APPENDIX C - 2009 SEDIMENT AND HABITAT ASSESSMENT

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ACRONYMS

Acronym	Definition
BEHI	Bank Erosion Hazard Index
BMP	Best Management Practices
DEQ	Department of Environmental Quality (Montana)
GIS	Geographic Information System
LWD	Large Woody Debris
MR	Middle Rockies
NAIP	National Agricultural Imagery Program
NBS	Near Bank Stress
NHD	National Hydrography Data(set)
RSI	Riffle Stability Index
SWAT	Soil & Water Assessment Tool
TMDL	Total Maximum Daily Load
TPA	Trading Partner Agreement
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WARSSS	Watershed Assessment of River Stability and Sediment Supply

C1.0 INTRODUCTION

This appendix is derived from a report prepared by Atkins (formerly PBS&J) (2010) for the Montana Department of Environmental Quality (DEQ). In 2009, DEQ initiated an effort to collect data to support the development of sediment TMDLs for streams within the Little Blackfoot TPA. The data collection effort involved assessing sediment and habitat conditions within the Little Blackfoot River watershed, as these conditions influence aquatic life beneficial uses. The data collection effort included stream stratification, sampling design, ground surveys, and sediment and habitat analyses, and is intended to assist DEQ in evaluating the impairment status of streams in the Little Blackfoot TPA and for developing TMDLs where necessary.

Within the Little Blackfoot TPA, Dog Creek, Telegraph Creek, Snowshoe Creek, Spotted Dog Creek and the Little Blackfoot River are listed as impaired due to sediment on the 2010 303(d) List. In addition, Elliston Creek and Threemile Creek are listed for alterations in stream-side or littoral vegetative covers, which is commonly a sediment-related impairment. Trout Creek is also included in this assessment based on stakeholder concerns and existing data indicating sediment impairments may be present.

A detailed sediment and habitat assessment of streams in the Little Blackfoot TPA was conducted to facilitate development of sediment TMDLs. During this assessment, streams were first analyzed in GIS using color aerial imagery and broken into similar reaches based on landscape characteristics. Following the aerial assessment reach stratification process, field data was collected at 19 monitoring sites during July of 2009. Field data collected during this effort was then used to quantify the existing condition of streams within the Little Blackfoot TPA and to estimate sediment loads from eroding streambanks to facilitate the development of sediment TMDLs. Although annual streambank load estimates are included in this assessment, only the percent reductions and percentage of natural versus human-induced erosion will be used for TMDL development in the Little Blackfoot TPA because actual load estimates are from the SWAT model (see **Appendix D**).

The three main components of this project are presented in the following sections: aerial assessment reach stratification, sediment and habitat assessment, and streambank erosion assessment.

C2.0 AERIAL ASSESSMENT REACH STRATIFICATION

C2.1 METHODS

An aerial assessment of streams in the Little Blackfoot TPA was conducted using National Agricultural Imagery Program (NAIP) color imagery from 2005 in GIS along with other relevant data layers, including the National Hydrography Dataset (NHD) 1:100,000 stream layer and United States Geological Survey 1:24,000 Topographic Quadrangle Digital Raster Graphics. GIS data layers were used to stratify streams into distinct reaches based on landscape and land-use factors following techniques described in *Watershed Stratification Methodology for TMDL Sediment and Habitat Investigations* (Montana Department of Environmental Quality, 2008).

The reach stratification methodology involves breaking a water body **stream segment** into **stream reaches** and **sub-reaches**. Montana DEQ tracks stream health by stream segment, which may encompass the entire stream or just a portion of the stream. Each of the stream segments in the Little

Blackfoot TPA was initially divided into distinct reaches based on four landscape factors: ecoregion, valley gradient, Strahler stream order, and valley confinement. Stream reaches classified by these four criteria were then further divided into sub-reaches based on the surrounding vegetation and land-use characteristics, including predominant vegetation type, adjacent land-use, riparian health, anthropogenic influences on streambank erosion, level of development, and the presence of anthropogenic (human) activity within 100 feet of the stream channel. This resulted in a series of stream reaches and sub-reaches delineated based on landscape and land-use factors which were compiled into an Aerial Assessment Database for the Little Blackfoot TPA.

C2.1.1 Reach Types

The aerial assessment reach stratification process involved dividing each stream segment into distinct reaches based on four landscape factors: ecoregion, valley gradient, Strahler stream order, and valley confinement. Each individual combination of the four landscape factors is referred to as a "**reach type**" in this report based on the following definition:

Reach Type -Unique combination of ecoregion, gradient, Strahler stream order and confinement

Reach types were described using the following naming convention based on the reach type identifiers presented in **Table C2-1**:

Level III Ecoregion – Valley Gradient – Strahler Stream Order – Confinement

Table C2-1. Reach Type Identifiers.

Landscape Factor	Stratification Category	Reach Type Identifier
Level III Ecoregion	Middle Rockies	MR
Valley Gradient	0-<2%	0
	2-<4%	2
	4-<10%	4
	>10%	10
Strahler Stream Order	first order	1
	second order	2
	third order	3
	fourth order	4
Confinement	unconfined	U
	confined	C

Thus, a stream reach identified as MR-0-3-U is a low gradient (0-<2%), 3rd order, unconfined stream in the Middle Rockies Level III ecoregion.

C2.2 Results

A total of 129 reaches were delineated during the aerial assessment reach stratification process covering 121.6 miles of stream in the Little Blackfoot TPA (**Table C2-2**). Based on the level III ecoregion, there were a total of 19 distinct reach types delineated in the Little Blackfoot TPA and field data was collect in nine of these reach types (**Table C2-3**). A map of monitoring site locations is in **Figure 5-1** of the main document.

Table C2-2. Aerial Assessment Stream Segments.

Waterbody Segment	Number of Reaches	Number of Reaches and Sub-Reaches	Length (Miles)
Dog Creek	13	48	16.6
Elliston Creek	11	19	4.8
Little Blackfoot River, upstream of Dog Creek	25	50	21.5
Little Blackfoot River, downstream of Dog Creek	5	30	26.1
Snowshoe Creek	18	24	10.7
Spotted Dog Creek	12	23	11.1
Telegraph Creek	10	15	6.0
Threemile Creek	18	33	13.3
Trout Creek	17	38	11.5

C3.0 Sediment and Habitat Assessment

C3.1 Methods

Sediment and habitat data was collected following the approach described in *Longitudinal Field Methods for the Assessment of TMDL Sediment and Habitat Impairments* (Montana Department of Environmental Quality, 2007). Field monitoring sites were typically selected in relatively low-gradient portions of the study streams where sediment deposition is likely to occur. Other considerations in selecting field monitoring sites included representativeness of the reach to other reaches of the same slope, order, confinement and ecoregion, the extent of anthropogenic impacts relative to other reaches, and ease of access, as outlined in *Little Blackfoot River TMDL Planning Area Sediment Monitoring Sampling and Analysis Plan (Montana Department of Environmental Quality, 2009)*.

Sediment and habitat assessments were performed at 19 field monitoring sites, which were selected based on the aerial assessment in GIS and on-the-ground reconnaissance. Sediment and habitat data was collected within nine reach types (**Table C3-1**, **Figures C3-1** and **C3-2**). Monitoring sites were assessed progressing upstream and the length of the monitoring site was based on the bankfull channel width. A monitoring site length of 500 feet was used at four sites in which the bankfull width was less than 10 feet and a monitoring site length of 1,000 feet was used at 11 sites in which the bankfull width was between 10 feet and 50 feet. A monitoring site length of 2000 feet was used a four sites in which the bankfull width was greater than 50 feet. Each monitoring site was divided into five equally sized study cells in which a series of sediment and habitat measurements were performed. Study cells were numbered 1 through 5 progressing in an upstream direction. The following sections provide brief descriptions of the field methodologies employed during this assessment. A more in-depth description is available in *Longitudinal Field Methods for the Assessment of TMDL Sediment and Habitat Impairments* (Montana Department of Environmental Quality, 2007).

Table C3-1. Reach Types and Monitoring Sites.

Reach Type	Number of Reaches	Number of Monitoring Sites	Monitoring Sites
MR-0-1-U	1		
MR-0-2-C	2		
MR-0-2-U	28	2	SNOW18-05, TROU17-04
MR-0-3-C	4		
MR-0-3-U	33	4	DOG11-09, SPOT12-02, TELE10-02, THRE17-01
MR-0-4-U	34	3	DOG12-04, DOG13-03, LBR24-03
MR-0-5-U	30	3	LBR26-06, LBR27-06, LBR30-05
MR-10-1-C	7		
MR-10-1-U	14		
MR-2-1-U	5		
MR-2-2-C	8	2	ELLI08-01, ELLI08-02
MR-2-2-U	45	2	SPOT01-01, TROU15-01
MR-2-3-C	1		
MR-2-3-U	11	1	THRE16-01
MR-4-1-C	7		
MR-4-1-U	21	1	SNOW08-01
MR-4-2-C	9		
MR-4-2-U	10		
MR-4-3-U	5	1	TELE04-01

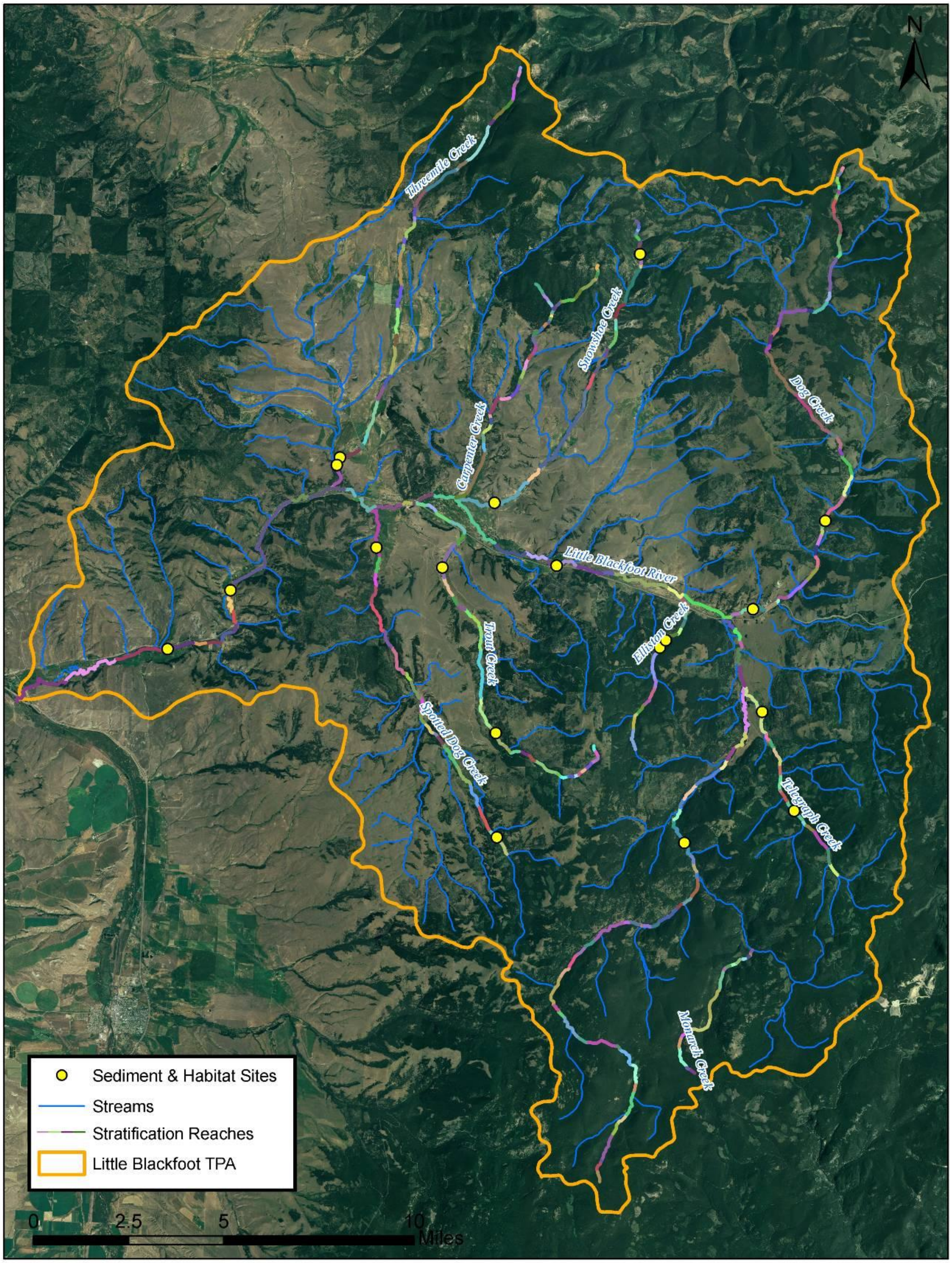


Figure C3-1. Aerial Assessment Reach Stratification.

