland areas and improving forage stand health are the two keys to preventing nonpoint source pollution from grazing. Grazing operations should use some or all of the following practices:

- Minimizing or preventing livestock grazing in riparian and wetland areas
- Providing off-stream watering facilities or using low-impact water gaps to prevent ‘loafing’ in wet areas
- Managing riparian pastures separately from upland pastures
- Installing salt licks, feeding stations, and shelter fences to prevent ‘loafing’ in riparian areas
- Replanting trodden down banks and riparian and wetland areas with native vegetation (this should always be coupled with a reduction in grazing pressure)
- Rotational grazing or intensive pasture management

The following resources may be able to help you prevent pollution and maximize productivity from your grazing operation:

- USDA, Natural Resources Conservation Service. You can find your local USDA Agricultural Service Center listed in your phone directory or on the internet at www.nrcs.usda.gov
- Montana State University Extension Service www.extn.msu.montana.edu
- DEQ Watershed Protection Section, Nonpoint Source Program www.deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram

The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian and wetland vegetation and minimize disturbance of the streambank and channel. The primary recommended BMPs for the Flint Creek watershed are providing off-site watering sources, limiting livestock access to streams and stabilizing the stream at access points, planting woody vegetation along streambanks, and establishing riparian buffers. Although bank revegetation is a preferred BMP, in some instances bank stabilization may be necessary prior to planting vegetation.

8.5.3.2 Animal Feeding Operations

Animal feeding operations (AFOs) can pose a number of risks to water quality and public health if the animal manure and wastewater they generate contaminates nearby waters. To minimize water quality and public health concerns from AFOs and land applications of animal waste, the USDA and EPA released the Unified National Strategy for AFOs in 1999 (United States Department of Agriculture, Natural Resources Conservation Service, 2005). This strategy encouraged owners of AFOs of any size or number of animals to voluntarily develop and implement site-specific Comprehensive Nutrient Management Plans (CNMPs). A CNMP is a written document detailing manure storage and handling systems, surface runoff control measures, mortality management, chemical handling, manure application rates, schedules to meet crop nutrient needs, land management practices, and other options for manure disposal.

An AFO that meets certain specified criteria is referred to as a Concentrated Animal Feeding Operation (CAFO). CAFOs may be required to obtain a Montana Pollution Discharge Elimination System (MPDES) permit as a point source. Montana's AFO compliance strategy is based on federal law and has voluntary, as well as, regulatory components. If voluntary efforts can eliminate discharges to state waters, no direct regulation is necessary through a permit.

Operators of AFOs may take advantage of effective, low cost practices to reduce potential runoff to state waters. In addition to water quality benefits, these practices may help to increase property values and operation productivity. Properly installed vegetative filter strips, in conjunction with other practices to reduce wasteloads and runoff volume, are very effective at trapping and detaining sediment and reducing transport of nutrients and pathogens to surface waters, with removal rates approaching 90 percent (United States Department of Agriculture, Natural Resources Conservation Service, 2005). Other options may include clean water diversions, roof gutters, berms, sediment traps, fencing, structures for temporary manure storage, shaping, and grading. Animal health and productivity also benefit when clean, alternative water sources are installed to prevent contamination of surface water. Studies have shown benefits in red meat and milk production of 10 to 20 percent by livestock and dairy animals when good quality drinking water is substituted for contaminated surface water.

Opportunities for financial and technical assistance (including CNMP development) in achieving voluntary AFO and CAFO compliance may be available from conservation districts, NRCS field offices, or the Montana DEQ Watershed Protection Section (among other sources). Further information on CAFO discharge permitting may be obtained from the DEQ website at: www.deq.mt.gov/wqinfo/mpdes/cafo.mcpx

8.5.3.3 Irrigation

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to streamflow can have a profound effect on the ability of a stream to attenuate pollutants, especially nutrients, metals and heat. Flow reduction may increase water temperature, allow sediment to accumulate in stream channels, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced (Andrews and Nankervis, 1995; Schmidt and Potyondy, 2004). Restoration targets and implementation strategies recognize the need for specific flow regimes, and may suggest flow-related improvements as a means to achieve full support of beneficial uses. However, local coordination and planning are especially important for flow management because State law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana's water quality law (MCA 75-5-705).

Irrigation management is a critical component of attaining both cold water fishery conservation and TMDL goals. Management practices for irrigation efficiency in the Flint Creek watershed should investigate reducing the amount of stream water diverted during July and August, while still maintaining healthy crops. It may also be desirable to investigate irrigation practices earlier in the year that promote groundwater return during July, August, and September. Understanding irrigation water, groundwater and surface water interactions is an important part of understanding how irrigation practices will affect streamflow during specific seasons.

Many of the irrigation practices in western Montana are based in flood irrigation methods. In some cases, head gates and ditches leak, which can decrease the amount of water in diversion flows. The following recommended activities could result in notable water savings.

- Install upgraded head gates for more exact control of diversion flow and to minimize leakage when not in operation.
- Develop more efficient means to supply water to livestock.
- Determine necessary diversion flows and timeframes that would reduce over watering and improve forage quality and production.
- Where appropriate, redesign or reconfigure irrigation systems.
- Upgrade ditches (including possible lining) to increase ditch conveyance efficiency.

Future studies could investigate irrigation water return flow timeframes from specific areas along the Flint Creek watershed. Some water from spring and early summer flood irrigation likely returns as cool groundwater to the streams during the heat of the summer. These critical areas could be identified so that they can be preserved as flood irrigation areas. Other irrigated areas which do not contribute to summer groundwater returns to the river should be identified as areas where year round irrigation efficiencies could be more beneficial than seasonal management practices. Winter baseflow should also be considered during these investigations.

8.5.2 Forestry and Timber Harvest

Currently, active timber harvest is not significantly affecting sediment loads in the Flint Creek TPA, but harvesting will likely continue in the future within the Beaverhead-Deer Lodge National Forest, and on private land. Future harvest activities should be conducted by all landowners according to Forestry BMPs for Montana (Montana State University, Extension Service, 2001) and the Montana SMZ Law (77-

5-301 through 307 MCA). The Montana Forestry BMPs cover timber harvesting and site preparation, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. While the SMZ Law is intended to guide commercial timber harvesting activities in streamside areas (i.e. within 50 feet of a waterbody), the riparian protection principles behind the law can be applied to numerous land management activities (i.e. timber harvest for personal use, agriculture, development). Prior to harvesting on private land, landowners or operators are required to notify the Montana DNRC. The DNRC is responsible for assisting landowners with BMPs and monitoring their effectiveness. The Montana Logging Association and DNRC offer regular Forestry BMP training sessions for private landowners.

Timber harvest should not increase the peak water yield by more than 10 percent of historic conditions. If a natural disturbance, such as a forest fire, increases peak water yield, the increase should be accounted for as part of timber harvest management.

8.5.3 Riparian Corridors and Wetlands

Reduction of riparian and wetland vegetative cover by various land management activities is a principal cause of water quality and habitat degradation in watersheds throughout Montana. Although implementation of passive BMPs that allow riparian and wetland vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e. plantings) may be necessary in some instances. The primary advantage of riparian and wetland plantings is that installation can be accomplished with minimum impact to the stream channel, existing vegetation, and private property. In addition to providing shade (and possible reduced water temperature) and cover for aquatic species, riparian and wetland plantings can develop root masses that penetrate deep into the soils, increasing bank resilience to erosion. All areas that are actively restored with vegetation should have a reasonable approach to protecting the invested effort from future degradation from livestock or hay production.

Factors influencing the appropriate riparian and wetland restoration would include severity of degradation, site-potential for various species, and availability of local sources for native transplant materials. In general, riparian and wetland plantings would promote establishment of functioning stands of native species. The following recommended restoration measures would allow for stabilization of the soil, decrease sediment delivery to the stream, and increase absorption of nutrients from overland runoff.

- Harvest and transplant locally available sod mats with an existing dense root mass which provide immediate promotion of bank stability and filtering nutrients and sediments.
- Transplanting mature native shrubs, particularly willows (*Salix* sp.), provides rapid restoration of instream habitat and water quality through overhead cover and stream shading as well as uptake of nutrients.
- Seeding with native graminoids (grasses and sedges) and forbs is a low cost activity at locations where lower bank shear stresses would be unlikely to cause erosion.
- Willow sprigging expedites vegetative recovery, but involves harvest of dormant willow stakes from local sources.
- ***Note***: Before transplanting *Salix* from one location to another it is important to determine the exact species so that we do not propagate the spread of non-native species. There are several non-native willow species that are similar to our native species and commonly present in Montana watersheds.

In addition to the benefits noted above, it should be noted that in some cases wetland act as areas of shallow subsurface groundwater recharge and/or storage areas, and can have added links to the issues discussed in **Section 8.5.3.3**. The captured water via wetlands is then generally discharged to the stream later in the season and contributes to the maintenance of base flows and stream temperatures. Restoring ditched or drained wetlands can have a substantial effect on the quantity, temperature, and timing of water returning to a stream, as well as the pollutant filtering capacity that improved riparian and wetlands provide.

8.5.4 Unpaved Roads

The road sediment reductions in this document represent a gross estimation of the sediment load that would remain once road BMPs were applied, assuming no current BMPs are in place. In general, a road with associated BMPs assumes contributing road treads, cutslopes, and fillslopes were reduced to 100 feet (from each side of a crossing). This distance is selected as an example to illustrate the potential for sediment reduction through BMP application and is not a formal goal at every crossing. For example, many roads may easily allow for a smaller contributing length, while others may not be able to meet a 100ft goal. Achieving this reduction in sediment loading from roads may occur through a variety of methods at the discretion of local land managers and restoration specialists. Road BMPs can be found on the Montana DEQ or DNRC websites and within Montana’s NPS Management Plan (Montana Department of Environmental Quality, 2007). Examples include:

- Providing adequate ditch relief up-grade of stream crossings.
- Constructing waterbars, where appropriate, and up-grade of stream crossings.
- Use rolling dips on downhill grades with an embankment on one side to direct flow to the ditch.
- Inslope roads along steep banks with the use of cross slopes and cross culverts.
- Outslope low traffic roads on gently sloping terrain with the use of a cross slope.
- Use ditch turnouts and vegetative filter strips to decrease water velocity and sediment carrying capacity in ditches.
- For maintenance, grade materials to the center of the road and avoid removing the toe of the cutslope.
- Prevent disturbance to vulnerable slopes.
- Use topography to filter sediments; flat, vegetated areas are more effective sediment filters.
- Where possible, limit road access during wet periods when drainage features could be damaged.