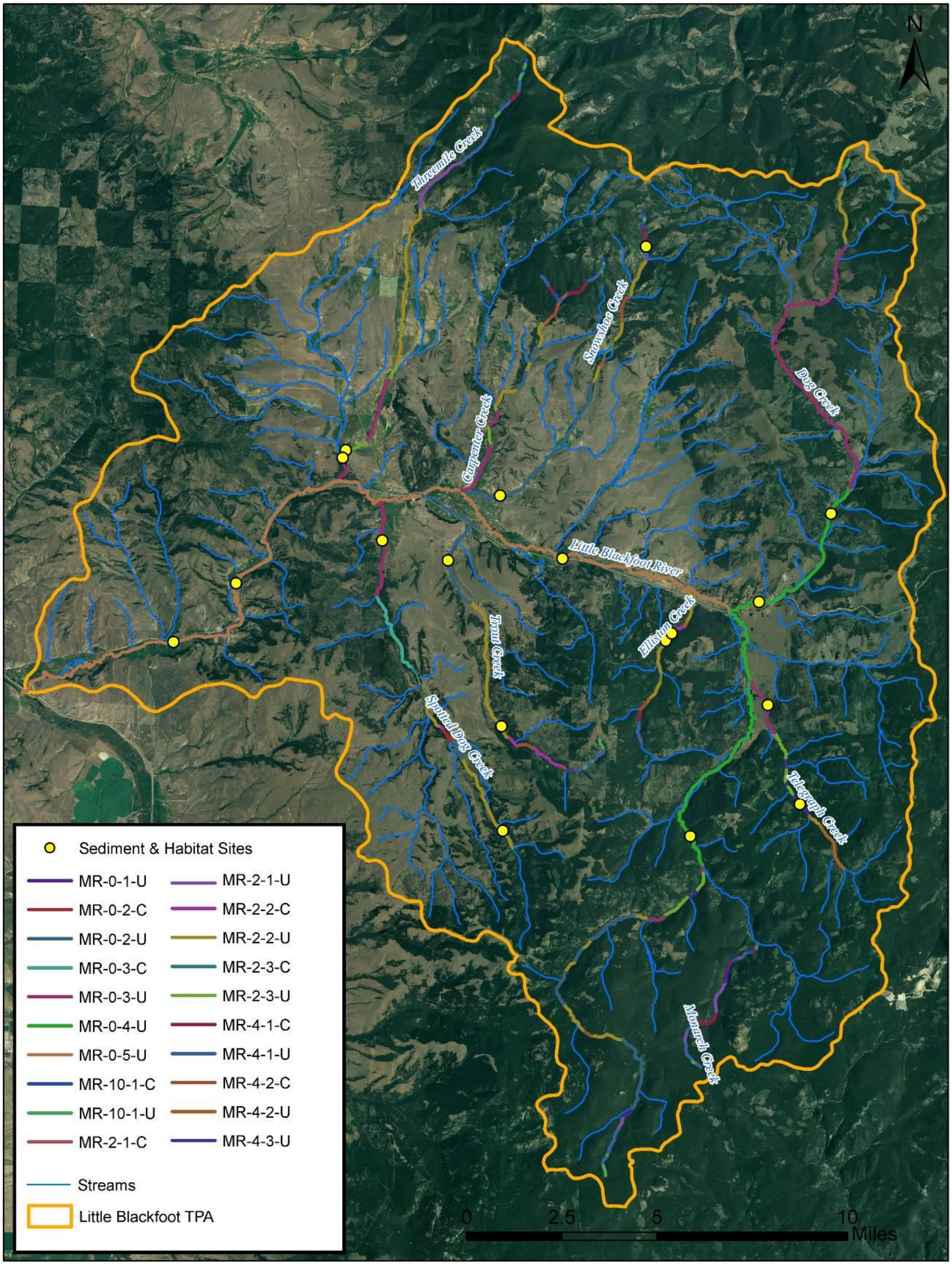


Figure C3-2. Distribution of Reach Types.

C3.1.1 Channel Form and Stability Measurements

Channel form and stability measurements include the field determination of bankfull, channel cross-sections, floodprone width, and surface water slope.

C3.1.1.1 Field Determination of Bankfull

The bankfull elevation was determined for each monitoring site. Bankfull is a concept used by hydrologists to define a regularly occurring channel-forming high flow. One of the first generally accepted definitions of bankfull was provided by Dunne and Leopold (1978):

> "The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels."

Indicators that were used to estimate the bankfull elevation included scour lines, changes in vegetation types, tops of point bars, changes in slope, changes in particle size and distribution, staining of rocks, and inundation features. Multiple locations and bankfull indicators were examined at each site to determine the bankfull elevation, which was then applied during channel cross-section measurements.

C3.1.1.2 Channel Cross-sections

Channel cross-section measurements were performed at the first riffle in each cell using a line level and a measuring rod. At each cross-section, depth measurements at bankfull were performed across the channel at regular intervals, which varied depending on channel width. The thalweg depth was recorded at the deepest point of the channel independent of the regularly spaced intervals.

C3.1.1.3 Floodprone Width Measurements

The floodprone elevation was determined by multiplying the maximum depth value by two (Rosgen, 1996). The floodprone width was then measured by stringing a tape from the bankfull channel margin on both the right and left banks until the tape (pulled tight and "flat") touched the ground at the floodprone elevation. When dense vegetation or other features prevented a direct line of tape from being strung, the floodprone width was estimated by pacing or making a visual estimate.

C3.1.1.4 Water Surface Slope

Water surface slope measurements were estimated using a clinometer. This measurement was used to evaluate the slope assigned in GIS based on the aerial assessment. The field measured slope was used when evaluating the Rosgen stream type at each monitoring site.

C3.1.2 Fine Sediment Measurements

Fine sediment measurements include the riffle pebble count, riffle grid toss, pool tail-out grid toss, and the riffle stability index.

C3.1.2.1 Riffle Pebble Count

One Wolman pebble count (Wolman, 1954) was performed at the first riffle encountered in cells 1, 3 and 5, providing a minimum of 300 particles measured within each assessment reach. Particle sizes were measured along their intermediate length axis (b-axis) and results were grouped into size categories. The pebble count was performed from bankfull to bankfull using the "heel to toe" method.

C3.1.2.2 Riffle Grid Toss

The riffle grid toss was performed at the same location as the pebble count measurement. The riffle grid toss measures fine sediment accumulation on the surface of the streambed. Grid tosses were performed prior to the pebble count to avoid disturbances to surface fine sediments.

C3.1.2.3 Pool Tail-out Grid Toss

A measurement of the percent of fine sediment in pool tail-outs was taken using the grid toss method at each pool in which potential spawning gravels were identified. Three measurements were taken in each pool with appropriate sized spawning gravels using a 49-point grid. The spawning potential was recorded as “Yes” (Y) or “Questionable” (Q). No grid toss measurements were made when the substrate was observed to be too large to support spawning. Grid toss measurements were performed when the substrate was observed to be too fine to support spawning since the goal of this assessment is to quantify fine sediment accumulation in spawning areas.

C3.1.2.4 Riffle Stability Index

In streams that had well-developed point bars, a Riffle Stability Index (RSI) evaluation was performed. For streams in which well-developed point bars were present, a total of three RSI measurements were conducted, which consisted of intermediate axis (b-axis) measurements of 15 particles determined to be among the largest size group of recently deposited particles that occur on over 10% of the point bar. During post-field data processing, the riffle stability index was determined by calculating the geometric mean of the dominant bar particle size measurements and comparing the result to the cumulative particle distribution from the riffle pebble count in an adjacent or nearby riffle.

C3.1.3 Instream Habitat Measurements

Instream habitat measurements include channel bed morphology, residual pool depth, pool habitat quality and woody debris quantification.

C3.1.3.1 Channel Bed Morphology

The length of each monitoring site occupied by pools and riffles was recorded progressing in an upstream direction. The upstream and downstream stations of “dominant” riffle and pool features were recorded. Features were considered “dominant” when occupying over 50% of the bankfull channel width.

C3.1.3.2 Residual Pool Depth

At each pool encountered, the maximum depth and the depth of the pool tail crest at its deepest point was measured. The difference between the maximum depth and the tail crest depth is considered the residual pool depth. No pool tail crest depth was recorded for dammed pools.

C3.1.3.3 Pool Habitat Quality

Qualitative assessments of each pool feature were undertaken, including pool type, size, formative feature, and cover type, along with the depth of any undercut banks associated with the pool. The total number of pools was also quantified.

C3.1.3.4 Woody Debris Quantification
The amount of large woody debris (LWD) within each monitoring site was recorded. Large pieces of woody debris located within the bankfull channel that were relatively stable so as to influence the channel form were counted as either single, aggregate or "willow bunch". A single piece of large woody debris was counted when it was greater than 9 feet long or spanned two-thirds of the wetted stream width, and 4 inches in diameter at the small end (Overton, et al., 1997).

C3.1.4 Riparian Health Measurements
Riparian health measurements include the riparian greenline assessment.

C3.1.4.1 Riparian Greenline Assessment
Along each monitoring site, an assessment of riparian vegetation cover was performed. Vegetation types were recorded at 10 to 20-foot intervals, depending on the bankfull channel width. The riparian greenline assessment described the general vegetation community type of the groundcover, understory and overstory on both banks. At 50-foot intervals, the riparian buffer width was estimated on either side of the channel. The riparian buffer width corresponds to the belt of vegetation buffering the stream from adjacent land uses.

C3.2 Results

In the Little Blackfoot TPA, sediment and habitat parameters were assessed in July of 2009 at 19 monitoring sites. Out of the 19 reach types delineated in GIS, sediment and habitat assessments were performed in nine reach types, with a focus on low gradient reach types. A statistical analysis of the sediment and habitat data is presented by reach type and for individual monitoring sites in the following sections. The complete sediment and habitat dataset is presented in **Attachment A**.

C3.2.1 Reach Type Analysis
This section presents a statistical analysis of sediment and habitat base parameters for each of the reach types assessed in the Little Blackfoot TPA. For this assessment, stream reaches were grouped by stream order and bankfull channel width into the following groups:

- MR-0-2-U and MR-2-2-U
- MR-0-3-U and MR-2-3-U
- MR-0-4-U
- MR-0-5-U
- MR-2-2-C and MR-4-1-U
- MR-4-3-U

Reach type discussions are based on median values, while summary statistics for the minimum, 25th percentile, 75th percentile and maximum values are also provided since these may be more applicable for developing sediment TMDL criteria. Sediment and habitat base parameter analysis is provided by reach type for the following parameters:

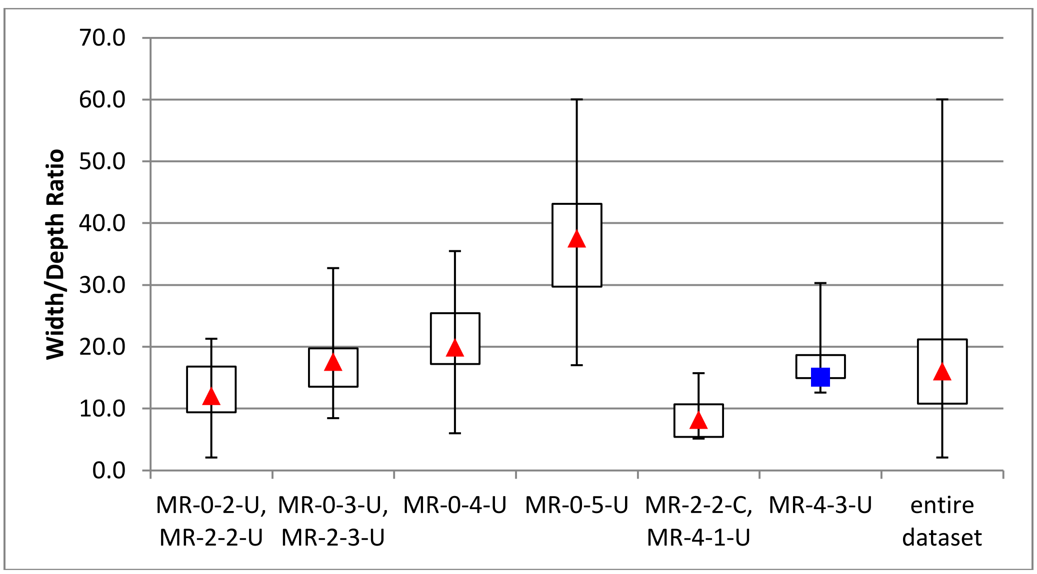
- width/depth ratio
- entrenchment ratio
- riffle pebble count <2mm
- riffle pebble count <6mm
- riffle grid-toss <6mm

- pool tail-out grid toss <6mm
- residual pool depth
- pool frequency
- LWD frequency
- greenline understory shrub cover
- greenline bare ground

C3.2.1.1 Width/Depth Ratio

The channel width/depth ratio is defined as the channel width at bankfull height divided by the mean bankfull depth (Rosgen, 1996). The channel width/depth ratio is one of several standard measurements used to classify stream channels, making it a useful variable for comparing conditions between reaches with the same stream type (Rosgen, 1996). A comparison of observed and expected width/depth ratios is also a useful indicator of channel over-widening and aggradation, which are often linked to excess streambank erosion and/or sediment inputs from sources upstream of the study reach. Channels that are over-widened are often associated with excess sediment deposition and streambank erosion, contain shallower and warmer water, and provide fewer deepwater habitat refugia for fish.

Median width/depth ratios for assessed reach types ranged from 8.2 in MR-2-2-C/MR-4-1-U to 37.6 in MR-0-5-U (**Figure C3-3, Table C3-2**). In the Little Blackfoot TPA, the width/depth ratio tends to increase as stream order increases.



Reach types with only one monitoring site denoted in blue square. Reach types with greater than one monitoring site denoted in red arrow.

Figure C3-3. Width/Depth Ratio.

Table C3-2. Width/Depth Ratio.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	**MR-0-3-U, MR-2-3-U**	**MR-0-4-U**	**MR-0-5-U**	**MR-2-2-C, MR-4-1-U**	**MR-4-3-U**	**entire dataset**
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	15	18	15	11	13	5	77
Minimum	2.1	8.5	6.0	17.1	5.2	12.6	2.1

Table C3-2. Width/Depth Ratio.

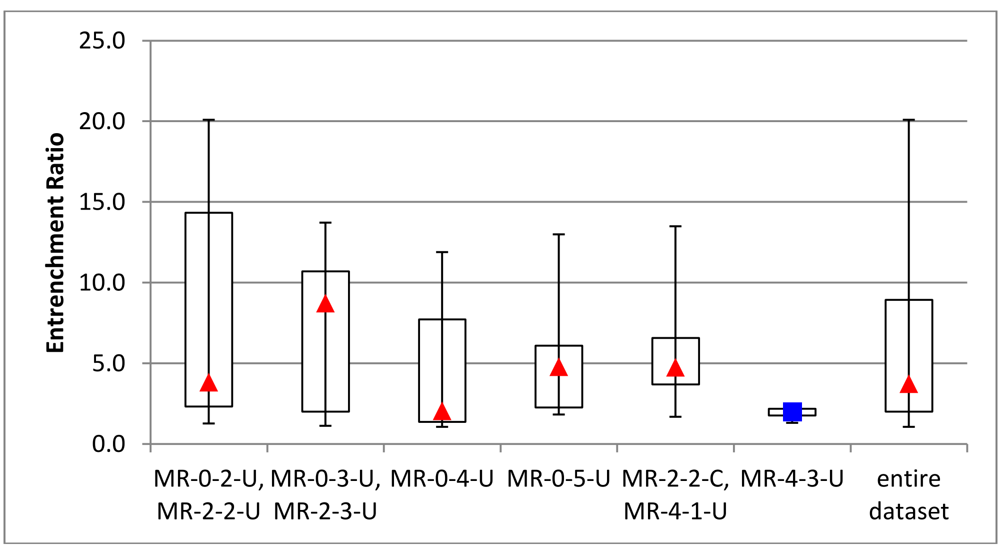
Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
25th Percentile	9.4	13.6	17.2	29.8	5.4	15.0	10.8
Median	12.1	17.6	20.0	37.6	8.2	15.1	16.1
75th Percentile	16.8	19.7	25.4	43.1	10.7	18.6	21.2
Maximum	21.3	32.8	35.5	60.1	15.8	30.3	60.1
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.2 Entrenchment Ratio

A stream's entrenchment ratio is equal to the floodprone width divided by the bankfull width (Rosgen, 1996). The entrenchment ratio is used to help determine if a stream shows departure from its natural stream type and is an indicator of stream incision that describes how easily a stream can access its floodplain. Streams can become incised due to detrimental land management activities or may be naturally incised due to landscape characteristics. A stream that is overly entrenched generally is more prone to streambank erosion due to greater energy exerted on the banks during flood events. Greater scouring energy along incised channels results in higher sediment loads derived from eroding banks. If the stream is not actively degrading (down-cutting), the sources of human caused incision may be historical in nature, though sediment loading may continue to occur. The entrenchment ratio is an important measure of channel conditions since it relates to sediment loading and habitat condition.

The median entrenchment ratio for assessed reach types ranged from 2.0 in MR-4-3-U to 8.7 in MR-0-3-U/MR-2-3-U (**Figure C3-4, Table C3-3**).



Reach types with only one monitoring site denoted in blue square. Reach types with greater than one monitoring site denoted in red arrow.

Figure C3-4. Entrenchment Ratio.

Table C3-3. Entrenchment Ratio

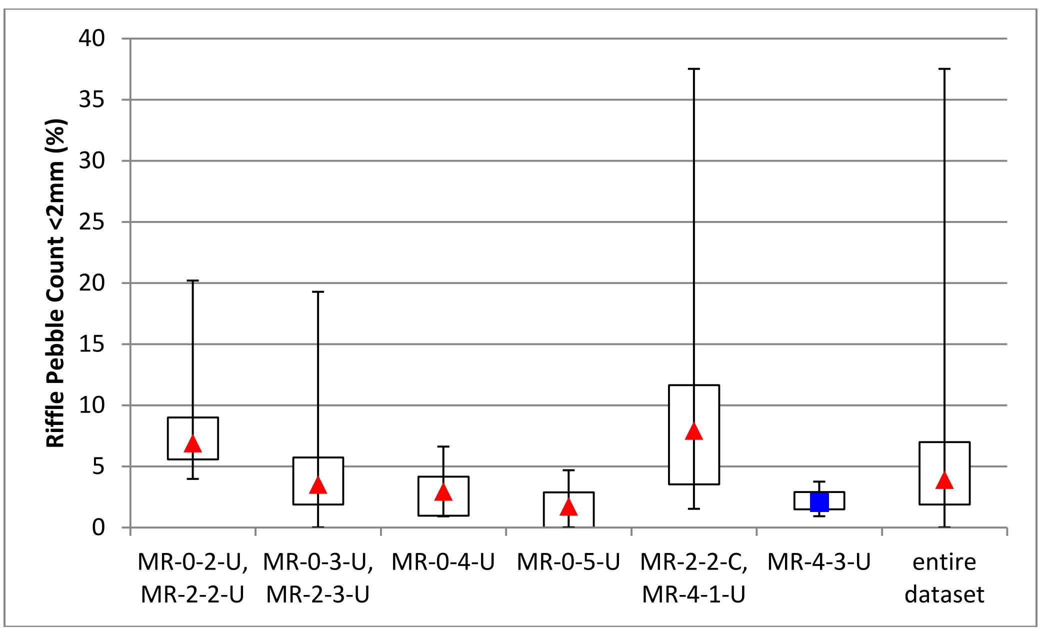
Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	15	18	15	11	13	5	77
Minimum	1.3	1.1	1.1	1.8	1.7	1.3	1.1
25th Percentile	2.3	2.0	1.4	2.3	3.7	1.8	2.0
Median	3.8	8.7	2.1	4.8	4.8	2.0	3.7
75th Percentile	14.3	10.7	7.7	6.1	6.6	2.2	8.9
Maximum	20.1	13.7	11.9	13.0	13.5	2.3	20.1
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.3 Riffle Pebble Count <2mm

Percent surface fine sediment provides a good measure of the siltation occurring in a river system. Surface fine sediment measured using the Wolman (1954) pebble count method is one indicator of aquatic habitat condition and can signify excessive sediment loading. The Wolman pebble count provides a survey of the particle distribution of the entire channel width, allowing investigators to calculate a percentage of the surface substrate (as frequency of occurrence) composed of fine sediment.

Median values for the percent of fine sediment <2mm based on riffle pebble counts ranged from 2% in MR-0-5-U and MR-4-3-U to 8% in MR-2-2-C/MR-4-1-U (**Figure C3-5**, **Table C3-4**).



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-5. Riffle Pebble Count <2mm.

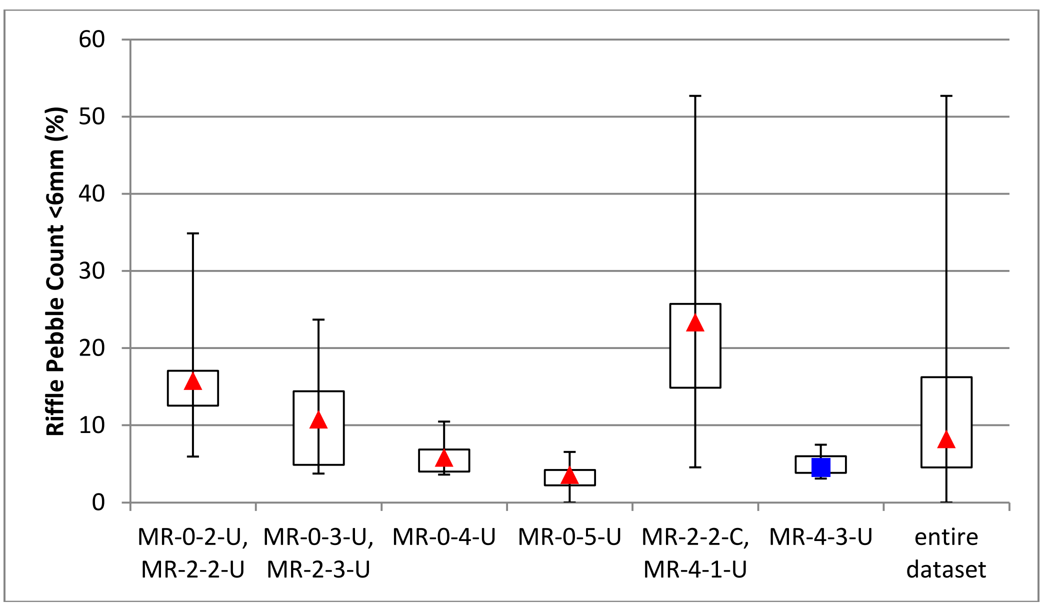
Table C3-4. Riffle Pebble Count <2mm.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	12	13	9	8	9	3	54
Minimum	4	0	1	0	2	1	0
25th Percentile	6	2	1	0	4	1	2
Median	7	4	3	2	8	2	4
75th Percentile	9	6	4	3	12	3	7
Maximum	20	19	7	5	38	4	38
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.4 Riffle Pebble Count <6mm

As with surface fine sediment <2mm, an accumulation of surface fine sediment <6mm may indicate excess sedimentation. Median values for the percent of fine sediment <6mm based on pebble counts conducted in riffles ranged from 4% in MR-0-5-U to 23% in MR-2-2-C/MR-4-1-U (**Figure C3-6, Table C3-5**). The percent of fine sediment <6mm followed the same general trend as the percent of fine sediment <2mm.



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-6. Riffle Pebble Count <6mm.

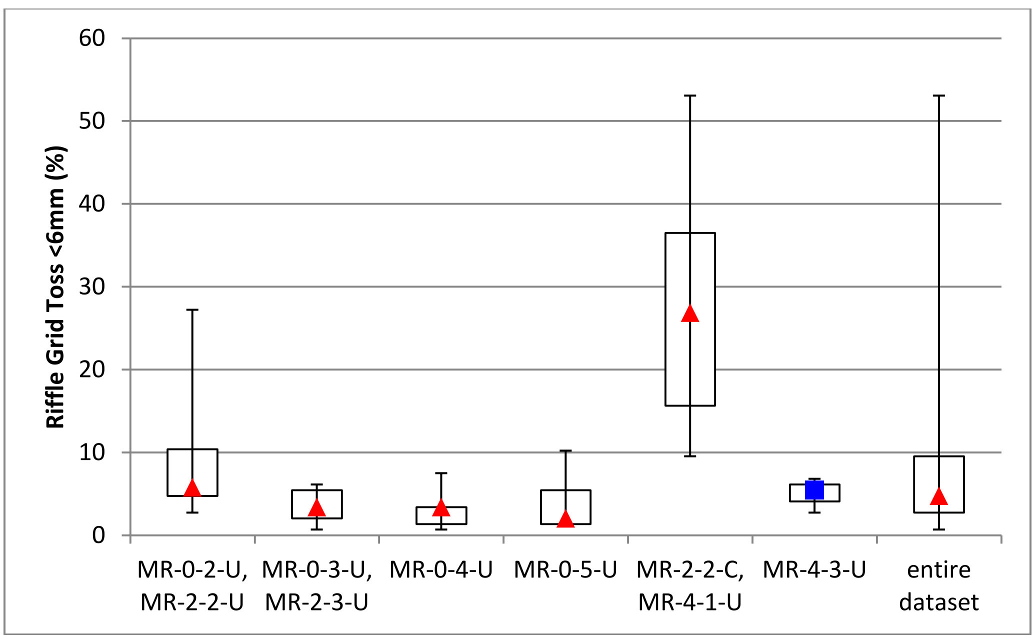
Table C3-5. Riffle Pebble Count <6mm.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	12	13	9	8	9	3	54
Minimum	6	4	4	0	5	3	0
25th Percentile	13	5	4	2	15	4	5
Median	16	11	6	4	23	5	8
75th Percentile	17	14	7	4	26	6	16
Maximum	35	24	10	7	53	7	53
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.5 Riffle Grid Toss <6mm

The riffle grid toss is a standard procedure frequently used in aquatic habitat assessment that provides complimentary information to the Wolman pebble count. Median values for riffle grid toss fine sediment <6mm in the Little Blackfoot TPA range from 2% in MR-0-5-U to 27% in MR-2-2-C/MR-4-1-U (**Figure C3-7, Table C3-6**).



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-7. Riffle Grid Toss Fine Sediment <6mm.

Table C3-6. Riffle Grid Toss Fine Sediment <6mm.

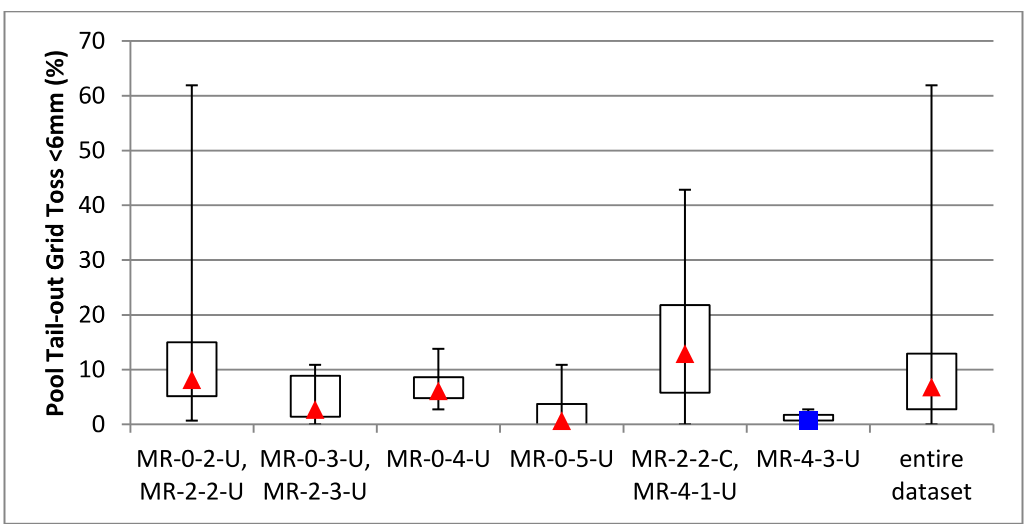
Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	12	9	9	7	8	3	48
Minimum	3	1	1	1	10	3	1
25th Percentile	5	2	1	1	16	4	3
Median	6	3	3	2	27	5	5
75th Percentile	10	5	3	5	36	6	10
Maximum	27	6	7	10	53	7	53
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.6 Pool Tail-out Grid Toss <6mm

Grid toss measurements in pool tail-outs provide a measure of fine sediment accumulation in potential spawning sites, which may have detrimental impacts on aquatic habitat by cementing spawning gravels, preventing flushing of toxins in egg beds, reducing oxygen and nutrient delivery to eggs and embryos, and impairing emergence of fry (Meehan, 1991). Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material less than 6.35mm and the emergence success of westslope cutthroat trout and bull trout.

Median values for pool tail-out grid toss fine sediment <6mm range from 1% in MR-0-5-U and MR-4-3-U to 13% in MR-2-2-C/MR-4-1-U (**Figure C3-8, Table C3-7**).



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-8. Pool Tail-out Grid Toss <6mm.

Table C3-7. Pool Tail-out Grid Toss <6mm.