8.5.4.1 Culverts

Although culverts were not part of the source assessment, they can be large sources of sediment, and should be included in the restoration strategy. A field survey should be conducted and combined with local knowledge to prioritize culverts for restoration. As culverts fail, they should be replaced with culverts that pass a 100 year flood on fish bearing streams and at least 25 year events on non fish bearing streams. Culverts should be installed at grade with the streambed, and inlets and outlets should be vegetated and armored. Some road crossings may not pose a feasible situation for size upgrades because of road bed configuration; in those circumstances, the largest size culvert feasible should be used.

Another consideration for culvert upgrades will be to provide fish passage. During the assessment and prioritization of culverts, additional crossings should be assessed for streams where fish passage is a concern. Each fish barrier should be assessed individually to determine if it functions as an invasive species and/or native species barrier. These two functions should be weighed against each other to determine if each culvert acting as a fish passage barrier should be mitigated. Montana FWP can aid in determining if a fish passage barrier should be mitigated, and, if so, they should be involved in culvert design. If funding is available, culverts should be prioritized and replaced prior to failure.

8.5.5 Bank Hardening/Riprap/Revetment/Floodplain Development

The use of riprap or other “hard” approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although it is necessary in some instances, it generally redirects channel energy and exacerbates erosion in other places. Bank armoring should be limited to areas with a demonstrated threat to infrastructure. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the upper bank, reduce stream scouring energy, and provide shading and cover habitat. Limit threats to infrastructure by reducing floodplain development through land use planning initiatives.

Bank stabilization using natural channel design techniques can provide both bank stability and habitat potential. The primary recommended structures include natural or “natural-like” structures, such as large woody debris jams. These natural arrays can be constructed to emulate historical debris assemblages that were introduced to the channel by the adjacent cottonwood dominated riparian community types. When used together, woody debris jams and straight log vanes can benefit the stream and fishery by improving bank stability, reducing bank erosion rates, adding protection to fillslopes and/or embankments, reducing near-bank shear stress, and enhancing aquatic habitat and lateral channel margin complexity.

8.5.6 Mining

Because restoration of metals sources that are not also associated with sediment are typically implemented under state and federal programs, this section will discuss general restoration programs and funding mechanisms that may be applicable to the metals sources instead of specific BMPs. The need for further characterization of impairment conditions and loading sources is addressed through the framework monitoring plan in **Section 9.0**. A number of state and federal regulatory programs have been developed over the years to address water quality problems stemming from historic mines, associated disturbances, and metal refining impacts. Some regulatory programs and approaches considered most applicable to the Flint Creek watershed include:

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- The State of Montana Mine Waste Cleanup Bureau’s Abandoned Mine Lands (AML) Reclamation Program
- The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA)

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA (a.k.a. Superfund) is a Federal law that addresses cleanup on sites, such as historic mining areas, where there has been a hazardous substance release or threat of release. Sites are prioritized on the National Priority List (NPL) using a hazard ranking system with significant focus on human health. Under CERCLA, the potentially responsible party or parties must pay for all remediation efforts based upon the application of a strict, joint and several liability approaches whereby any existing or historical land owner can be held liable for restoration costs. Where viable landowners are not available to fund cleanup, funding can be provided under Superfund authority. Federal agencies can be delegated Superfund authority, but cannot access funding from Superfund. Cleanup actions under CERCLA must be based on professionally developed plans and can be categorized as either Removal or Remedial.

Removal actions can be used to address the immediate need to stabilize or remove a threat where an emergency exists. Removal actions can also be non-time critical. Once removal activities are completed, a site can then undergo Remedial Actions or may end up being scored low enough from a risk perspective that it no longer qualifies to be on the NPL for Remedial Action. Under these conditions the site is released back to the state for a "no further action" determination. At this point there may still be a need for additional cleanup since there may still be significant environmental threats or impacts, although the threats or impacts are not significant enough to justify Remedial Action under CERCLA. Any remaining threats or impacts would tend to be associated with wildlife, aquatic life, or aesthetic impacts to the environment or aesthetic impacts to drinking water supplies versus threats or impacts to human health. A site could, therefore, still be a concern from a water quality restoration perspective, even after CERCLA removal activities have been completed.

Remedial actions may or may not be associated with or subsequent to removal activities. A remedial action involves cleanup efforts whereby Applicable or Relevant and Appropriate Requirements and Standards (ARARS), which include state water quality standards, are satisfied. Once ARARS are satisfied, then a site can receive a "no further action" determination.

Currently the EPA superfund program is conducting a site investigation near Philipsburg Montana in the Douglas Creek drainage. During 2011, a sampling effort was conducted to further characterize metals sources and threats to human life. Depending on the results and analysis, future removal actions or remediation actions may be pursued.

Montana Mine Waste Cleanup Bureau Abandoned Mine Reclamation Program (AML)

The Mine Waste Cleanup Bureau (MWCB), which is part of the DEQ Remediation Division, is responsible for reclamation of historical mining disturbances associated with abandoned mines in Montana. The MWCB abandoned mine reclamation program is funded through the Surface Mining Control and Reclamation Act of 1977 (SMCRA) with SMCRA funds distributed to states by the federal government. In order to be eligible for SMCRA funding, a site must have been mined or affected by mining processes, and abandoned or inadequately reclaimed, prior to August 3, 1977 for private lands, August 28, 1974 for Forest Service administered lands, and prior to 1980 for lands administered by the U.S. Bureau of Reclamation. Furthermore, there must be no party (owner, operator, other) who may be responsible for reclamation requirements, and the site must not be located within an area designated for remedial action under the federal Superfund program or certain other programs. Priority abandoned mines within the Flint Creek TPA are presented in **Table 8-1**. In addition to the priority abandoned mines cleanup, the Mine Waste Cleanup Bureau (MWCB) is also responsible for cleanup of Black Pine Mine area through a consent decree between ASARCO and the State of Montana.

Table 8-1 Priority Abandoned Mines in the Flint Creek Watershed

Site Name	Mining District	Primary Drainage	Secondary Drainage	Priority AM Rank
Trout	Philipsburg	Cliff Gulch	-	4
Bi-Metallic/Old Red	Philipsburg	Flint Creek	Douglas Creek	6
Scratch All	Philipsburg	Camp Creek	-	7
Granite Mountain	Philipsburg	Flint Creek	Douglas Creek	10
Algonquin	Philipsburg	Douglas Creek	Frost Creek	16
Douglas Creek	Philipsburg	Douglas Creek	-	17
True Fissure	Philipsburg	Douglas Creek	Camp Creek	20

Table 8-1 Priority Abandoned Mines in the Flint Creek Watershed

Site Name	Mining District	Primary Drainage	Secondary Drainage	Priority AM Rank
Little Gem	Philipsburg	Camp Creek	Cliff Gulch	31
Nonpareil	South Boulder	Flint Creek	Boulder Creek	32
Millers Mine	Frog Pond	Copper Creek	Lutz Creek	73
Port Royal Mill Tailings	South Boulder	Flint Creek	Royal Gold Creek/Boulder Creek	84
Sunrise/Queen Millsite	Combination	Flint Creek	Henderson Creek	110
Combination Mine		Flint Creek	S.F. Lower Willow Creek	
Wasa	Philipsburg	Douglas Creek	N.F. Douglas Creek	
Maxville Tailings/Londonderry	Philipsburg	Flint Creek	Boulder Creek	
Rumsey	Philipsburg	Flint Creek	Fred Burr Creek	
Wenger #2	Philipsburg	Camp Creek	Cliff Gulch	
Brooklyn	Philipsburg	Flint Creek	Boulder Creek	
Combination II	Combination	Flint Creek	S.F. Lower Willow Creek	

Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA)

Reclamation of historic mining-related disturbances administered by the State of Montana and not addressed under SMCRA, are typically addressed through the DEQ State Superfund or CECRA program. The CECRA program maintains a list of facilities potentially requiring response actions based on the confirmed release or substantial threat of a release of a hazardous or deleterious substance that may pose an imminent and substantial threat to public health, safety or welfare or the environment (ARM 17.55.108). Listed facilities are prioritized as maximum, high, medium, or low priority or in operation and maintenance status based on the potential threat posed. Currently, there are two sites on the CECRA priority list within the Flint Creek watershed; Granite Timber Co (near Philipsburg) and Sluice Gulch Leaking Mine Adit (near Philipsburg).

CECRA also encourages the implementation of voluntary cleanup activities under the Voluntary Cleanup and Redevelopment Act (VCRA), and the Controlled Allocation and Redevelopment Act (CALA). It is possible that any historic mining-related metals loading sources identified in the watershed in the future could be added to the CECRA list and addressed through CECRA, with or without the VCRA and/or CALA process. A site can be added to the CECRA list at DEQ’s initiative, or in response to a written request made by any person to the department containing the required information.

Other Programs

In addition to the programs discussed above, other funding may be available for water quality restoration activities. These sources include the following:

- Upper Clark Fork River Basin Grant Program (UCFRB)
- Resource Indemnity Trust/Reclamation and Development Grants Program (RIT/RDGP)
- EPA Section 319 Nonpoint Source Grant Program

UCFRB

The State of Montana was awarded monies through a series settlement agreements signed between 1999 and 2008 against the Atlantic Richfield Company (ARCO) as a result the extensive mining-related damages to natural resources within the Upper Clark Fork watershed. The Natural Resource Damage Program (NRDP), which is part of the Montana Department of Justice, filed the lawsuit and administers a grant process as a way to disperse the settlement funds. Government agencies and private entities/individuals are eligible for the grant funding, and UCFRB is a unique opportunity for remediation in the Upper Clark Fork TPA because funding must be applied within the Upper Clark Fork watershed.

Several types of projects are eligible for funding but those most applicable to TMDL implementation are *restoration projects* and *monitoring and research project*s. UCFRB is an annual program and has a slightly different application process for grants under $25,000 than for those over $25,000. Certain areas that are still being investigated as part of the Superfund sites are not eligible for funding.

RIT/RDGP

The RIT/RDGP is an annual program that can provide up to $300,000 to address environmental related issues. This money can be applied to sites included on the Mine Waste Cleanup Bureau's Abandoned Mine Lands (AML) priority list, but of low enough priority where cleanup under AML is uncertain. RIT/RDGP program funds can also be used for conducting site assessment/ characterization activities such as identifying specific sources of water quality impairment.

Section 319 funding

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 percent or more match requirement. RIT/RDGP and 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.

8.5.7 Metals WLAs

A phased implementation approach for reaching WLAs for metals is provided. The stormwater WLAs should be met after Black Pine Mine remediation process is complete.

Copper and lead WLAs for the city of Philipsburg shall follow the following phased approach:

1. The existing WWTP copper and lead loads represent less than ½ of a percent of the allowable copper and lead loads (i.e., less than ½ percent of the TMDL). The WWTP is not a significant source of copper or lead.
2. Impairment conditions only exist in the receiving water (Flint Creek) during high flow conditions. During lower and baseflow conditions, there is assimilative capacity and the WWTP discharge does not contribute to impairment.
3. The elevated copper and lead loads originate from root deterrent treatment, leaching from pipes and from infiltration of contaminated groundwater into the WWTP collection system.
4. The extent of achievable remediation is unknown within the upstream tributaries and within Flint Creek. Adaptive management, as it relates to future copper and lead target concentrations, could result in site specific standards or some other modification to the copper and/or lead targets. This type of modification would change the current basis for setting the WLA. Therefore, the final WWTP copper and lead treatment determinations should be based on a watershed – scale remediation plan that evaluates all contributing sources, natural background conditions, and achievable in-stream concentrations after implementing all reasonable remediation and restoration activities.

The Mercury WLA for the city of Philipsburg shall follow the following phased approach:

1. Collect and analyze ultra low detection limit mercury samples in coordination with DEQ in the effluent and upstream of the effluent.

2. Collaborate with DEQ to determine increased certainly associated with sampling indicates a mercury problem in the effluent or in Flint Creek.
3. Follow the phased approach for copper and lead WLAs provided in this section.

For the phased metals WLA implementation, the city of Philipsburg has 20 years to achieve the WLA at levels consistent with discharge flow times the TMDL target concentration. During that time period, the WLA is to be capped at existing load and the WWTP facility must provide quarterly water quality and flow data for Flint Creek above and below the WWTP discharge, with focus on ensuring that yearly high flow sampling is included.

The WLA can be modified prior to the end of the 20 year period if a comprehensive remediation plan is developed and implemented to create assimilative capacity (dilution) within Flint Creek and/or site-specific standards are adopted.

9.0 MONITORING STRATEGY AND ADAPTIVE MANAGEMENT

9.1 INTRODUCTION

The monitoring strategies discussed in this section are an important component of watershed restoration, a requirement of TMDL development under Montana's TMDL law, and the foundation of the adaptive management approach. Water quality targets and allocations presented in this document are based on available data at the time of analysis, however the scale of the watershed coupled with constraints on time and resources often result in compromises that must be made that include estimations, extrapolation, and a level of uncertainty. The margin of safety (MOS) is put in place to reflect some of this uncertainty, but other issues only become apparent when restoration strategies are underway. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities (whether TMDL targets are being met), if all significant sources have been identified, and whether attainment of TMDL targets is feasible. Data from long-term monitoring programs also provide technical justifications to modify restoration strategies, targets, or allocations where appropriate.

The monitoring strategy presented in this section provides a starting point for the development of more detailed and specific planning efforts regarding monitoring needs; it does not assign monitoring responsibility. Monitoring recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet aforementioned goals. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on stakeholder priorities for restoration and funding opportunities.

9.2 ADAPTIVE MANAGEMENT APPROACH

An adaptive management approach is recommended to control costs and meet the water quality standards to support all beneficial uses. This approach works in cooperation with the monitoring strategy, and as new information is collected, it allows for adjustments to restoration goals or pollutant targets, TMDLs, and/or allocations, as necessary.

9.3 FUTURE MONITORING GUIDANCE

The objectives for future monitoring in the Flint Creek watershed include: 1) strengthen the spatial understanding of sources for future restoration work, which will also strengthen source assessment analysis for future TMDL review, 2) gather additional data to supplement target analysis, better characterize existing conditions, and improve or refine assumptions made in TMDL development, 3) gather consistent information among agencies and watershed groups that is comparable to targets and allows for common threads in discussion and analysis, 4) expand the understanding of streams throughout the Flint Creek beyond those where TMDL have been developed and address issues if necessary, and 5) track restoration projects as they are implemented and assess their effectiveness.

9.3.1 Strengthening Source Assessment

In the Flint Creek TPA, the identification of sources was conducted largely through watershed field tours, aerial assessment, the incorporation of GIS information, available data and literature review, with limited field verification and on-the-ground analysis. In many cases, assumptions were made based on overall TPA conditions and extrapolated throughout the watershed. As a result, the level of detail often does not provide specific areas by which to focus restoration efforts, only broad source categories to reduce sediment loads from in each of the discussed subwatersheds. Strategies for strengthening source assessments for each of the pollutants may include:

Sediment
Field surveys of road and road crossing to identify specific contributing road crossings, their associated loads, and prioritize those road segments/crossings of most concern.

Review of land use practices specific to subwatersheds of concern to determine where the greatest potential for improvement and likelihood of sediment reduction can occur for the identified major land use categories.

More thorough examinations of bank erosion conditions and investigation of related contributing factors for each subwatershed of concern through site visits and subwatershed scale BEHI assessments. Additionally, the development of bank erosion retreat rates specific to the Flint Creek TPA would provide a more accurate quantification of sediment loading from bank erosion. Bank retreat rates can be determined by installing bank pins at different positions on the streambank at several transects across a range of landscapes and stability ratings. Bank erosion is documented after high flows and throughout the year for several years to capture retreat rates under a range of flow conditions.

Metals
Because of both limited data and the complexity of sources, many of the TMDL allocations to mining sources are combined into composite allocations. In watersheds with composite WLAs to unpermitted point sources and in watersheds with composite LAs to diffuse mining-related sources that also include some abandoned mines or mining wastes, follow up monitoring should focus on defining the contribution from abandoned mines and other discrete mining sources.

Although many of the mines in the DEQ and/or MBMG databases have been visited to determine the location and condition of abandoned mines, in most cases the load contribution from individual abandoned mines is not well known. Additionally, there may be discrete abandoned mine sources that are contributing to exceedances of metals targets that are not identified in either of the State databases. As additional information becomes available regarding contributions from abandoned mines, TMDLs may be modified via adaptive management to split composite WLAs into separate WLAs and/or to develop WLAs for discrete mining sources in watersheds dominated by nonpoint source loading that currently have a composite LA. Additionally, if certain sites are known to contribute a large portion of metals loads, a higher level of soil and water monitoring will almost always be needed to guide site specific cleanup plans.

Although there is well documented mercury contamination within the watershed, there is a level of uncertainty associated with the mercury TMDLs that should be strengthened. Lower level mercury analysis using clean sampling techniques should be conducted across the Flint Creek Watershed. This is especially stressed in respect to Philipsburg WWTP effluent and upper Flint Creek. The mercury data used to assess existing effluent conditions and upstream conditions is less certain than desirable. New data collection may prove Philipsburg is meeting their Mercury WLA.

9.3.2 Increase Available Data

While the Flint Creek watershed has been the recipient of significant remediation and restoration activities, data is still often limited depending on the stream and pollutant of interest. Infrequent sampling events at a small number of sampling sites may provide some indication of overall water quality and habitat condition, however regularly scheduled sampling at consistent locations, under a variety of seasonal conditions is the best way to assess overall stream health and monitor change.

Sediment

For sediment investigation in the Flint Creek, each of the streams of interest were stratified into unique reaches based on physical characteristics and anthropogenic influence. A total of 25 sites were sampled throughout the watershed, however this equates to only a small percentage of the total number of stratified reaches, and even less on a stream by stream basis. Sampling additional monitoring locations to represent some of the various reach categories that occur would provide additional data to assess existing conditions, and provide more specific information on a per stream basis as well as the TPA as a whole, by which to assess reach by reach comparisons and the potential influencing factors and resultant outcomes that exist throughout the watershed.

Metals

In general, Mercury TMDLs are based upon smaller data sets than other metals. Low level mercury sampling should occur in Flint Creek and all major tributaries to better define mercury sources and impairment conditions. Water chemistry mercury sampling should include a coordinated sampling of fish tissue.

9.3.3 Consistent Data Collection and Methodologies

Data has been collected throughout the Flint Creek watershed for many years and by many different agencies and entities, however the type and quality of information is often variable. Where ever possible, it is recommended that the type of data and methodologies used to collect and analyze the information be consistent so as to allow for comparison to TMDL targets and track progress toward meeting TMDL goals.

The Montana Department of Environmental Quality (DEQ) is the lead agency for developing and conducting impairment status monitoring. However, other agencies or entities may work closely with DEQ to provide compatible data if interest arises. Impairment determinations are conducted by the state but can use data collected from other sources. The information in this section provides general guidance for future impairment status monitoring and effectiveness tracking.

It is important to note that monitoring recommendations are based on TMDL related efforts to protect beneficial uses in a manner consistent with Montana's water quality standards. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws. For example, reclamation of a mining related source of metals under CERCLA and CECRA typically requires source-specific sampling requirements, which cannot be defined at this time, to determine the extent of and the risk posed by contamination, and to evaluate the success of specific remedial actions.