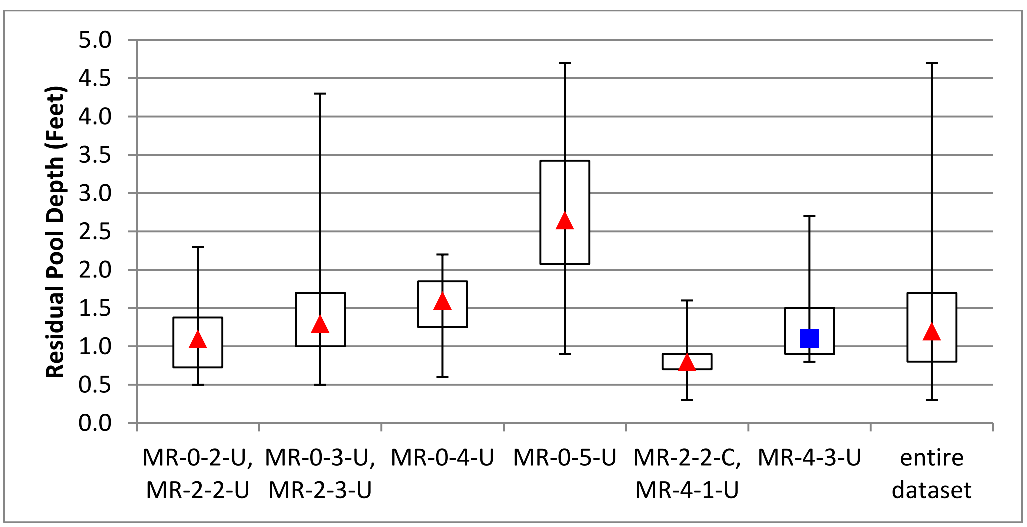
Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	39	13	4	11	23	3	93
Minimum	1	0	3	0	0	1	0
25th Percentile	5	1	5	0	6	1	3
Median	8	3	6	1	13	1	7
75th Percentile	15	9	9	4	22	2	13
Maximum	62	11	14	11	43	3	62
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.7 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 the quality of pool habitat. Deep pools are important resting and hiding habitat for fish, and provide refugia during temperature extremes and high flow periods. Residual pool depth is also an indirect measurement of sediment inputs to streams since an increase in sediment loading would be expected to cause pools to fill, thus decreasing residual pool depth over time.

Median residual pool depths ranged from 0.8 feet in MR-2-2-C/MR-4-1-U to 2.7 feet in MR-0-5-U (**Figure C3-9, Table C3-8**). This analysis indicates that the deepest pools are found in the Little Blackfoot River downstream of the confluence with Dog Creek. In the Little Blackfoot TPA, residual pool depth tends to increase as stream order increases.



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-9. Residual Pool Depth.

Table C3-8. Residual Pool Depth.

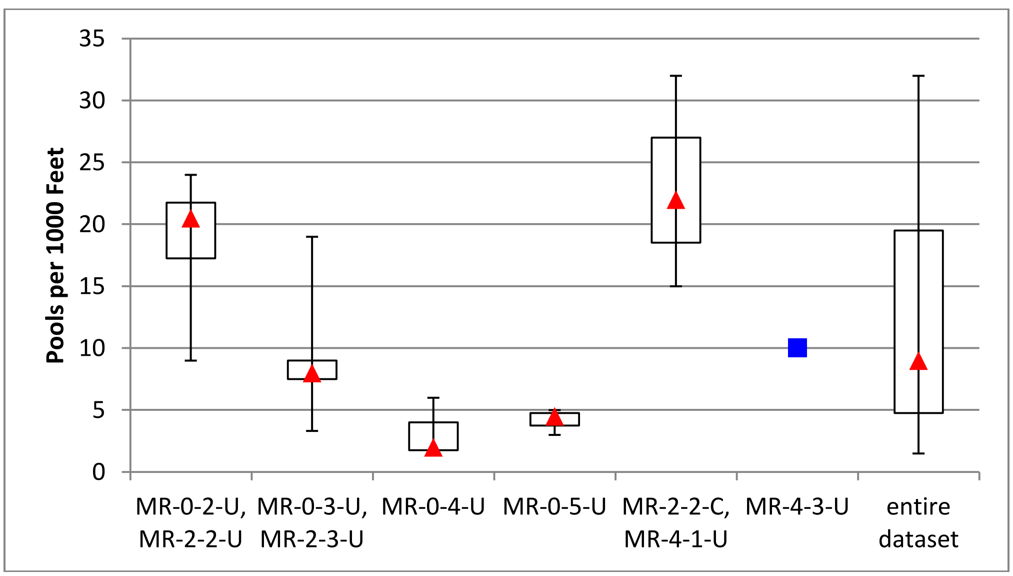
Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	58	41	11	24	30	9	173
Minimum	0.5	0.5	0.6	0.9	0.3	0.8	0.3
25th Percentile	0.7	1.0	1.3	2.1	0.7	0.9	0.8
Median	1.1	1.3	1.6	2.7	0.8	1.1	1.2
75th Percentile	1.4	1.7	1.9	3.4	0.9	1.5	1.7
Maximum	2.3	4.3	2.2	4.7	1.6	2.7	4.7
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.1.8 Pool Frequency

Pool frequency is a measure of the availability of pools to provide rearing habitat, cover, and refugia for salmonids. Pool frequency is related to channel complexity, availability of stable obstacles, and sediment supply. Excessive erosion and sediment deposition can reduce pool frequency by filling in smaller pools. Pool frequency can also be adversely affected by riparian habitat degradation resulting in a reduced supply of large woody debris or scouring from stable root masses in streambanks.

The median value for the number of pools per 1,000 feet ranged from two in MR-0-4-U to 22 in MR-2-2-C/MR-4-1-U (**Figure C3-10, Table C3-9**). Pool frequency tends to decrease as stream order increases in the Little Blackfoot TPA.



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-10. Pools per 1000 Feet.

Table C3-9. Pools per 1000 feet.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	**1**	19
Sample Size	4	5	3	3	3	**1**	19
Minimum	9	3	2	3	15	**10**	2
25th Percentile	17	8	2	4	19	**10**	5
Median	21	8	2	5	22	**10**	9
75th Percentile	22	9	4	5	27	**10**	20
Maximum	24	19	6	5	32	**10**	32
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions. Reach types with only one monitoring site denoted in **bold** italics.

Pool frequency data is also provided as pools per mile in **Table C3-10** for future TMDL applications.

Table C3-10. Pools per Mile.

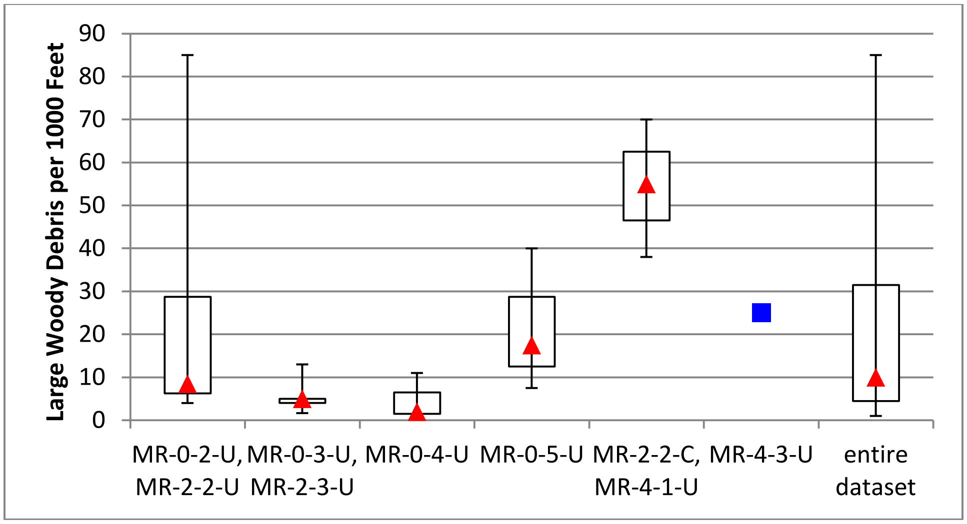
Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
Minimum	48	18	8	16	79	**53**	8
25th Percentile	91	40	9	20	98	**53**	25
Median	108	42	11	24	116	**53**	48
75th Percentile	115	48	21	25	143	**53**	103
Maximum	127	100	32	26	169	**53**	169

Note: See **Table C2-1** for reach type descriptions. Reach types with only one monitoring site denoted in **bold** italics.

C3.2.1.9 Large Woody Debris Frequency

Large woody debris (LWD) is a critical component of high-quality salmonid habitat, providing habitat complexity, quality pool habitat, cover, and long-term nutrient inputs. LWD also constitutes a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward, 1989). LWD frequency can be measured and compared to reference reaches or literature values to determine if more or less LWD is present than would be expected under optimal conditions.

The median value for the amount of large woody debris (LWD) per 1,000 feet ranged from two in MR-0-4-U to 55 in MR-2-2-C/MR-4-1-U (**Figure C3-11, Table C3-11**). Note that “willow bunches” assigned in the field were tallied as large woody debris. Thus, this analysis makes no distinction as to the size of the woody material.



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-11. Large Woody Debris per 1000 Feet.

Table C3-11. Large Woody Debris per 1000 Feet.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	**MR-0-3-U, MR-2-3-U**	**MR-0-4-U**	**MR-0-5-U**	**MR-2-2-C, MR-4-1-U**	**MR-4-3-U**	**entire dataset**
# of Monitoring Sites	4	5	3	3	3	**1**	19
Sample Size	4	5	3	3	3	**1**	19
Minimum	4	2	1	8	38	**25**	1
25th Percentile	6	4	2	13	47	**25**	5
Median	9	5	2	18	55	**25**	10
75th Percentile	29	5	7	29	63	**25**	32
Maximum	85	13	11	40	70	**25**	85
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions. Reach types with only one monitoring site denoted in **bold** italics.

Data is also provided as large woody debris per mile in **Table C3-12** for future TMDL applications.

Table C3-12. Large Woody Debris per Mile.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	**MR-0-3-U, MR-2-3-U**	**MR-0-4-U**	**MR-0-5-U**	**MR-2-2-C, MR-4-1-U**	**MR-4-3-U**	**entire dataset**
Minimum	21	9	5	40	201	**132**	5
25th Percentile	33	21	8	66	246	**132**	24
Median	45	26	11	92	290	**132**	53
75th Percentile	152	26	34	152	330	**132**	166
Maximum	449	69	58	211	370	**132**	449

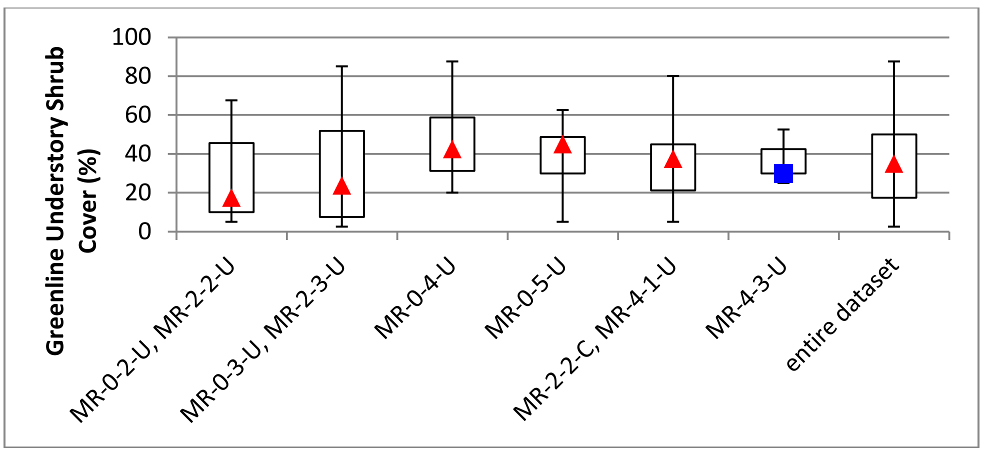
Note: See **Table C2-1** for reach type descriptions. Reach types with only one monitoring site denoted in **bold** italics.

C3.3.1.10 Greenline Understory Shrub Cover

Riparian shrub cover is one of the most important influences on streambank stability. Removal of riparian shrub cover 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 water scours the lowest portion of streambanks, 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 of the main food sources for fish. Organic inputs from shrubs, such as leaves and small twigs, provide food for aquatic macroinvertebrates, which are also an important food source for fish.

The median value for greenline understory shrub cover ranged from 18% in MR-0-2-U/MR-2-2-U to 45% in MR-0-5-U (**Figure C3-12, Table C3-13**).



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-12. Greenline Understory Shrub Cover.

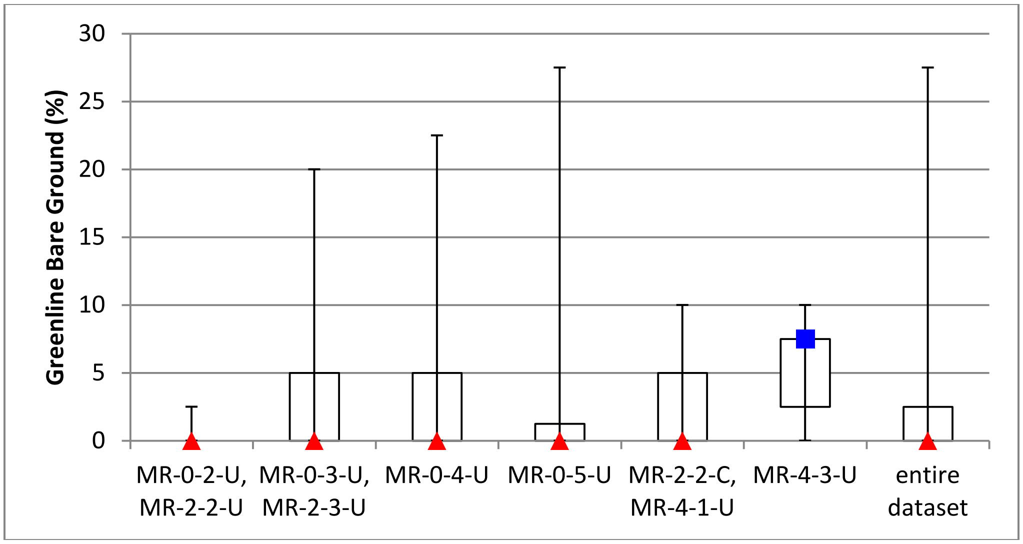
Table C3-13. Greenline Understory Shrub Cover.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	MR-0-3-U, MR-2-3-U	MR-0-4-U	MR-0-5-U	MR-2-2-C, MR-4-1-U	MR-4-3-U	entire dataset
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	20	20	15	15	15	5	90
Minimum	5	3	20	5	5	25	3
25th Percentile	10	8	31	30	21	30	18
Median	18	24	43	45	38	30	35
75th Percentile	46	52	59	49	45	43	50
Maximum	68	85	88	63	80	53	88
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

C3.2.1.11 Greenline Bare Ground

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 has resulted in exposed bare soil. 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 since sediment can wash in from unprotected areas during snowmelt, storm runoff and 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.

The median value for greenline bare ground was 0% in all of the reach types except MR-4-3-U, which had a median value of 8% (**Figure C3-13, Table C3-14**).



Reach types with only one monitoring site denoted in blue squares. Reach types with greater than one monitoring site denoted in red arrows.

Figure C3-13. Greenline Bare Ground.

Table C3-14. Greenline Bare Ground.

Statistical Parameter	Reach Type						
	MR-0-2-U, MR-2-2-U	**MR-0-3-U, MR-2-3-U**	**MR-0-4-U**	**MR-0-5-U**	**MR-2-2-C, MR-4-1-U**	**MR-4-3-U**	**entire dataset**
# of Monitoring Sites	4	5	3	3	3	1	19
Sample Size	20	20	15	15	15	5	90
Minimum	0	0	0	0	0	0	0
25th Percentile	0	0	0	0	0	3	0
Median	0	0	0	0	0	8	0
75th Percentile	0	5	5	1	5	8	3
Maximum	3	20	23	28	10	10	28
Monitoring Sites	SNOW18-05, TROU 15-01, TROU 17-04, SPOT01-01	DOG11-09, SPOT12-02, TELE10-02, THRE16-01, THRE17-01	DOG12-04, DOG13-03, LBR24-03	LBR26-06, LBR27-06, LBR30-05	ELLI08-01, ELLI08-02, SNOW08-01	TELE04-01	

Note: See **Table C2-1** for reach type descriptions.

C3.2.2 Monitoring Site Analysis

Sediment and habitat data collected at each monitoring site was reviewed individually in the following sections. Monitoring site discussions are based on median values. Summary statistics for the minimum, 25th percentile, 75th percentile and maximum values are presented graphically, since these may be more applicable for developing sediment TMDL criteria.

C3.2.2.1 Width/Depth Ratio

The highest median width/depth ratio was observed in LBR27-06 (**Figure C3-14**). In the Little Blackfoot TPA, width/depth ratios generally increased in the downstream direction, which is the expected result as streams become larger.

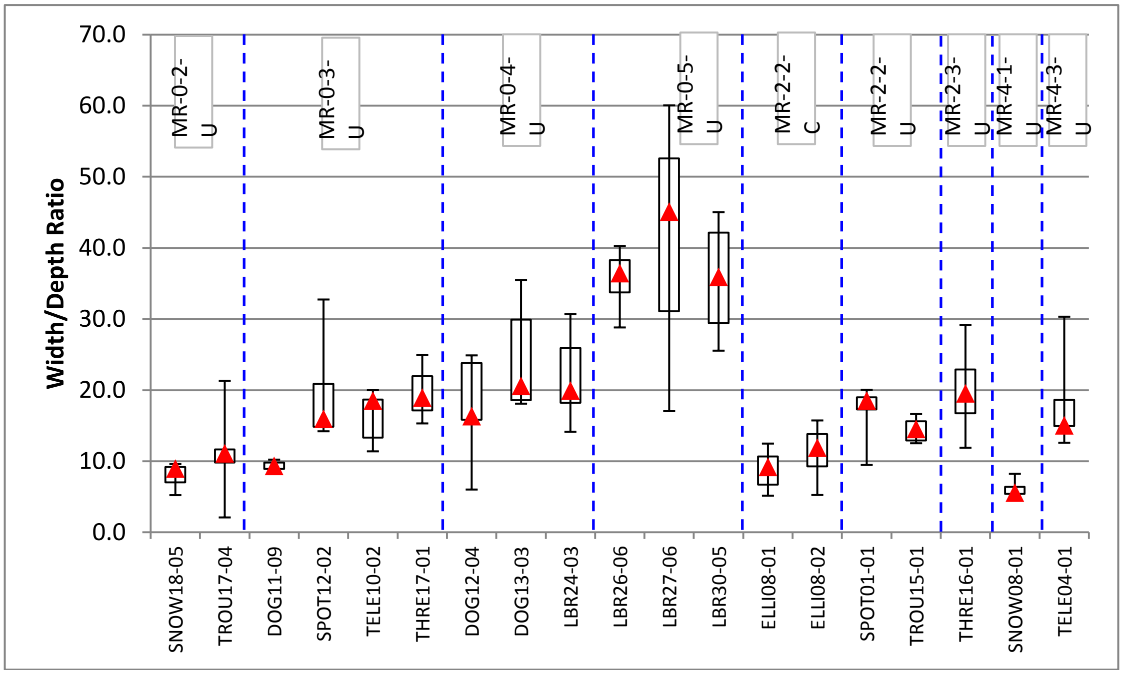


Figure C3-14. Width/Depth Ratio.

C3.2.2.2 Entrenchment Ratio

Entrenchment ratio data collected within the Little Blackfoot TPA indicates the following (**Figure C3-15**):

1. TROU17-04 has the greatest amount of floodplain access out of the sites assessed.
2. Entrenched conditions were documented in TELE10-02, DOG13-03, LBR30-05 and TELE04-01. Within the Little Blackfoot TPA, entrenched conditions are primarily the result of historic and ongoing agricultural practices and channelization due to railroad and road construction.

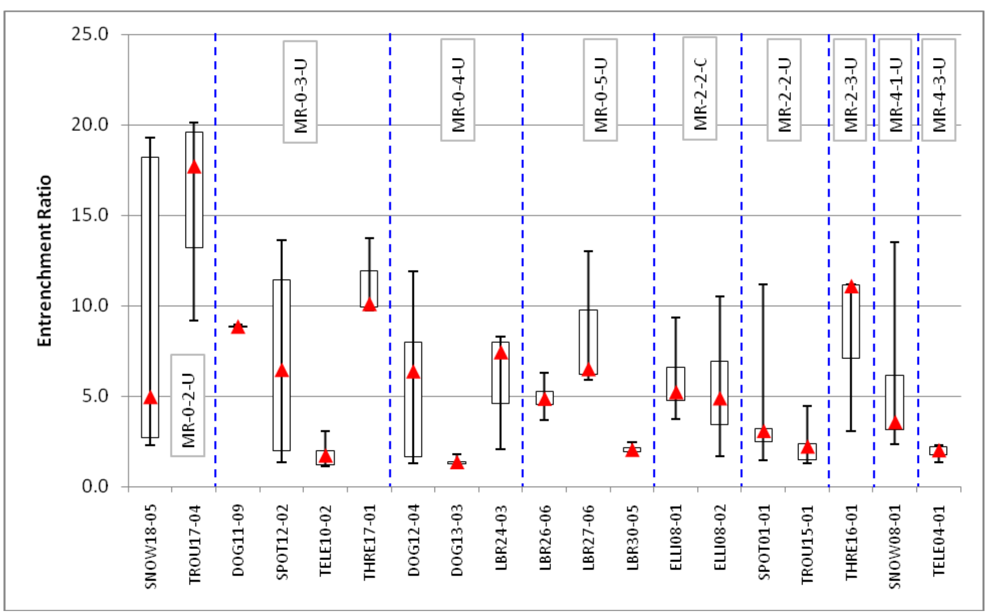


Figure C3-15. Entrenchment Ratio.

C3.2.2.3 Riffle Pebble Count <2mm

The median percent of fine sediment in riffles <2mm as measured by a pebble count was highest in ELLI08-01 and THRE16-01 (**Figure C3-16**).

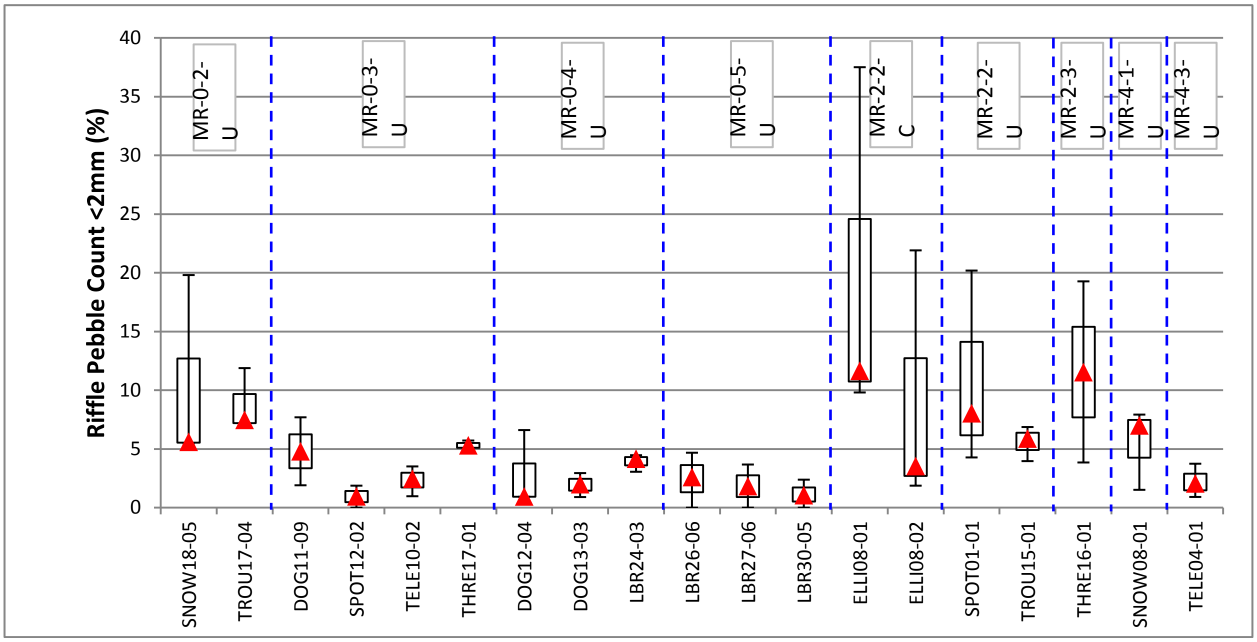


Figure C3-16. Riffle Pebble Count <2mm.

C3.2.2.4 Riffle Pebble Count <6mm

The percent of fine sediment in riffles <6mm as measured by a pebble count followed a similar trend as the percent of fine sediment <2mm, with the highest median values in ELLI08-01, ELLI08-02 and THRE16-01 (**Figure C3-17**).

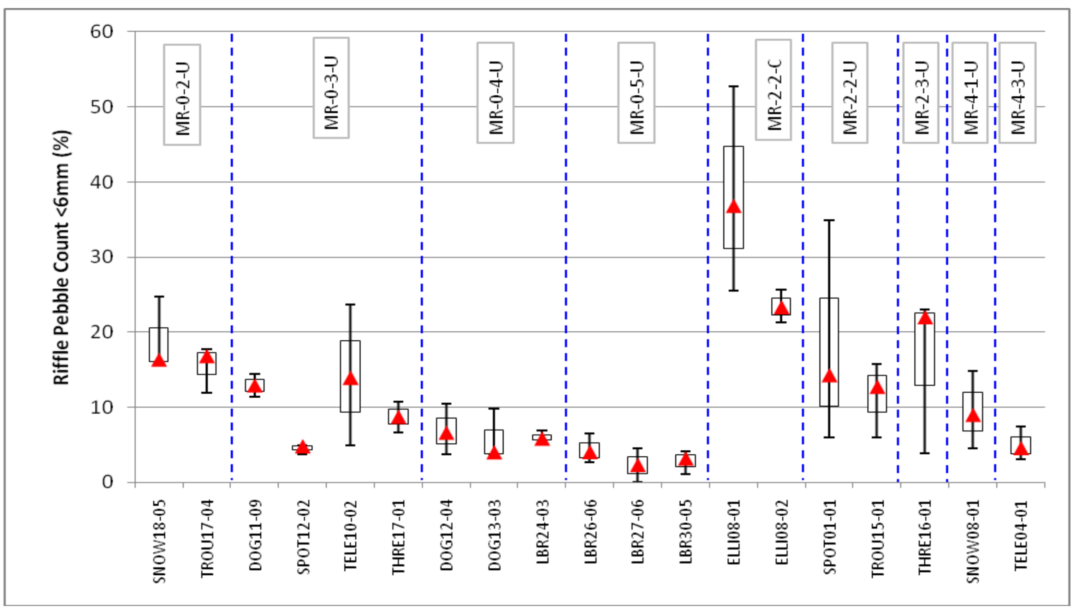


Figure C3-17. Riffle Pebble Count <6mm.

C3.2.2.5 Riffle Grid Toss <6mm

The median percent of fine sediment in riffles <6mm as measured by a grid toss was highest in ELLI08-01 and ELLI08-02 (**Figure C3-18**).

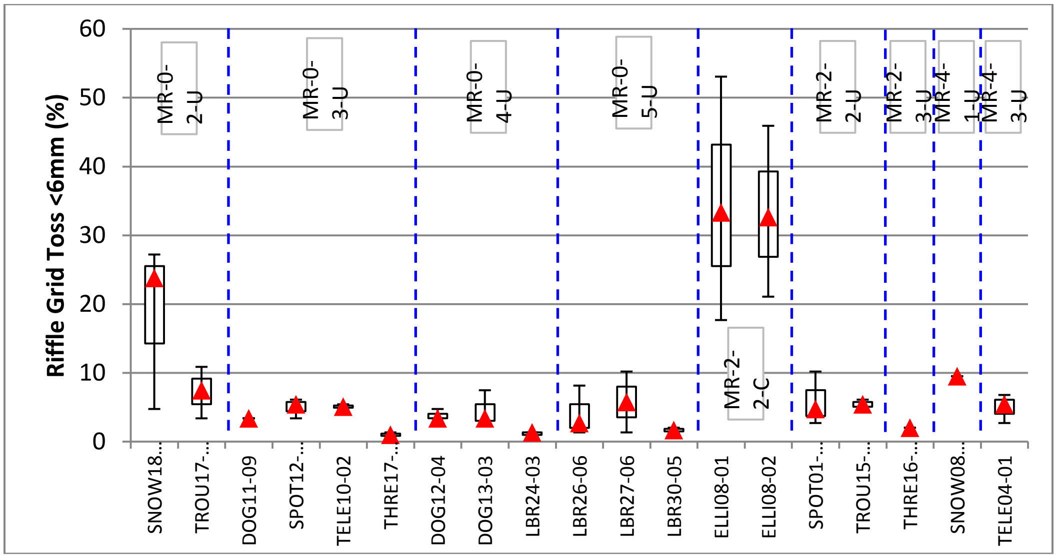


Figure C3-18. Riffle Grid Toss <6mm.