Sediment

Sediment and habitat assessment protocols consistent with DEQ field methodologies and that serve as the basis for sediment targets and assessment within this TMDL should be conducted whenever possible. Current protocols are identified within Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (Montana Department of Environmental Quality, 2010). It is acknowledged that various agencies and entities have differing objectives, as well as time and resources available to achieve those objectives. However, when possible, when collecting sediment and habitat data in the Flint Creek watershed it is recommended that at a minimum the following parameters be collected to allow for comparison to TMDL targets:

- Riffle Cross Section; using Rosgen methodology
- Riffle Pebble Count; using Wolman Pebble Count methodology
- Pool Assessment; Count and Residual Pool Depth Measurements
- Greenline Assessment; NRCS methodology

Additional information will undoubtedly be useful and assist DEQ with TMDL effectiveness monitoring in the future. Macroinvertebrate studies, McNeil core sediment samples, and fish population surveys and redd counts are examples of additional useful information used in impairment status monitoring and TMDL effectiveness monitoring which were not developed as targets but reviewed where available during the development of this TMDL.

Metals

Standards attainment monitoring should include analysis of a suite of total recoverable metals (e.g. As, Cu, Cd, Pb, Zn), sediment samples, hardness, pH, discharge and TSS for all pollutant-waterbody combinations. As a result of water and sediment data collected during TMDL development, TMDLs were developed for several metals that were not on the 2012 303(d) List, and TMDLs were not developed for some listed metals because recent data did not exceed water quality targets and/or anthropogenic sources were not identified. Based on the data evaluations within this document (**Section 6.0**), several metals have been identified as recommendations for future monitoring.

9.3.4 Effectiveness Monitoring for Restoration Activities

As restoration activities are implemented, watershed-scale monitoring may be valuable in determining if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort.

Due to the natural high variability in water quality conditions, trends in water quality are difficult to define and even more difficult to relate directly to restoration or other changes in management. Improvements in water quality or aquatic habitat from restoration activities will most likely be evident in fine sediment deposition and channel substrate embeddedness, changes in channel cumulative width/depths, improvements in bank stability and riparian habitat, increases in instream flow, and changes in communities and distribution of fish and other bio-indicators. Specific monitoring methods, priorities, and locations will depend heavily on the type of restoration projects implemented, landscape or other natural setting, the land use influences specific to potential monitoring sites, and budget and time constraints.

As restoration activities begin throughout the watershed, pre and post monitoring so as to understand the change that follows will be necessary to track the effectiveness of specific given practices or implementation projects. The following recommendations are categorized by the type of restoration practice to which they apply.

9.3.4.1 Road BMPs

Monitoring road sediment delivery is necessary to determine if BMPs are effective, to determine which are most effective, and to determine which practices or sites require modification to achieve water quality goals. Effectiveness monitoring should be initiated before implementing BMPs at treatment sites.

Monitoring actual sediment routing is difficult or prohibitively expensive. It is likely that budget constraints will influence the number of monitored sites. Once specific restoration projects are identified, a detailed monitoring study design should be developed. To overcome environmental variances, monitoring at specific locations should continue for a period of two to three years after BMPs are initiated.

Specific types of monitoring for separate issues and improvements are listed in **Table 9-1**.

Table 9-1. Monitoring Recommendations for Road BMPs

Road Issue from Section 8.0 (Restoration)	Restoration Recommendation	Monitoring Recommendation	Recommended Methodology
Ditch Relief Combined with Stream Crossings	Re-engineer & rebuild roads to completely disconnect stream sloped ditches from stream crossings. Techniques may include: • Ditch relief culverts • Rolling dips • Water Bars • Outsloped roads • Catch basins • Raised road grade near stream crossing	• Place silt trap directly upslope of tributary crossing to determine mass of sediment routed to that point. • Rapid inventory to document improvements and condition.	• Sediment yield monitoring based on existing literature/USFS methods. • Revised Washington Forest Practices Board methodology.
Ditch Relief Culverts	• Consider eliminating stream sloped ditches and outsloping the road or provide rolling dips. • When maintaining/ cleaning ditch, do not disturb toe of cutslope. • Install culverts with proper slope and angle following Montana road BMPs. • Armor culvert outlets. • Construct stable catch basins. • Vegetate cutslopes above ditch. • Increase vegetation or install slash filters. • Provide infiltration galleries where culvert outlets are near a stream.	• Rapid inventory to document improvements and condition. • Silt traps below any ditch relief culvert outlets close to stream.	• Revised Washington Forest Practices Board methodology. • Sediment yield monitoring based on existing literature/USFS methods.
Stream Crossings	• Place culverts at streambed grade and at base of road fill. • Armor and/or vegetate inlets and outlets. • Use proper length and diameter of culvert to allow for flood flows and to extend beyond road fill.	• Repeat road crossing inventory after implementation. • Fish passage and culvert condition inventory.	• Revised Washington Forest Practices Board methodology. • Montana State (DNRC) culvert inventory methods.

Table 9-1. Monitoring Recommendations for Road BMPs

Road Issue from Section 8.0 (Restoration)	Restoration Recommendation	Monitoring Recommendation	Recommended Methodology
Road Maintenance	• Avoid casting graded materials down the fillslope & grade soil to center of road, compact to re-crown. • Avoid removing toe of cutslope. • In some cases graded soil may have to be removed or road may have to be moved.	• Repeat road inventory after implementation. • Monitor streambed fine sediment (grid or McNeil core) and sediment routing to stream (silt traps) below specific problem areas.	• Revised Washington Forest Practices Board methodology. • Standard sediment monitoring methods in literature.
Oversteepened Slopes/ General Water Management	• Where possible outslope road and eliminate inboard ditch. • Place rolling dips and other water diverting techniques to improve drainage following Montana road BMPs. • Avoid other disturbance to road, such as poor maintenance practices and grazing.	• Rapid inventory to document improvements and condition.	• Revised Washington Forest Practices Board methodology.

9.3.4.2 Agricultural BMPs

Grazing BMPs reduce grazing pressure along streambanks, riparian and wetland areas. Implementing BMPs may improve water quality, create narrower channels and cleaner substrates, and result in recovery of streambank, riparian and wetland vegetation. Effectiveness monitoring for grazing BMPs should be conducted over several years, making sure to start monitoring before BMPs are implemented. If possible, monitoring reaches should be established in pastures keeping the same management as well as in those that have changed. Where grazing management includes moving livestock according to riparian use level guidelines, it is important to monitor changes within the growing season as well as over several years. Monitoring recommendations to determine seasonal and long-term changes resulting from implementing grazing BMPs are outlined below in **Table 9-2**.

Table 9-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern

Recovery Concern	Monitoring Recommendations	Methodology or Source
Seasonal impacts on riparian and wetland area and streambanks	• Seasonal monitoring during grazing season using riparian grazing use indicators. • Streambank alteration. • Riparian browse. • Riparian stubble height at bank and “key area”.	BDNF/BLM riparian standards (Bengeyfield and Svoboda, 1998)
Long-term riparian and wetland area recovery	• Photo points. • PFC/NRCS Riparian Assessment (every 5-10 yrs). • Vegetation Survey (transects perpendicular to stream and spanning immediate floodplain) every 5-10 years. • Strip transects- Daubenmire 20cm x 50cm grid or point line transects • Greenline.	(Harrelson et al., 1994; Bauer and Burton, 1993; United States Department of Agriculture, Natural Resources Conservation Service, 2001)

Table 9-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern

Recovery Concern	Monitoring Recommendations	Methodology or Source
Streambank stability	• Greenline including bare ground, bank stability, woody species regeneration (every 3-5 years)	Modified from Winward (2000)
Channel stability	• Cross-sectional area, with % fines/ embeddedness. • Channel cross-section survey. • Wolman pebble count. • Grid or McNeil core sample. • Bank Erosion Hazard Index.	(Harrelson et al., 1994; Rosgen, 1996)
Aquatic habitat condition	• Aquatic macroinvertebrate sampling. • Pool quality. • R1/R4 aquatic habitat survey. • Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments.	(Hankin and Reeves, 1988; Overton et al., 1997; Water Quality Planning Bureau, Montana Department of Environmental Quality, 2005; Montana Department of Environmental Quality, 2011)
General stream corridor condition	• EMAP/Riparian Assessment (every 5-10 yrs).	(Overton et al., 1997; United States Department of Agriculture, Natural Resources Conservation Service, 2001)

9.3.4.3 Reclamation in Areas Affected by Historic Mining Abandoned Mine Sites

Each reclamation site will have site-specific needs but general recommendations for abandoned mine site remediation effectiveness monitoring are outlined in **Table 9-3**.

Table 9-3. Effectiveness Monitoring Recommendations for Abandoned Mine Site Remediation

Parameter	Monitoring Recommendations
Water quality	Sample for heavy metals, pH, flow and TSS in water column at high and low flow above and below mine site. Collect sediment samples at low flow. Monitoring should be initiated prior to remediation efforts and continue for at least 10 years after site restoration. If possible, monitoring should include biomonitoring (i.e. periphyton and macroinvertebrates) at low flow every 5 years.
Vegetation re-establishment	Greenline survey every 5 years, including bank stability, shrub regeneration, and bare ground. Vegetation transects across floodplain for vegetation community structure and regeneration.

9.3.5 Watershed Wide Analyses

Recommendations for monitoring in the Flint Creek watershed should not be confined to only those streams addressed within this document. The water quality targets presented herein are applicable to all streams in the watershed, and the absence of a stream from the State’s 303(d) list does not necessarily imply a stream that fully supports all beneficial uses. Furthermore, as conditions change over time and land management evolves, consistent data collection methods throughout the watershed will allow resource professionals to identify problems as they occur, and to track improvements over time.

10.0 STAKEHOLDER AND PUBLIC PARTICIPATION

Public and stakeholder involvement is a component of TMDL planning efforts. Stakeholders, included the Granite Headwaters Watershed Group, the Granite Conservation District, the City of Philipsburg, Granite County, USDA Natural Resource Conservation Service, US Environmental Protection Agency, US Forest Service (Beaverhead-Deerlodge National Forest), Montana Fish, Wildlife, and Parks, Montana Department of Natural Resources, the Montana Department of Environmental Quality, as well as private landowners in the watershed. In addition, Technical Advisory Group meetings, and other outreach and education efforts conducted by the DEQ and Granite Headwaters Watershed Group provided opportunities to review and comment on technical documents. Stakeholder review drafts were provided throughout the process to several agency representatives, landowners, conservation district and government representatives, and representatives from conservation and watershed groups. Stakeholder comments, both verbal and written, were accepted and are addressed within the document.

An additional opportunity for public involvement is the public comment period. This public review period was initiated on February 17th, 2012 and extended to April 2nd, 2012. At a public meeting on March 7th in Philipsburg, MT, DEQ provided an overview of the TMDLs for sediment and metals in the Flint Creek Planning Area, made copies of the document available to the public, and solicited public input and comment on the plan. The announcement for that meeting was distributed among the Technical Advisory Group, and advertised in the following newspapers: the Anaconda Leader, The Philipsburg Mail, and The Montana Standard. This section includes DEQ's response to all official public comments received during the public comment period. This final document was updated, based on public input and comment.

10.1 RESPONSE TO PUBLIC COMMENTS

The formal public comment period for the Flint Creek Planning Area Sediment and Metals TMDLs and Framework Water Quality Improvement Plan extended from February 17th to April 2nd, 2012. One package of comments from various stakeholders as part of the Granite Headwaters Watershed Group was submitted to DEQ during the public comment period. Excerpts from the comment letter are provided below. Responses prepared by DEQ follow each of the individual comments and where applicable, the text of the Final document has been modified to address these comments. Original comment letters are held on file at the DEQ and may be viewed upon request.

Granite Headwaters Watershed Group

Comment #1
According to the Draft Plan a number of metal samples found "human health exceedances." The Draft Plan lists by creek the number of and rate of samples labeled as human health exceedances, and we enclose a table which attempts to summarize this information. We are concerned because the draft plan does not explain the significance of the exceedances. Presumably, a human health exceedance translates to human health hazard. We need DEQ's help to understand the nature of the hazard that the metal contamination poses. Also, our reading the Draft Plan indicates that the DEQ does not expect that either local landowners or county or city government would be responsible for cleanuip of the metals contamination caused by historic mining activities. What specific alternatives are available to fund and conduct the mine cleanups? Are they adequate to eliminate the human health hazard? How soon can clean up occur?

Response #1
Metals conditions in a number of streams within the Flint Creek Watershed are at levels that could potentially affect human health if they are used as a drinking water source. The magnitude, duration and frequency of the exceedances in the streams of interest would become a factor in risk management. The sampling for the TMDL project provides limited information to use for leveraging future risk based studies and cleanup based on more detailed study. Also, the magnitude, duration and frequency of exposure (drinking water) would be a major consideration in determining health risk. There is a health risk of using stream water at some locations in the watershed as drinking water sources in locations below mining, milling or waste rock areas. Arsenic and mercury are the predominant pollutants with human health effects found in the Flint Creek Watershed.

Montana's human health standards do consider risk of health problems based on toxicity studies. They are developed using guidance from the EPA which includes:

- National Recommended Water Quality Criteria (NRWQC) [1] developed under Section 304(a) of the CWA; and
- Drinking Water Lifetime Health Advisory (HA) and Maximum Contaminant Levels (MCL) developed under the Safe Drinking WaterAct.[2]

TMDL plans do not explore detailed risk management or comprehensive assessment of cleanup costs. Other environmental restoration programs are intended to investigate more detailed risk and cost management considerations as they collect more thorough and focused environmental data. **Section 8.5.6** identifies primary government agencies that usually deal with mining cleanup. The DEQ TMDL program advises concerned stakeholders to engage the primary programs that administer mine cleanup activities within Montana for collaboration and funding alternatives.

[1] See http://www.epa.gov/waterscience/criteria/wqctable/ .
[2] See http://www.epa.gov/waterscience/criteria/drinking/ .

Comment #2
Executive Summary - 6th paragraph, 1st sentence states that sediment was identified as impairing "industrial" beneficial uses in both segments of Flint Creek. Tables ES-1 and 3.1 show upper Flint Creek as fully supporting industrial uses. Which is correct?

Response #2
Tables ES-1 and 3.1 have the correct listing information. The description in the 6th paragraph of the executive summary has been corrected. It should be noted that because of when the draft report was written, the listing history associated with this document was based on the 2010 Water Quality Integrated Report. Subsequently, there have been changes to the Integrated Report impaired use categories. Aquatic life and Cold Water Fish have been combined as a single "Aquatic Life" category; and Industrial Use no longer appears as an impaired cause because it has been determined that Industrial Use is the least sensitive of the uses and is addressed when dealing with the other beneficial uses. The Final document has been corrected to reference the 2012 Integrated Report.

Comment #3
Page 2-3 to 2-4: Streamflow:

1) *Why not include information on streamflow conditions during the period when data for TMDL was collected (2007-2009). Peak flows for the station at Southern Cross in those years were 168*

cfs (June 10, 2007), 192 cfs (June 15, 2008 and highest recorded peak flow for period of record), and 127 cfs (May 19, 2009). Including a hydrograph from 2005 does not seem particularly useful.

2) *Include some explanation about why the hydrograph at Southern Cross shows sustained high discharge levels in the spring.*
3) *Regarding streamflow in general, were the years the water-quality data was collected normal in terms of streamflow? Wouldn't that be useful information to summarize?*

Response #3

1. Streamflow information was adjusted to include more recent data from 2007-2011 for those gages where data exists. Hydrographs have been updated to include these years and narrative summaries were edited where appropriate.
2. Discussion related to hydrograph trends and observations has been expanded to provide additional discussion that may relate to watershed conditions and response.
3. Discussion in **Section 2.1.3** has been edited where appropriate, however it should be noted that **Section 2.0** is intended to provide a general overview of the character of the watershed. Specifics related to the collected data used in analysis, and events that may have an influence on those results occur in context of the discussions of individual waterbody-pollutant combinations in **Sections 5.0** and **6.0**.

Comment #4

Page 2-5: Groundwater Quality:

1) *First Paragraph: The MBMG groundwater study in the Flint Creek TPA (part of Region 5, Upper Clark Fork River Basin) has been published and is available. It would be useful to reference that report and the link to the web site where report is available for download.*
2) *3rd paragraph: Why not provide a brief summary of the groundwater quality? The Flint Creek TMDL technical advisory committee had questions about whether the groundwater has similar metals issues as the surface water.*

Response #4

The MBMG GWIC database was downloaded and used to inform the metals TMDL project. While the groundwater conditions varied greatly according to localized landuse and geology, the groundwater data was not that useful for informing the metals TMDLs. Additionally, the groundwater data was not usually located near mining areas and therefore didn't help inform how groundwater may be affected by mining activities. This is likely because the sampled wells are mostly drinking sources that would not be located in areas likely contaminated with metals. The groundwater report or GWIC data will likely be cited in the nutrient TMDL efforts in the Flint Creek Watershed.

Comment #5

Page 2-6: Geology

1) *1st paragraph: Summary statement at end of paragraph is incorrect. Both extension and compression contributed to the complex folds and faults in the Flint Creek Range. Recognition of the Anaconda Core Complex was key to understanding that extension, in addition to compression, was important structural history of the area.*
2) *2nd paragraph: Sapphire Block is a term this is still used, but since it extends beyond the boundary of the Philipsburg 30' x 60' map, the term western structural block was used by Lonn and others (2003), for this particular map.*
3) *Basin Sediments: The map by Portner and Hendrix (2005) referenced in the first paragraph is a detailed map of the surficial deposits for part of the lower Flint Creek valley. Also, geology*

section mentions the "boulder debris-flow (Beaty, 1961) just north of the canyon mouth". Identify which canyon (Boulder Creek).

Response #5
DEQ revised this section of the TMDL document to address the comment.

Comment #6
Page 5-4: Relevant Local and Regional Reference Data

1) *It is unclear how the reference data was used in developing the TMDL's. Are there maps that show where USFS reference sites are located?*

Response #6
Appendices C & **D** provide a good description of how DEQ uses reference data. **Section 5.3.4** has been clarified to reference these appendices, better describe what data was used for reference development, and a map was included to identify these locations of reference data.

Comment #7
Page 5-11: Section 5.4.3.3

1) *3rd sentence: States residual pool depths are slightly below target values and pool numbers are considerably beneath the target of >103. Table 5-3 doesn't list any targets as ">103".*
2) *5th sentence: States… "width/depth value for this reach is well above the target of >20. Should that be <20?*

Response #7

1. The appropriate target value for pool numbers for this site, as listed in **Table 5-3**, is ≥70. The text has been corrected in **Section 5.4.3.3** to reflect that value.
2. The appropriate target value for width/depth ratio for this site, as listed in **Table 5-3**, is ≤20. Thank you for highlighting these errors.

Comment #8
Page 5-12: Section 5.4.3.3

1) *2nd full sentence: Regarding FLIN 11-01, states "Percent fines results in each of the three categories are slightly exceeding target values…". According to table 5-8, FLIN 11-01 meets targets for Percent fines < 6mm (Wolman Pebble Count).*
2) *Table 5-9. For FLIN 06-01, for Large Wood #/mile, 438 is in bold (exceedence) yet the target is >250 based on bankfull width of 23.1 feet. It appears to meet the target unless 438 is incorrect.*
3) *In the field notes summary for FLIN 06-01, it states that bank vegetation was primarily non-native grasses and weeds. The observation seems to contradict the amount of large wood listed in Table 5-9.*

Response #8

1. The document text has been corrected to note that percent fines results are slightly exceeding target values in two of the three categories, and slightly below the target for percent fines <6mm as measured via Wolman pebble count.
2. 438 pieces of large wood/mile is the correct value for FLIN 06-01. The correct target value for this site, due to the site's bankfull width of 23.1 feet, is >250. Table 5-9 has been edited to reflect compliance with the target and the text edited accordingly.