C3.2.2.6 Riffle Stability Index

The mobile percentile of particles on the riffle is termed "Riffle Stability Index" (RSI) and provides a useful estimate of the degree of increased sediment supply to riffles. The RSI addresses situations in which increases in gravel bedload from headwater activities is depositing material on riffles and filling pools, and it reflects qualitative differences between reference and managed watersheds. In the Little Blackfoot TPA, RSI evaluations were performed in ELLI08-01, SPOT12-02, LBR24-03, LBR26-06, LBR27-06, LBR30-05, and TROU17-04 (**Table C3-15**).

Table C3-15. Riffle Stability Index Summary.

Site	Mobile Particle Analysis		Pebble Count Analysis		RSI
	Cell	Geometric Mean	Cell	D50	
ELLI08-02	1	19	1	13	71
SPOT12-02	1	49	2	40	54
LBR24-03	2	104	1	68	87
LBR24-03	3	92	3	85	51
LBR26-06	1	87	1	84	51
LBR26-06	4	87	4	38	78
LBR26-06	5	79	5	78	51
LBR27-06	3	55	3	70	32
LBR27-06	4	47	4	50	44
LBR30-05	3	71	3	70	51
TROU17-04	5	45	5	31	68

C3.2.2.7 Pool Tail-out Grid Toss <6mm

The median percent of fine sediment in pool tail-outs as measured with the grid toss was highest in TROU17-04 and SNOW08-01 (**Figure C3-19**).

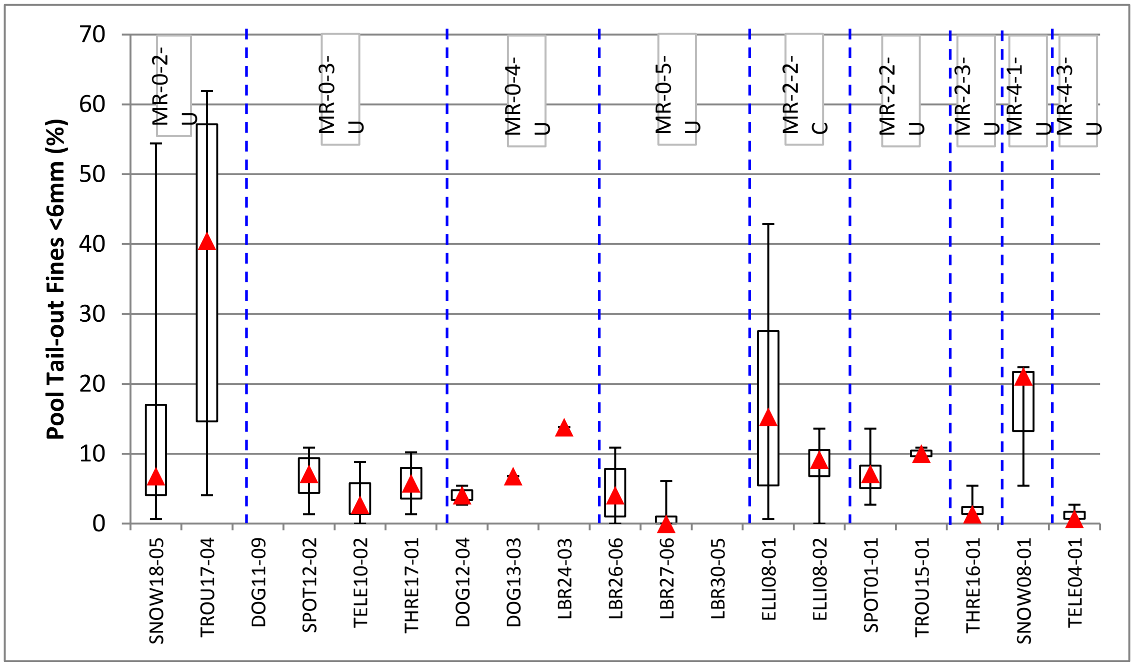


Figure C3-19. Pool Tail-out Grid Toss <6mm.

C3.2.2.8 Residual Pool Depth

The greatest median residual pool depth was measured in THRE17-01 and LBR27-06 (**Figure C3-20**). The lowest residual pool depth was found in SNOW08-01. In general, residual pool depths increase in the downstream direction within the assessed streams.

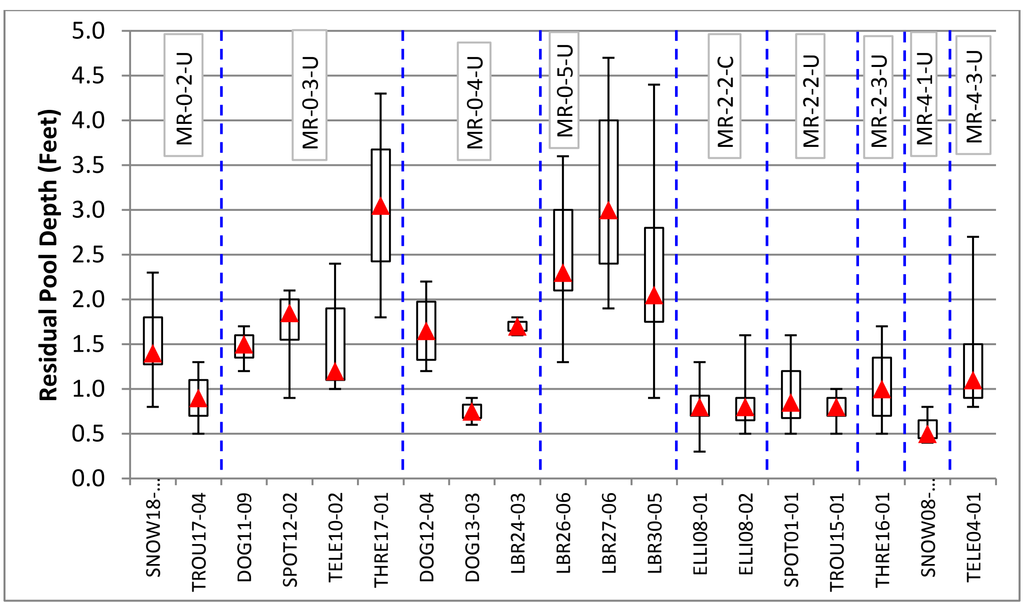


Figure C3-20. Residual Pool Depth.

C3.2.2.9 Pool Frequency

The greatest number of pools was found in ELLI08-01, while the fewest number of pools was found in LBR24-03 (**Figure C3-21**).

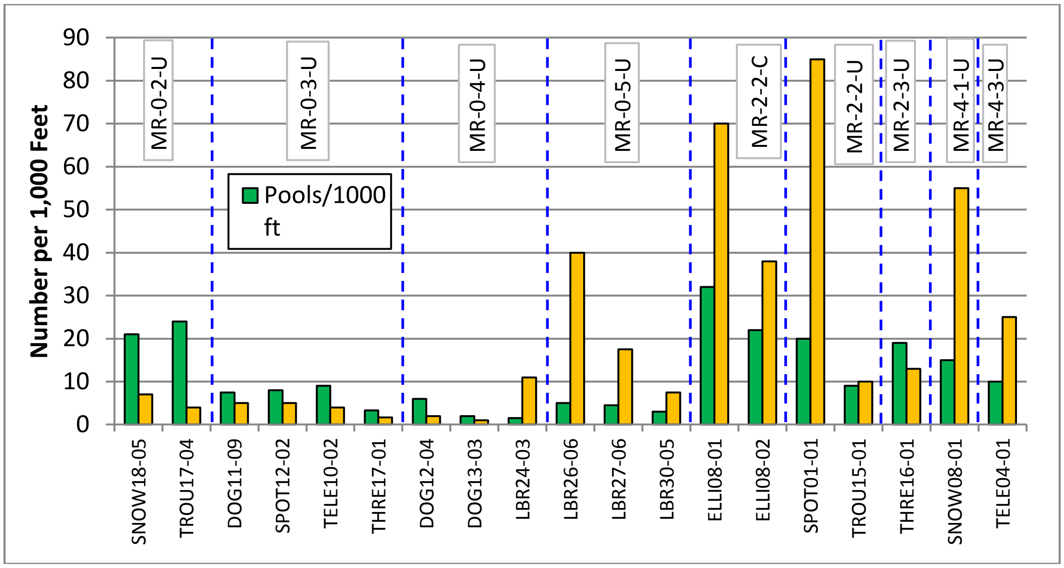


Figure C3-21. Pool and Large Woody Debris Frequency.

C3.2.2.10 Large Woody Debris Frequency

The greatest amount of large woody debris was found in SPOT01-01, while the least amount of large woody debris was found in DOG13-03 (**Figure C3-21**).

C3.2.2.11 Greenline Understory Shrub Cover

Median understory shrub cover exceeded 50% in TELE10-02, LBR24-03, LBR26-06, TROU15-01 and SNOW08-01 (**Figure C3-22**).

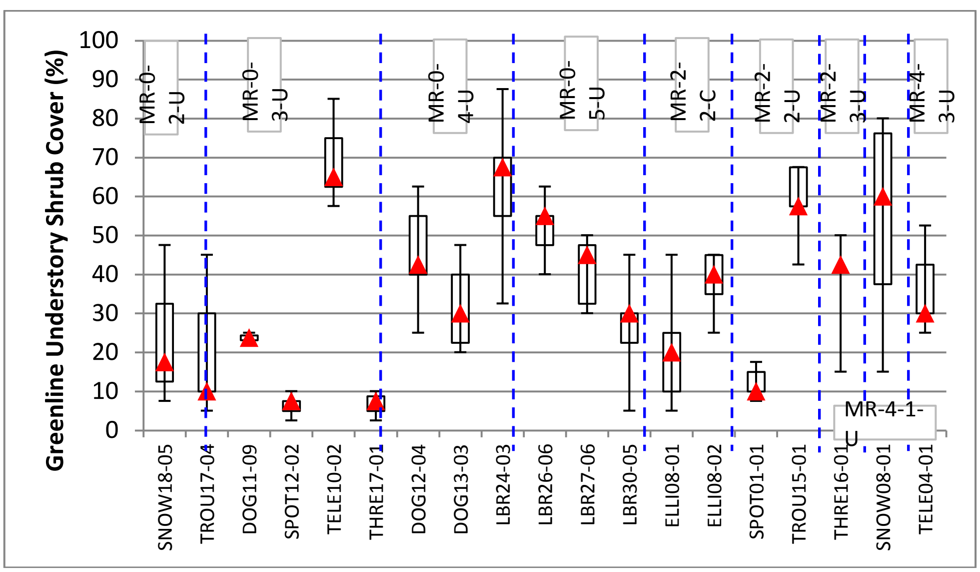


Figure C3-22. Greenline Understory Shrub Cover.

C3.2.2.12 Greenline Bare Ground

Median bare ground values ranged from 0% to 8%, with median values greater than 0% in DOG11-09, TELE10-02, LBR24-03, LBR30-05, ELLI08-01 and TELE04-01 (**Figure C3-23**).

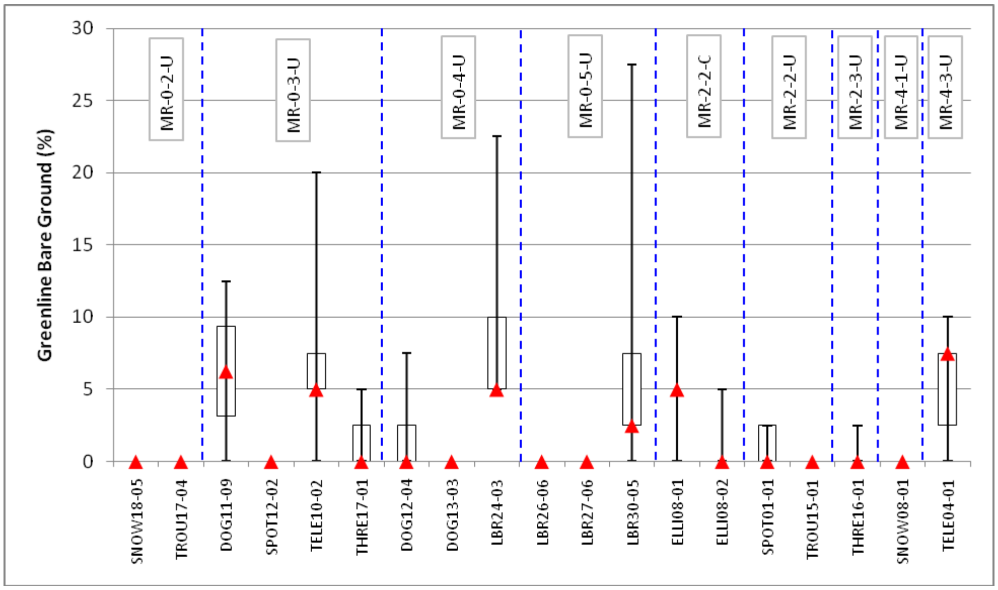


Figure C3-23. Greenline Bare Ground.