3. The statement that bank vegetation was primarily non-native grasses and weeds does seem to contradict both the large wood present at the site, and the Greenline Shrub percent value of 97. However, in review of the site notes, data, and photos, the near bank vegetation (the vegetation that would have significant influence on bank stability through this reach) does appear to be largely composed of less desired, non-native, and weak stabilizing vegetation. The presence of shrubs throughout the reach does exist, but the high percentage witnessed in the greenline value may be in part due to the shrub canopy extending into the area where measurements are being taken, while the trunk of the plants occur somewhat off the bank, hence allowing non-native and grasses to populate the immediate bank areas. This site occurs in an area of significant disturbance and heavy recreational use and non-native weeds and grasses are common in these types of environments. The large wood numbers are surprising given this environment however given the disturbance and instability at the site, it is not surprising that some of the riparian shrubs and trees through this corridor may be more prone to recruitment during larger flow events. In addition, the large wood found at a site may not necessarily be indicative of large wood from the immediate area. FLIN 06-01 occurs at the downstream end of a long, steep section of the stream and wood from upstream areas may be transported to this reach where it accumulates as the gradient lessens and stream power is reduced.

Comment #9

Page 5-24: Section 5.5.1.6 Assumptions and Considerations, First Bullet

1) *Please explain how the geology of NW Wyoming is similar in character to that in the Flint Creek TPA. Be more specific. Northwest Wyoming is a big area, and a large part of the area is dominated by the volcanic rock in Yellowstone which is not similar to major rock types underlying the Flint Creek watershed.*

Response #9

1. The streambank erosion rating curves used in the Flint Creek TPA actually used the Rosgen rating curves based on Colorado USDA Forest Service data for streams found in sedimentary and/or metamorphic geology; the reference of the BEHI studies in northwest Wyoming was in error (although that dataset has been used in previous TMDLs for streams influenced by alpine glaciations and/or areas of volcanism). There are not many rating curves available to represent broad geologic settings, and no sediment rating curves were available to our knowledge specific to the Flint Creek TPA at the time this document was developed. Although Colorado is certainly geographically distant from the Flint Creek TPA, the sedimentary and/or metamorphic geology the Colorado dataset represents is, in a broad sense, appropriate given the predominance of sedimentary and metamorphic geology found in the Flint Creek TPA. These rating curves provide a general estimation of loading rates for the given BEHI Index value and Near-Bank Stress combinations that were encountered in the bank erosion analysis, and subsequently provide a way to estimate sediment loads from bank erosion throughout the watershed. It should be reiterated that the sediment loads derived from eroding banks in this analysis are estimations and should not be taken as an exact quantification of the sediment loads, particularly when extrapolated to the watershed scale; however, the percent reductions that are estimated and provided as part of the TMDL and allocations are considered reasonable expectations given our current information.

Comment #10

Section 6.0 Metals TMDLs Components

1) *A general comment regarding the data presented in this section. It is difficult to get a clear idea of where the areas of greatest concern are located. The tables for each reach give general summary statistics, but all sites along the reach are combined in the table making it difficult to understand what is happening upstream and downstream of the reach. Why not include the water quality data on a map for each site, including the actual measured concentrations and stream flow. It would then be possible to determine what parts of the specific reaches are most impacted.*
2) *It would also be helpful to present more of the metals data as graphs, showing the range of concentrations for each site and including a line showing target values. This would make it easier to prioritize sites-those with a few exceedences just slightly above a target would presumably be lower priority than those greatly exceeding targets.*

Response #10

Thank you for your comment. It is difficult to distill all of the information compiled in a TMDL document into a concise and informative presentation that provides technical details, as well as common language and easily understood messages for a broad range in audience. We will try to keep your comment at the forefront of our minds as we complete TMDL documents in the future.

Comment #11

Page 8-1: Section 8-2

1) *MBMG is another agency that can also provide technical assistance, especially on geology and groundwater resources.*

Response #11

MBMG has been added to the list of potential resources for technical assistance.

Comment #12

Appendix B

1) *The maps included in Appendix A are hard to read. It would be helpful if more landmarks were identified. For example, on the Metals Sampling Location maps, labeling the drainages and some of the side drainages would make it easier to determine where samples were collected.*

Response #12

Thank you for your comment. It is difficult to distill all of the information compiled in a TMDL document for such a large area into a map that is too detailed because the maps become very busy. The TMDL program at DEQ will consider this comment for future TMDL projects.

Comment #13

Appendix D

1) *Page D-4, paragraph above table D-1. There is a statement about similar width to depth targets in prior TMDLs dealing with similarly sized streams (e.g. Prospect Creek, St Regis Creek) as justification for the <28 target for Flint Creek. What specifically is meant by "similarly sized"? Same length? Same flow? This seems a weak justification. Is geology, slope, landuse, etc also similar? Provide data that explains more specifically how they are similar.*
2) *Page D-6, Percent fines in Riffles <6mm section: This section talks about the target being <14, but then also states that <15% is protective of beneficial uses. Is 15% a typo?*
3) *Page D-9, Pool Frequency: The justification for a pool frequency target of 70 for bankfull width 20-39 appears to be based on assumptions rather than science. If the median value is 32, a value*

> *of 70 is not "somewhat higher". It is higher than any number reported in the table (D-7) for a reach of that width, including the 26 PIBO reaches (11 of which were reference reaches). Further justification for the target value is that the numbers may be skewed lower than expected by the limited number of reaches evaluated. Maybe the two reaches with 79 and 100 pools per miles are outliers. If the limited number of reaches evaluated is a problem, why isn't it a problem for the >40 width, where only six reaches were measured?*

Response #13

1) The basis for comparison between these streams is that they are categorized as western Montana streams with stream order size of larger 4th order or smaller 5th order. Bankfull width (in feet) at the sites reviewed for these streams ranges from mid 40s to low 100s depending on the stream, location, and local influences, but the general expected bankfull widths for the sites investigated is around 60 feet. These similarities factor into the width/depth target determination. Specific information regarding the compared watersheds is as follows: Prospect Creek has a mean annual daily discharge of 233 cfs and a drainage area of 182 mi^2; St. Regis has a mean annual daily discharge of 539 cfs and a drainage area of 303 mi^2; and Flint Creek has mean annual daily discharge of 135 cfs and a drainage area of 490 mi^2 (however some of this drainage area is controlled by Georgetown Lake and Upper Willow Creek Dam). There are some differences in the watersheds and their hydrologic regimes, but using the expected bankfull widths as a guide for comparison allows for relationships to be made. Best professional judgment and experience in the field, along with the factors above, suggests that a width/depth target of <28 is appropriate for these types of systems.
2) The text was corrected to state <14% is protective of beneficial uses.
3) When developing targets for the various parameters, statistics based on data collected from good methods and sampling design is a major factor in setting values, however best professional judgment based on years of experience is also incorporated to arrive at a value that, with limited data, seems appropriate for a given site.

   Both experience and available data tell us that typically, as streams increase in size, the number of pools encountered for a given length will decrease. The pools themselves will increase in size and depth, but often, the features that influence these pools (boulders, large wood, meander bends, etc) are less frequent or not large enough to create definable pools (pools being defined as a feature that has a max depth 1.5 times the pool tail crest depth).

   In this case, the PIBO data served as our primary reference for developing appropriate targets. However, because of differences in how pools were counted (PIBO only counts pools greater than 1/2 the wetted width, where as DEQ counts all pools but categorizes them as small: <1/2 wetted width, or large: > 1/2 wetted width) some interpretation must be used rather than a straight analysis of the numbers. The differences between PIBO and DEQ methods suggest that DEQ target values (which count all pools), will be higher than the values of the PIBO data for a given size class.

   The PIBO median value for all the <20 feet bankfull width streams used in this report is 78. The median for the DEQ reaches <20 feet bankfull is 95. Because it is expected that the DEQ numbers would be naturally higher than the PIBO number given the methods used, the target for pools was set at >95. This value is also the median of the DEQ data, of which 10 sites of varying degrees of impact were assessed (therefore making the median a reasonable value to investigate).

The PIBO median value for the 20-39 feet bankfull width streams used in this report is 52. It is expected that under desired conditions the DEQ numbers would be higher as they include both small and large pools, whereas PIBO only includes large pools. A target value of 70 was chosen as a result. In this case, the DEQ data was reviewed, and of the 7 sites that constituted the 20-39 feet bankfull width category, 6 were found to be largely influenced by human influences, and therefore the DEQ dataset was of little value to develop a target to represent a desired condition. The target incorporated best professional judgment that factored in the target value for the <20 feet, and the median of the PIBO data.

For the >40 feet bankfull width category, there were no PIBO sites to reference. The DEQ data was again limited in the number of sites (6); however review of the sites suggested they were not quite as skewed as the 20-39 feet toward the direction of disturbed or highly influenced sites. Therefore, it was expected that an appropriate target value would be above the median of the DEQ data (32), and review of the other target values suggested that 50 pools per mile for streams >40 feet bankfull width may be appropriate. The resulting target values for pools per mile considers the decrease in pool numbers as stream size increases, and used PIBO data as a reference point to help discern what would be expected under desired conditions for the various size classes.

It should be noted here as well, that the strength in the target values is dependent on the available data and resources, and are used to represent desired and achievable conditions. Target values may be revised over time as better information becomes available. The development of target values, and other elements of the TMDL, are greatly improved with discussion and input from other stakeholders and resource professionals who may hold additional data or experience to inform the TMDL development results. The DEQ appreciates the comments received as part of the public review process, but also encourages these discussions to occur throughout the process whenever possible.

Comment #14

2.1.2 Climate

1) *It is not clear why climate summary did not take into account data past 2005.*

Response #14

The watershed characterization report that served as the major reference material for **Section 2.0** was completed in 2005. Generally speaking, the watershed characterizations are often completed at the beginning or in advance of TMDL project development to help the planners and stakeholders put the watershed into context with its environment. These reports are used to provide a broad picture of the general conditions and potential influences that have shaped the watershed over time, and less a description of the specific episodic events. However, due to the watershed characterization being completed well ahead of the completion of this document, DEQ has reviewed some of these sections and updated them to include more recent information. The climate summary has been updated to include information through 2011.

Comment #15

2.1.4 Geology and Soils

1) *Soils – first paragraph, last sentence (page 2-8): "No values greater than 0.4 are mapped in the TPA", this statement is not accurate, there are soils with K factors of 0.43 along Flint Creek (K of*

0.43 is the highest in the watershed). According to the NRCS Physical Soil Properties report for Granite County there are no soils with a K factor of 0.0. However, there are surface layers that have not been evaluated with K factors. NRCS only assigned K factors for soils, a duff/litter layer under a forest/deciduous canopy is not considered a soil but that does not mean it will not erode. Also, a rock outcrop is not a soil so no K factor was assigned.

2) *There is no explanation how K factors (soil erodibility factor) were derived other than in Attachment B 2.1.2 (page 6) where it states "Soils data were summarized and interpolated to 10m (meter?) grid format." What was used, most limiting or most abundant?*

Response #15

1) The soil K-factors are based on the USGS Water Resources Division data set of hydrology-relevant soil attributes (Schwartz and Alexander, 1995), based on the USDA Natural Resource Conservation Service (NRCS) STATSGO soil data base. The soil units in the mapping effort described in **Section 2.1.4** are grouped into ranges to present general soil erodibility conditions at the watershed scale. These ranges and the subsequent presentation in **Figure A-9** does not suggest that there are soils with a K-factor of 0.0, only that the low range is from 0.0-0.2. Furthermore, there may be soils with a K-factor of 0.43 in the Flint that were not mapped because they represent a small percentage of the watershed and may not be discernible given the scale of the map. These areas are undoubtedly captured in the 0.3-0.4 range.
2) Soil erodibility is based on soil type, porosity, and slope among other factors. For specific information on how K-factors are developed see documentation on the Universal Soil Loss Equation (USLE) K-factor from Wischeier and Smith, 1979. For the USLE model used in the Flint Creek analysis, the K-factors were obtained from the NRCS Soil Survey Geographic Database (SSURGO), which is the most detailed level of soil data developed by the National Cooperative Soil Survey. **Figure 2-2** in **Attachment B** presents a range of values from 0.0 – 0.43.

Comment #16

5.5.3 Upland Sediment (page 5-29 to page 5-32)

1) *The Upland Sediment results: particularly Table 5-23 (page 5-31), Attachment B Table 2-1 (page 12), Attachment B Figure 2-4 (page 13), Attachment B Table 3-1 (page 19-22), and Attachment B Table 3-2 (page 23) are significantly flawed. – The acres attributed to "Land Use Type – Cultivated Crops" cannot be substantiated by field investigation, local knowledge, or available data sources. The Philipsburg USDA – NRCS estimated between 1,100 to 1,500 acres of annual crops being tilled in the Flint Creek watershed during 2011. Interviews with local small grain producers estimated a maximum, during any one year, of 2,000 acres of tilled crops in the watershed. Montana 2011 Agricultural Statistics (Issn: 1095-7278, Volume XLVIII, October 2011) for Granite County (Flint Creek watershed and Rock Creek watershed) for small grains estimated 1,200 acres for 2009 and 600 acres for 2010. The Land Use Type – Cultivated Crops acres used for the Universal Soil Loss Equation (USLE) totaled 16,662 acres (Attachment B Table 2-1). After reviewing Attachment B Figure 2-4, a substantial number of these acres may be irrigated meadows that are subsequently hayed and have not been tilled-up in the last 50 years.*
2) *An extreme example can be found in the data from Trout Creek (Attachment B Table 3-1 page 22) where 2,064 acres are attributed to Land Use Type – Cultivated Crops. The subsequent Existing Condition Load (Tons/Year) results from USLE are 1033 tons/year. There are no cultivated annual crops in the Trout Creek sub-watershed.*
3) *Areas denoted as "Land Use Type – Shrub/Scrub" have a similar validation problem as discussed with Cultivated Crops. These areas may have woody species less than 5 meters tall but they also have groundcover of native range species.*

4) *All sediment loads appear to be modeled, no empirical data was found in the document. Without some sampling data to corroborate the USLE model data and the Cultivated Crops classification where no such land exists severely compromises Attachment B – Flint Creek Watershed Sediment Assessment as a valid document.*

Response #16

1) and 2) The USLE model used for the Flint Creek upland sediment load estimations used the 2001 National Land Cover Dataset (NLCD). The 2001 NLCD is a widely used and well respected source of information for determining land cover types at the watershed scale. "The NLCD serves as the definitive Landsat-based, 30-meter resolution, land cover database for the Nation. NLCD provides spatial reference and descriptive data for characteristics of the land surface such as thematic class (for example, urban, agriculture, and forest), percent impervious surface, and percent tree canopy cover. NLCD supports a wide variety of Federal, State, local, and nongovernmental applications that seek to assess ecosystem status and health, understand the spatial patterns of biodiversity, predict effects of climate change, and develop land management policy. NLCD products are created by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of Federal agencies led by the U.S. Geological Survey." (USGS website http://pubs.usgs.gov/fs/2012/3020/) However, because it is based on 2001 land cover, comparisons between 2011 acreage may not be entirely appropriate (although it is presumed that most land cover types in the Flint Creek watershed have changed little over the last decade). It should be noted that the USGS recently released a 2006 version of the NLCD but that was unavailable at the time this assessment took place.

However, your comment regarding the significant discrepancy between locally understood Cultivated Crop acreage and those reported in the 2001 NLCD does bring up a concern regarding the proper delineation of this land cover type in the Flint watershed. In this instance, the land cover type in question is that categorized as Cultivated Crops, which is defined as "Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled." Based on your comment, you suggested the Cultivated Crop category acres used in the model, in actuality, is more likely irrigated hay meadows.

In your review, you cited the Montana 2011 Agricultural Statistics report to illustrate the discrepancy between the USLE numbers and the local knowledge of land cover in the Flint watershed. This was a prudent and informative comparison, however because the NLCD is based on 2001 information the DEQ first reviewed the 2001 edition of the Montana Agricultural Report. For Granite County, in the category of All Crops: Irrigated and Non-irrigated, Harvested Acres 1999-2000, it listed 33,000 irrigated harvested acres, and 2,000 non-irrigated harvested acres in 1999; and 26,700 irrigated harvested acres, and 6,500 non-irrigated harvested acres in 2000. This is a total of 35,000 Crop acres in 1999, and 33,200 in 2000. In the Montana Agricultural report, crops in this category are defined as "wheat, barley, oats, sugar beets, potatoes, and hay". The 2001 NLCD acreage for Cultivated Crops in the Flint watershed was delineated as 16,662 acres. However, when combined with the NLCD land cover category of Pasture/Hay, the total acreage is 31,895.

Further review of the Montana 2001 Agricultural Statistics report, for the category "All Hay", presents a total of 34,000 acres for Granite County. These numbers support your estimates of very low acres of cultivated crop production in comparison to land used for hay production in the Flint watershed. Review of more recent years shows some slight change in Hay acreage but still, very little cultivated crop acreage throughout the Flint Creek watershed.

In light of this information, it was decided to revisit the model numbers and essentially reclassify all land use from Cultivated Crops to Pasture/Hay. NLCD defines Pasture/Hay as “Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle.” Time and resource constraints did not allow for a complete re-run of the model itself; however we were able to use some basic computations to reasonably represent this modification. For each watershed, the load per acre rate from the Pasture/Hay land cover class was applied to all Cultivated Crop land cover acres, thereby effectively treating Cultivated Crops as Pasture/Hay and calculating an appropriate load. The same was done for the load per acre rates after BMP application. The new loads were then tallied and the additional percent reductions from riparian improvements were applied to provide the equivalent scenario loads.

Although this method does not account for any true Cultivated Crops that may exist, it is presumed that because the acres of Cultivated Crops are apparently so low, the difference is negligible. While these modifications do have some effect on the sediment loads from upland erosion in each of the watersheds, interestingly, because the relative BMP associated percent reductions are similar between Cultivated Crop and Pasture/Hay land categories, the overall percent reduction of sediment in each watershed was affected by 0-2%, depending on the watershed; and 1% for the Flint watershed as a whole.

Tables in **Section 5.5.3** have been updated with the new values and all TMDLs have been edited to reflect the changes to upland sediment loads. In addition, an errata page has been included with **Attachment B** to describe this modification and details the changes to the report.

3) Shrub/Scrub land cover category is defined as “Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation cover. This class includes tree shrubs, young trees in an early successional stage or trees stunted from environmental conditions.” This definition does not preclude the existence of native range species as a percentage of the groundcover within this land classification, nor does the definition exclude land cover that may otherwise colloquially be defined as ‘range’. Although the 2001 NLCD appears to have had issues differentiating Cultivated Crop and Pasture/Hay in the Flint Creek watershed, that does not invalidate other land cover delineations.

4) All upland sediment loads for the Flint Creek watershed were modeled using methods and data sources which are widely used by many natural resource agencies and environmental consultants. These methods are heavily peer reviewed and vetted and are commonly regarded as reasonable approaches to estimate sediment loads in watersheds of this scale. The collection of empirical data to corroborate actual sediment loads from specific land use categories would be nice to have, but given the time and resource constraints available to the Department, this was infeasible. In the development of the USLE model for the Flint Creek watershed, experts on the USLE model from the USDA NRCS in Montana were consulted to help define the C-factors (vegetative cover) used to best represent the various land use covers, and vegetative cover changes that may occur after BMP implementation. Apart from the apparent misclassification between Cultivated Crop and Pasture/Hay acreage, there is good confidence that the other land cover classes are reasonably estimated, and the associated sediment loading rates are appropriate.

This comment and the subsequent research and edits made to correct this issue, illustrate an important part of the TMDL development process. The inclusion of a stakeholder group and technical advisory committee is a component of every TMDL project the Montana DEQ undertakes. This process allows for an exchange of information, and review of data sources and assessment methods, by those who are most invested in the watershed, and those who have the most knowledge regarding the watershed's details. Unfortunately, the participation and involvement from individuals within the watershed are a function of their availability and interest. In this case, the USLE modeling report was available to the stakeholder and technical advisory group in the Flint Creek watershed for over a year before the Flint Creek TMDL Public Review draft report was published. It is understood that many people are very busy with their own work and their personal lives, however ultimately it is review and collaboration from those within the watershed that will determine whether or not the TMDL will be successful. In this case, we are very grateful for the legitimate concerns brought up through this comment, and glad that we had the opportunity to address and correct this issue before the document became final. The DEQ encourages all stakeholders to bring this kind of scrutiny and analytical expertise into the process as early as possible in future TMDLs.