C4.0 Streambank Erosion Assessment

C4.1 Methods

Streambank erosion data was collected at 19 monitoring sites in the Little Blackfoot TPA. At each of the 19 monitoring sites, eroding streambanks were assessed for erosion severity and categorized as either "actively/visually eroding" or "slowly eroding/vegetated/undercut". At each eroding bank, **Bank Erosion Hazard Index (BEHI)** measurements were performed and the **Near Bank Stress (NBS)** was evaluated (Rosgen, 1996; 2004). Bank erosion severity was rated from "very low" to "extreme" based on the BEHI score, which was determined based on the following six parameters: bank height, bankfull height, root depth, root density, bank angle, and surface protection. Near Bank Stress was also rated from "very low" to "extreme" depending on the shape of the channel at the toe of the bank and the force of the water (i.e. "stream power") along the bank. In addition, the source, or underlying cause, of streambank erosion was evaluated based on observed anthropogenic disturbances within the riparian corridor, as well as current and historic land-use practices observed within the surrounding landscape. The source of streambank instability was identified based on the following near-stream source categories: transportation, riparian grazing, cropland, mining, silviculture, irrigation, natural, and "other". Naturally eroding streambanks were considered the result of "natural sources" while the "other" category was chosen when streambank erosion resulted from a source not described in the list, which included historic mining activities, irrigation infrastructure development, and willow removal in the Little Blackfoot TPA. If multiple sources were observed, then a percent was noted for each source.

Streambank erosion data collected at **monitoring sites** were extrapolated to the **stream reach**, **stream segment**, and **sub-watershed** scales based on similar reach type characteristics as identified in the Aerial Assessment Database. Sediment load calculations were performed for monitoring sites, stream reaches, stream segments, and sub-watersheds which are distinguished as follows:

Monitoring Site - *A 500, 1000, or 2000 foot section of a stream reach where field monitoring was conducted*
Stream Reach - *Subdivision of the stream segment based on ecoregion, stream order, gradient and confinement as evaluated in GIS*
Stream Segment - *303(d) listed segment*
Sub-watershed - *303(d) listed segment and tributary streams based on 1:100,000 NHD data layer*

For each eroding streambank, the average annual sediment load was estimated based on the streambank length, mean height, and the annual retreat rate. The length and mean height were measured in the field, while the annual retreat rate was determined based on the relationship between the BEHI and NBS ratings. Annual retreat rates were estimated based on retreat rates from the Lamar River in Yellowstone National Park (Rosgen, 1996) (**Table C4-1**). The annual sediment load in cubic feet was then calculated from the field data (annual retreat rate x mean bank height x bank length), converted into cubic yards, and finally converted into tons per year based on the bulk density of streambank material, which was assumed to average 1.3 tons/yard^3 as identified in *Watershed Assessment of River Stability and Sediment Supply* (WARSSS) (Rosgen, 2006a; 2006b). This process resulted in a sediment load for each eroding bank expressed in tons per year.

Table C4-1. Annual Streambank Retreat Rates (Feet/Year), Lamar River, Yellowstone National Park (adapted from (Rosgen, 1996)).

BEHI	Near Bank Stress					
	very low	**low**	**moderate**	**high**	**very high**	**extreme**
very Low	0.002	0.004	0.009	0.021	0.050	0.12
low	0.02	0.04	0.10	0.24	0.57	1.37
moderate	0.10	0.17	0.28	0.47	0.79	1.33
high - very high	0.37	0.53	0.76	1.09	1.57	2.26
extreme	0.98	1.21	1.49	1.83	2.25	2.76

C4.1.1 Streambank Erosion Sediment Load Extrapolation

Monitoring site sediment loads were extrapolated to the stream reach, stream segment and sub-watershed scales based on the aerial assessment reach type analysis. Streambank erosion data was extrapolated based on the following criteria:

1. Monitoring site sediment loads were extrapolated directly to the stream reach in which the monitoring site was located.

2. For un-assessed reaches, streambank erosion sediment loads were applied based on reach type averages. Field data was collected within nine individual reach types that were delineated by confinement, stream order and gradient. The nine reach types were consolidated into five reach type groups based on stream order and average bankfull width (**Table C4-2)**. Average sediment loads from the field assessed reach type groups were applied to the corresponding un-assessed reach types as presented in **Table C4-2**. The reach type load from SPOT12-02 (MR-0-3-U) was not included within the reach type group for 3rd order streams since this site was deemed to be unique within the Little Blackfoot TPA.

Table C4-2. Reach Type Streambank Erosion Sediment Loads by Reach Type Group.

Field Assessed Reach Type Group	Number of Monitoring Sites	Average Sediment Load per 1000 Feet (Tons/Year)	Un-Assessed Reach Types
MR-4-1-U	1	0.28	MR-0-1-U, MR-2-1-U, MR-4-1-C, MR-10-1-C, MR-10-1-U
MR-0-2-U, MR-2-2-U, MR-2-2-C	6	5.06	MR-0-2-C, MR-4-2-U, MR-4-2-C
MR-0-3-U, MR-2-3-U, MR-4-3-U	5	4.40	MR-0-3-C, MR-2-3-C
MR-0-4-U	3	19.99	none
MR-0-5-U	3	45.80	none

3. When streambank erosion sources exceeded 75% natural (as identified in the Aerial Assessment Database), erosion was assumed to be at the background rate per reach type grouping. The background erosion rate is based on an assessment of the five monitoring sites in the Little Blackfoot TPA (ELLI08-02, SNOW08-01, SPOT01-01, TELE04-01, and THRE17-01) in which streambank erosion sources were determined to be 100% natural. A background erosion rate based on 70% of the actively eroding banks and 30% of the slowly eroding streambanks was applied for each reach type group based on the field data from these five sites, which averaged 67% actively eroding streambanks and 33% slowly eroding streambanks. This approach was also used for calculating load reductions and is discussed in more detail in **Section C4.2.3**.

C4.2 Results

C4.2.1 Streambank Erosion Sediment Load Extrapolation

A total average annual sediment load of 438.2 tons/year was attributed to the 92 assessed eroding streambanks within the 19 monitoring sites. Predominant sources of streambank erosion observed during the field assessment include cropland and riparian grazing. Average annual sediment loads for each monitoring site were normalized to a length of 1,000 feet for the purpose of comparison and extrapolation. Sediment loads due to streambank erosion for each monitoring site are presented in **Table C4-3**. Monitoring site sediment loads per 1,000 feet ranged from 0.28 tons/year at SNOW08-01 on Snowshoe Creek to 67.30 tons/year at LBR27-06 on the Little Blackfoot River.

Monitoring site sediment loads were extrapolated to the stream segment scale based on the reach type groups (**Table C4-2**). Stream segment sediment loads were estimated for all 128.1 miles of stream included in the Aerial Assessment Database. An average annual sediment load of 9,748 tons/year was attributed to eroding streambanks at the stream segment scale. In the Little Blackfoot TPA, streambank erosion sediment loads ranged from 89 tons/year in Elliston Creek to 7,711 tons/year in the lower Little Blackfoot River (**Table C4-4**). The lower Little Blackfoot River has the highest sediment load due to streambank erosion per mile of stream, followed by Spotted Dog Creek. Threemile Creek has the lowest streambank erosion sediment load per mile of stream. At the stream segment scale, this assessment indicates that irrigation, transportation and riparian grazing are the greatest anthropogenic contributors of sediment loads due to streambank erosion in the Little Blackfoot TPA (**Figure C4-1**). Sources assessed at the stream segment scale were also applied at the sub-watershed scale.

Average annual streambank erosion sediment loads at the sub-watershed scale were estimated for the assessed stream segments in the Little Blackfoot TPA based on the total length of stream within the sub-watershed. These sub-watershed sediment loads were estimated from the sum of the average annual streambank erosion sediment loads at the stream segment scale combined with an estimate of streambank erosion sediment loads from un-assessed streams. Based on a modified version of the

1:100,000 NHD stream layer in which ditches were removed, there are 523.1 miles of stream in the Little Blackfoot TPA (**Table C4-4**). Therefore, 395 miles of stream were not included within the Aerial Assessment Database and were not assessed. The majority of un-assessed streams were 1st and 2nd order tributaries. For the purposes of estimating an annual average sub-watershed streambank erosion sediment load, streambank erosion sediment inputs from un-assessed streams was assumed to be 12.52 tons per mile (2.37 tons/1000 feet) based on the 25th percentile of 1st and 2nd order streams assessed in the Little Blackfoot TPA. A total sediment load of 14,692 tons per year was derived for the Little Blackfoot TPA (**Table C4-4**).

Table C4-3. Monitoring Site Estimated Average Annual Sediment Loads due to Streambank Erosion.

Stream Segment	Reach ID	Reach Type	Length of Eroding Bank (Feet)	Monitoring Site Length (Feet)	Percent of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
Dog Creek	DOG11-09	MR-0-3-U	247	400	31	3.4	8.38
	DOG12-04	MR-0-4-U	254	1000	13	32.8	32.81
	DOG13-03	MR-0-4-U	301	1000	15	21.1	21.07
Elliston Creek	ELL08-01	MR-2-2-C	585	500	59	3.4	6.77
	ELLI08-02	MR-2-2-C	57	500	6	1.3	2.56
Little Blackfoot River	LBR24-03	MR-0-4-U	625	2000	16	12.1	6.07
	LBR26-06	MR-0-5-U	508	2000	13	103.2	51.62
	LBR27-06	MR-0-5-U	1145	2000	29	134.6	67.30
	LBR30-05	MR-0-5-U	1155	2000	29	37.0	18.48
Snowshoe Creek	SNOW08-01	MR-4-1-U	11	400	1	0.2	0.28
	SNOW18-05	MR-0-2-U	93	1000	5	2.2	2.18
Spotted Dog Creek	SPOT01-01	MR-2-2-U	88	1000	4	4.8	4.83
	SPOT12-02	MR-0-3-U	524	1000	26	63.6	63.62
Telegraph Creek	TELE04-01	MR-4-3-U	91	1000	5	2.1	2.10
	TELE10-02	MR-0-3-U	85	1000	4	1.7	1.70
Threemile Creek	THRE16-01	MR-2-3-U	35	1000	2	1.1	1.06
	THRE17-01	MR-0-3-U	88	600	7	5.3	8.78
Trout Creek	TROU15-01	MR-2-2-U	32	1000	2	2.8	2.76
	TROU17-04	MR-0-2-U	197	500	20	5.6	11.25

Table C4-4. Sub-watershed Sediment Loads.

Stream Segment	Stream Segment Length (Miles)	Stream Segment Sediment Load (Tons/Year)	Sub-watershed Stream Length (Miles)	Un-assessed Stream Length (Miles)	Sediment Load Applied to Un-assessed Stream Length (12.52 tons/year/mile)	Sub-watershed Sediment Load (Tons/Year)
Upper Little Blackfoot Sub-watershed						
Upper Dog Creek	4.3	78.8	26.8	22.5	281.7	360.5
Lower Dog Creek	17.9	838.1	76.1	58.2	728.4	1566.5
Upper Telegraph Creek	5.4	80.4	21.3	15.9	199.1	279.5
Lower Telegraph Creek	7.9	113.4	26.3	18.4	230.7	344.1
Little Blackfoot River, Upper	22.50	1085.3	195.7			
Upper Little Blackfoot Sub-watershed	**48.3**	**2,036.8**	**195.7**	**147.4**	**1,845.6**	**3,882.4**

Table C4-4. Sub-watershed Sediment Loads.

Stream Segment	Stream Segment Length (Miles)	Stream Segment Sediment Load (Tons/Year)	Sub-watershed Stream Length (Miles)	Un-assessed Stream Length (Miles)	Sediment Load Applied to Un-assessed Stream Length (12.52 tons/year/mile)	Sub-watershed Sediment Load (Tons/Year)
Lower Little Blackfoot Sub-watershed						
Elliston Creek	5.0	88.6	8.9	3.9	49.1	137.7
Snowshoe Creek	11.4	201.0	23.5	12.1	151.4	352.4
Spotted Dog Creek	11.6	753.5	54.4	42.8	536.0	1289.5
Threemile Creek	13.8	200.0	74.0	60.2	753.1	953.1
Trout Creek	11.5	296.3	25.6	14.1	176.0	472.3
Little Blackfoot River, Lower	26.50	6171.6	327.3			
Lower Little Blackfoot Sub-watershed	**79.8**	**7,711.0**	**327.3**	**247.5**	**3,098.8**	**10,809.8**
Little Blackfoot TPA						
Little Blackfoot Watershed	**128.1**	**9,747.8**	**523.1**	**394.9**	**4,944.3**	**14,692.2**

*Except for the Little Blackfoot River, the loads for any of the lower segments are cumulative for that watershed.

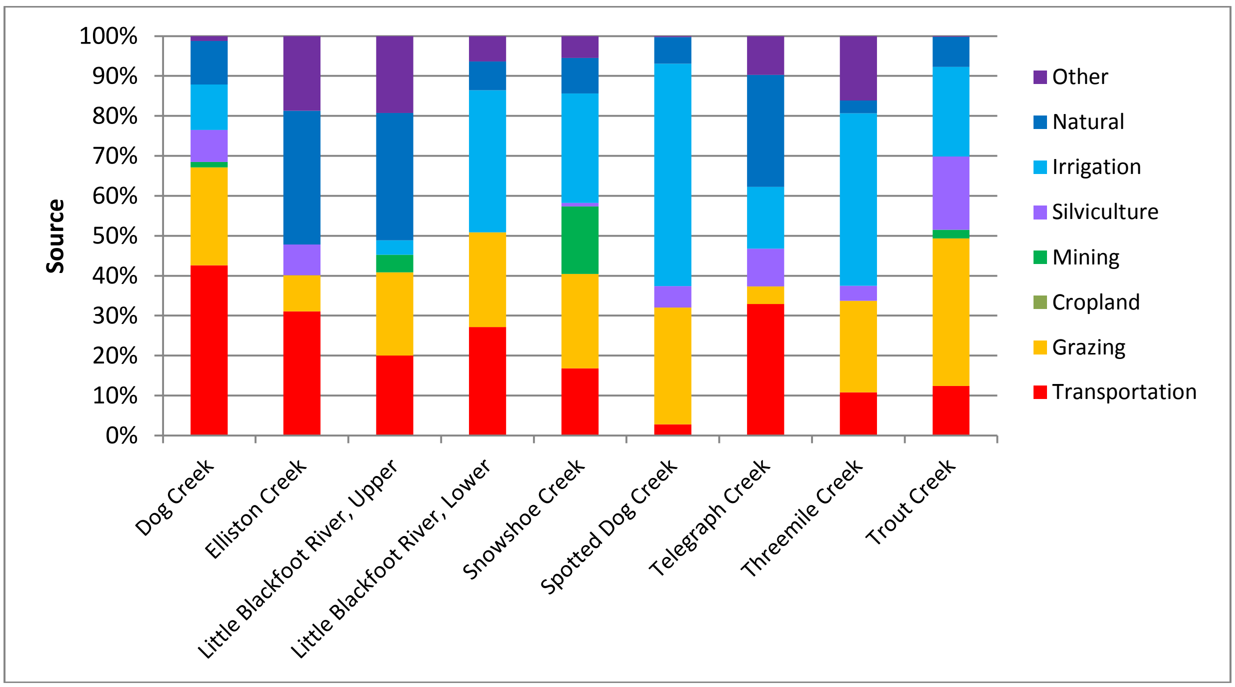


Figure C4-1. Stream Segment and Sub-watershed Streambank Erosion Sources.