Comment #17

8.4.1 Sediment Restoration Approach (page 8-2)

1) *2nd sentence states: "Native streamside riparian vegetation provides root mass which hold streambanks together." --- Comment: There are also non-native species which are adequate substitutions for native species.*

Response #17

It may be true that some non-native species may have properties that could substitute for a specific function of a native plant, however the Montana DEQ strongly encourages the use of native species whenever possible. Good quality riparian and wetland systems, especially at lower elevations around the state, are becoming increasingly rare due to the displacement of overstory and understory plant communities by non-native species. Some species, such as Russian olive and tamarix, may affect water availability, displace native vegetation, and can be detrimental to other ecosystem processes. Some non-native herbaceous species, such as reed canary grass, orchard grass, smooth brome, and others greatly decrease species diversity in the understory. Native shrubs, sedges, and other species are also often better at bank stabilization than introduced species because the native plants have evolved and adapted to the specific environments and associated complex conditions where they are found. As such, native plants play a significant role not only in bank stabilization, but in the overall ecology of a watershed as well. In addition to sediment stabilization properties, native plants provide diversity of food and structural cover for wildlife. While a given non-native plant may be suitable for bank stabilization due to its dense rooting structure, there are many other factors that should be considered to understand how that plant will respond in a non-native environment; and even then, the response is not always predictable. Because the goal of a TMDL is not simply the reduction of a pollutant, but the eventual achievement of all state standards within a watershed, the use of native plants to restore natural function, and ecological diversity and stability should be pursued whenever possible.

Comment #18

It was clear to me that there was concern about what remediation is mandated, and what is voluntary. And some of the presentation [at the TMDL document Public Meeting] seemed to say that what is voluntary now, may become mandatory later. More information about this would be good. There is a lot of good science here I am sure, but most of those gathered are looking for "what corner does this back me into, or might it back me into in the future?"

The crude way I might handle it if I did not care about losing my job, getting sued or possibly worse, as I understood it, would be:

Ag people, you get a pass. The analysis can show the effect of possible voluntary actions on your part, but nobody is going to make you do anything. You might get subsidies, grants or incentives if you choose to do something, but that is your choice.

Private land owners in general, you get a pass. See Ag people.

Point sources, mainly Philipsburg, this may very well be used to set your discharge limits for future permits.

State and federal land managers, not clear what if anything this will require.

If my statements are inaccurate, then that is feedback on how the message came across. I would like to see crystal clear statements about the above, and if it is not possible to be clear and unambiguous, a succinct statement of the sources of uncertainty.

Response #18

Your statements provide a reasonable and “to the point” summary of the messages conveyed at the meeting, and the overall influence that TMDLs may have in a given watershed.

The TMDL will directly affect permitted dischargers; i.e. the Philipsburg wastewater treatment plant. State law requires that TMDLs be incorporated when developing permit limits.

Some agencies, such as USFS or NRCS, may be obligated to include TMDL considerations into their resource management plans, however would not be required to impose those considerations on private landowners.

Private landowners, including “ag people”, are required to comply with any state and federal laws that may be applicable to them and their operations, but the TMDL does NOT impose new regulations or force individuals to engage in actions to meet TMDL allocations. The TMDL provides information that may help guide an individual to improve conditions on their property, which could eventually result in the achievement of TMDLs, but there is NO increased legal obligation to do so. It is true that having TMDLs completed in a watershed may help provide leverage for programs or financial incentives to implement projects on your property that align with TMDL goals, but that is dependent on the project and the programs available in a given year.

During the presentation, the question was raised about whether TMDL requirements will become mandatory for private landowners and sources of nonpoint pollution in the future. As years pass, and politics change, and opinions and information shape the world we live in, we cannot say undeniably that things that are voluntary now, may not be mandatory later (or vice versa). However, it can be said that the development of TMDLs has been a federal requirement since the passing of the Clean Water Act in 1972. And since that time, literally thousands of TMDLs have been developed throughout the United States, and hundreds in Montana alone. The voluntary nature of TMDL implementation for nonpoint sources has not changed in that time, nor have there been any viable efforts or discussions to make TMDL implementation mandatory for private landowners contributing to nonpoint source pollution. So, to answer the question of "what corner does this back me into", the answer is none now, and none in the foreseeable future.

Comment #19

Arsenic in Douglas Creek. Need to drill down on this. Where is it coming from, and how can it be reduced to an acceptable limit, and again, what is going to be mandatory and what is voluntary regarding work on public and private land required to clean this up.

Response #19

Your statement is appropriate as Arsenic in Douglas Creek near Philipsburg likely creates one of the highest human health concerns in the watershed. Most of the arsenic is derived from the granite drain and other mine waste areas near Douglas Creek. USEPA is assessing the metal sources and conditions within Douglas Creek watershed through the Superfund Technical Assessment and Response Team 3 in Region 8. Preliminary results are available from the Federal Superfund Program. As of now, there is no mandatory cleanup because none of the sources are NPDES permitted in the Douglas Creek Watershed.

Comment #20

General Comment: Lead with A) what is out of bounds; start with the biggest things from the perspective of the common person (like Arsenic!) and B) what needs to happen to bring it under control. The business of how you did the tests and how the limits were established is essential to the document, and be prepared to answer questions about, but it is not the reason why people came to the meeting. What is wrong, and how can it be fixed. That is your story; it should get the front page.

Response #20

Thank you for your comment. It is difficult to distill all of the information compiled in a TMDL document into a concise and informative presentation that provides technical details, as well as common language and easily understood messages for those non-technical members of the audience. DEQ agrees though, that the most basic point to convey is simply what the problem is, and what can be done to fix it. We will try to keep your comment at the forefront of our minds as we conduct more public meetings in the future.

Comment #21

We believe that the flow information to calculate the wasteload allocations (WLA) listed in tables 6-34 and 6-35 for Philipsburg wastewater treatment system (WLApberg) are low. The flow information that was used is from the effluent discharge at the wastewater lagoons. This measuring device is a parshall (sic) flume that is read twice a day each day of the work week and is not necessarily an accurate representation of the total flow that occurs throughout the day. Also the flume is old and the measurements are taken manually which may induce further error. The Town of Philipsburg has since installed a continuous measuring flume on the outfall line from Town (influent flow) and that information is transmitted to a computer at the town shop for record gathering and archiving. Due to the information that we have gathered from this, we feel that the flows you have used for you example calculations are low. When the final calculations are made by you or permitting; the flow data from the continuous measuring flume or a new flow meter at the proposed wastewater treatment plant should be used to ensure accuracy.

Response #21

Thanks for this information. Since these are only examples and DEQ does not have a very robust set of new, more accurate discharge measures, the TMDL WLA examples will not be changed in the document.

However, during future permit renewal efforts the effluent limits should be based upon the most reliable and up to date information.

Comment #22
The statement found in 6.5.3.9, "Actual TMDLs and allocations are variable equations presented in Section 6.5.1 and 6.5.2 are dependent upon streamflow and water quality conditions. Table 6-34 provides example metals TMDLs and load allocations for the upper Flint Creek, calculated based on flows and metals concentrations measured at the downstream end of the segment. The Philipsburg WLA examples are based upon end of pipe concentrations that would meet human health or chronic aquatic life standards end of pipe." should be reiterated in the Lower Flint Creek TMDL section 6.5.3.10 for clarification and understanding that these calculations are only examples. Also in the headers for 6-34 and 6-35 the word ***summary*** *should be replaced with* ***examples****.*

Response #22
The suggested language was added to the final document.

Comment #23
We would like to see the Mercury TMDLs and wasteload allocations implemented as a phased approach after a combined monitoring effort is completed by the Town of Philipsburg and the Montana Department of Environmental Quality. This is due to the high test results found because of lab testing minimum detection limits that are high, and because of questions of how the tests were taken.

Response #23
DEQ will provide a phased implementation approach for meeting the Philipsburg's mercury WLA. The phases will include: 1. Further characterizing mercury levels in the effluent and stream. 2. Identifying a strategy to reduce mercury in the effluent, if needed. 3. Implementing mercury reduction if necessary.

Comment #24
We would like to mention that there are background metals found in our drinking water (copper, lead, arsenic), that meet the drinking water standards but will not meet the limits set in the TMDLs. We are wondering why these metals don't get pulled out of the town's wasteload allocation and get put into the naturally occurring wasteload allocations.

Response #24
Philipsburg's drinking water source has very low metals concentrations. Lead and copper are leaching from the supply system pipes, being introduced as root killer or infiltrating into the collection system from groundwater. These sources are not naturally occurring and can be reduced using conventional mitigation approaches.

Comment #25
The last comment that we would like to make is that the limits for metals, whether from the TMDLs program, or the permitting program, could be very hard to meet, and very expensive for a community the size of Philipsburg. One has to question if the cost is worth the good we can do to clean up Flint Creek when we are such a small part of the problem.

Response #25
DEQ understands that most of the metals load comes from historic mining operations. DEQ also estimates that Philipsburg contributes less than 1% of total metals loads to Flint Creek. Yet, the NPDES

and MPDES systems are implemented to protect against dischargers from contributing to toxicity to aquatic life and humans. Therefore it doesn't allow for a permittee to discharge above standards if there is no assimilative capacity. Also, EPA policy does not allow for WLAs in TMDLs to be more lenient unless there is a firm plan about how unregulated sources will be remediated to achieve assimilative capacity for the WLAs.

Alternatively, DEQ will provide a phased implementation approach for meeting the Philipsburg's copper and lead WLAs. The phases will include:

1. No increases in lead or copper concentrations above current levels for up to 20 years or until abandoned mining sources are remediated and can meet standards upstream of the effluent.
2. If all reasonable remediation occurs upstream and standards are not met in Upper Flint Creek, DEQ will assess if site specific standards are needed and may assess further reductions can be reasonably expected from the Philipsburg WLA at that time.
3. If reasonable remediation occurs upstream and assimilative capacity is provided, the WLA will be revised to reflect assimilative capacity.

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