C4.2.2 Streambank Composition

Streambank erosion sediment loads were evaluated based on streambank composition for the following particle size categories: coarse gravel, fine gravel and sand/silt. The percent of eroding streambank within each particle size category was evaluated for each monitoring site based on the sediment load from each eroding bank relative to the total sediment load for the monitoring site. Streambank composition data for each monitoring site was then used to evaluate streambank composition at the sub-watershed scale based on the sum of the monitoring site loads relative to the total sediment load from the assessed monitoring sites within each individual stream segment (**Table C4-5**). Thus, it is assumed that streambank composition assessed at the field monitoring sites is representative of each streams sub-watershed. This analysis will help guide implementation activities geared toward reducing sediment loads for specific particle size categories. In the Little Blackfoot TPA, sand/silt generally comprised the greatest portion of the streambank sediment load, comprising greater than 55% of the sediment load in all of the assessed streams.

Table C4-5. Stream Segment Streambank Composition.

Stream Segment	Number of Monitoring Sites	Bank Composition Coarse Gravel >6mm (Percent)	Bank Composition Fine Gravel <6mm & >2mm (Percent)	Bank Composition Sand/Silt <2mm (Percent)
Dog Creek	3	31	10	59
Elliston Creek	2	6	2	92
Little Blackfoot River, Upper	1	48	9	43
Little Blackfoot River, Lower	3	28	6	67
Snowshoe Creek	2	9	9	82
Spotted Dog Creek	2	1	10	89
Telegraph Creek	2	16	6	78
Threemile Creek	2	8	8	85
Trout Creek	2	10	7	84

Streambank erosion sediment loads at the sub-watershed scale as presented in **Table C4-4** were analyzed based on the particle size distribution of the eroding streambanks. Sub-watershed sediment loads for each particle size class are presented in **Table C4-6**.

Table C4-6. Sub-watershed Sediment Loads due to Streambank Erosion for each Particle Size Class.

Stream Segment	Coarse Gravel >6mm Load (Tons/Year)	Fine Gravel <6mm & >2mm Load (Tons/Year)	Sand/Silt <2mm Load (Tons/Year)	Sub-watershed Sediment Load (Tons/Year)
Upper Little Blackfoot Sub-watershed				
Dog Creek	489.6	159.4	934.4	1583.3
Telegraph Creek	59.6	21.1	287.6	368.3
Little Blackfoot River, Upper				
Upper Little Blackfoot Sub-watershed	**1295.9**	**379.6**	**2260.0**	**3935.4**
Lower Little Blackfoot Sub-watershed				
Elliston Creek	8.5	2.7	129.5	140.6
Snowshoe Creek	32.8	32.8	295.7	361.3
Spotted Dog Creek	17.3	127.9	1150.3	1295.4
Threemile Creek	73.0	73.0	813.8	959.7
Trout Creek	45.5	31.1	395.8	472.3
Little Blackfoot River, Lower				
Lower Little Blackfoot Sub-watershed	**2325.8**	**697.8**	**7815.4**	**10838.9**
Little Blackfoot TPA				
Little Blackfoot Watershed	**3453.2**	**1030.2**	**10290.8**	**14774.2**

C4.2.3 Streambank Erosion Sediment Load Reductions

The narrative water quality standards that apply to sediment relate to the naturally occurring condition, which is typically associated with either reference conditions or those that occur if all reasonable land, soil, and water conservation practices are applied. Therefore, to assist with TMDL development, the streambank erosion assessment also includes an estimation of sediment loading reductions that could be achieved via the implementation of Best Management Practices (BMPs). Streambank erosion sediment load reductions were evaluated based on field collected data and streambank erosion sources identified in the Aerial Assessment Database through the following process:

1. Anthropogenic activities that remove streamside vegetation tend to de-stabilize streambanks and increase the amount of active streambank erosion. Through the implementation of riparian and streambank BMPs, streambanks can be stabilized and active erosion can be reduced. A reference site approach was used to identify an appropriate ratio of actively eroding streambanks compared to slowly eroding streambanks for streams in the Little Blackfoot TPA. Within the Little Blackfoot TPA, there were five monitoring sites (ELLI08-02, SNOW08-01, SPOT01-01, TELE04-01, and THRE17-01) in which streambank erosion sources were determined to be >75% natural. Streambank erosion data from these sites were used to approximate the effect of BMP implementation and to calculate load reductions. These five sites averaged 67% actively eroding streambanks and 33% slowly eroding streambanks. Based on these results, it is estimated that streams in the Little Blackfoot TPA would have approximately 70% actively eroding banks and 30% slowly eroding streambanks if all BMPs are applied. For the five reach type groups described in **Table C4-7**, streambank erosion sediment load reductions were derived using the average values for both actively eroding streambanks and slowly eroding streambanks. For each reach type group, the expected streambank erosion sediment load when BMPs were applied was calculated based on 70% of the actively eroding streambanks and 30% of the slowly eroding streambanks using the following equation:

   (0.70 x active) + (0.30 x slowly) = streambank erosion sediment load with BMPs

   For example, the reach type group for 2nd order streams, which includes the MR-0-2-U, MR-2-2-U, and MR-2-2-C reach types, averaged 4.23 tons/year from actively eroding streambanks and 1.00 tons/year from slowly eroding streambanks for 1,000 feet of stream, resulting in a reduced sediment load of 3.26 tons/year, as follows:

   $$(0.70 \times 4.23) + (0.30 \times 1.00) = 3.26$$

   In this analysis, the data from all actively eroding banks was utilized, including the two monitoring sites in which no active streambank erosion was observed. For the slowly eroding streambanks, the zero values were removed from the dataset since these monitoring sites tended to be dominated by anthropogenic disturbances. Streambank erosion sediment load reductions are presented for each reach type category in **Table C4-7**.

Table C4-7. Reach Type Streambank Sediment Load Reductions with BMPs.

Field Assessed Reach Type Group	Average Sediment Load per 1000 Feet	Reduced Sediment Load per 1000 Feet (Tons/Year)	Un-Assessed Reach Types
MR-4-1-U	0.28	0.08	MR-0-1-U, MR-2-1-U, MR-4-1-C, MR-10-1-C, MR-10-1-U
MR-0-2-U, MR-2-2-U, MR-2-2-C	5.06	3.26	MR-0-2-C, MR-4-2-U, MR-4-2-C
MR-0-3-U, MR-2-3-U, MR-4-3-U	4.40	2.85	MR-0-3-C, MR-2-3-C
MR-0-4-U	19.99	14.02	none
MR-0-5-U	45.80	32.36	none

2. For the reaches in which a monitoring site was located, the reach type category sediment load reduction was applied, except when this value exceeded the monitoring site value. In this case, the monitoring site sediment load was evaluated based on 70% of the actively eroding streambanks and 30% of the slowly eroding streambanks and this value was then applied to the entire reach in which the monitoring site was located.

3. Because they are assumed to be achieving the naturally occurring condition, no sediment load reductions were applied to reaches with >75% natural sources of erosion. In addition, no load reduction was applied to the natural load in reaches with <75% natural sources.

4. Because high gradient channels tend to be well armored and have a very low erosion rate, no sediment load reductions were applied to streams with slopes >10%.

5. Because little is known about the tributaries to the 303(d) listed stream segments and they are predominately 1st and 2nd order streams with a low streambank erosion load assigned during the extrapolation process, no sediment load reductions were applied to tributaries of the assessed 303(d) listed stream segments.

Based on the process described above, streambank erosion sediment load reductions for each sediment 303(d) listed sub-watershed in the Little Blackfoot TPA are provided in **Table C4-8**. Potential reductions in anthropogenic loading as a result of the application of BMPs range from 8% to 48%, with a 23% reduction identified to the entire Little Blackfoot watershed. The loading reductions listed in **Table C4-8** were calculated based on the achievable reductions in loading to the 303(d) listed water body segments, while additional reductions may also be possible from the tributaries to the listed water bodies. Because the actual loading estimates from this assessment will not be used for TMDL development, but the percentage of loading reductions and percentage of human-induced and natural erosion from this assessment will be used, **Table C4-9** includes the percentage by source for all waterbody segments with TMDLs in **Section 5.0** of the document.

Table C4-8. Sub-watershed Sediment Load Reductions with BMPs.

Stream Segment	Existing Sediment Load (Tons/Year)			Reduced Sediment Load through BMPs (Tons/Year)			Potential Reduction in Total Sediment Load (Total Existing-Total Reduced) (Tons/Year)	Percent Reduction in Total Sediment Load (Potential Reduction/Total Existing)	Potential Reduction in Anthropogenic Sediment Load (Anthropogenic Existing-Anthropogenic Reduced) (Tons/Year)	Percent Reduction in Anthropogenic Sediment Load (Potential Reduction/Anthropogenic Existing)
	Total Sediment Load (Tons/Year)	Anthropogenic Sediment Load (Tons/Year)	Natural Sediment Load (Tons/Year)	Total Sediment Load (Tons/Year)	Anthropogenic Sediment Load (Tons/Year)	Natural Sediment Load (Tons/Year)				
Upper Little Blackfoot										
Upper Dog Creek	360.5	310.0	50.5	336.6	286.1	50.5	23.9	7%	23.9	8%
Lower Dog Creek	1566.5	1395.8	170.8	1313.9	1143.2	170.8	252.6	16%	252.6	18%
Upper Telegraph Creek	279.5	198.4	81.0	257.8	176.7	81.0	21.7	8%	21.7	11%
Lower Telegraph Creek	344.1	247.6	96.5	313.6	217.2	96.5	30.5	9%	30.5	12%
Little Blackfoot River, Upper										
Upper Little Blackfoot Sub-watershed	3882.4	2987.1	895.3	3489.7	2594.4	895.3	392.7	10%	392.7	13%
Lower Little Blackfoot										
Elliston Creek	137.7	91.6	46.1	115.7	69.7	46.1	21.9	16%	21.9	24%
Snowshoe Creek	352.4	321.2	31.1	278.4	247.2	31.1	74.0	21%	74.0	23%
Spotted Dog Creek	1289.5	1203.4	86.1	709.1	623.0	86.1	580.4	45%	580.4	48%
Threemile Creek	953.1	922.5	30.6	880.3	849.6	30.6	72.8	8%	72.8	8%
Trout Creek	472.3	436.8	35.5	352.1	316.6	35.5	120.2	25%	120.2	28%
Little Blackfoot River, Lower										
Lower Little Blackfoot Sub-watershed	10809.8	10011.0	798.8	8221.6	7422.8	798.8	2588.2	24%	2588.2	26%
Little Blackfoot TPA										
Little Blackfoot Watershed	14692.2	13124.5	1567.7	11711.3	10143.7	1567.7	2980.8	20%	2980.8	23%

Table C4-9. Percentage of human-induced and natural streambank erosion per waterbody segment (only for those with TMDLs in Section 5.0).

Stream Segment	%Natural Load	% Human-Induced
Upper Little Blackfoot		
Upper Dog Creek	14%	86%
Lower Dog Creek	11%	89%
Upper Telegraph Creek	29%	71%
Lower Telegraph Creek	28%	72%
Upper Little Blackfoot Sub-watershed	23%	77%
Lower Little Blackfoot		
Elliston Creek	33%	67%
Snowshoe Creek	9%	91%
Spotted Dog Creek	7%	93%
Threemile Creek	3%	97%
Trout Creek	8%	92%
Lower Little Blackfoot Sub-watershed	7%	93%
Little Blackfoot Watershed	11%	89%

C5.0 Assumptions and Uncertainty

This assessment assumes that different streams with similar reach type characteristics will have similar physical attributes and sediment loads due to streambank erosion. Since only a portion of the streams within the Little Blackfoot TPA were assessed in the field, a degree of uncertainty is unavoidable when extrapolating data from assessed sites to un-assessed sites. There is also some uncertainty in identifying streambank erosion sources from aerial imagery and a portion of the identified anthropogenic load is likely due to natural streambank erosion processes. Use of the USGS 1:100,000 NHD stream layer in GIS also creates uncertainty, since this layer was created from topographic maps and may not accurately represent conditions on the ground.

Sediment limitations in many streams in the Little Blackfoot TPA relate to the fine sediment fraction found on the stream bottom, while streambank erosion sediment modeling examined all sediment sizes. Since sediment source modeling may under-estimate or over-estimate sediment inputs due to selection of sediment monitoring sites and the extrapolation methods used, model results should not be taken as an absolutely accurate account of sediment production within each sub-watershed. Instead, the streambank erosion assessment model results should be considered an instrument for estimating sediment loads and making general comparisons of sediment loads from various sources.

C6.0 Summary

The 2009 sediment and habitat assessment in the Little Blackfoot TPA provides a comprehensive analysis of existing sediment conditions within impaired stream segments and estimated streambank erosion sediment loads for use in TMDL development. A total of 129 reaches were delineated during the aerial assessment reach stratification process covering 128.1 miles of stream. Based on the level III ecoregion, there were a total of 19 distinct reach types and sediment and habitat parameters were assessed at 19 monitoring sites. Statistical analysis of the sediment and habitat data from the 19 monitoring sites will aid in developing sediment TMDL targets that are specific for the Little Blackfoot

TPA, while streambank erosion data will be utilized in the sediment TMDL. Within the 19 monitoring sites, an average annual sediment load of 438 tons/year was attributed to the 92 assessed eroding streambanks and average annual sediment load of 9,748 tons/year was estimated for the listed stream segments. Out of the 523.1 miles of stream within the Little Blackfoot TPA, a total sediment load of 14,692 tons per year was estimated. It is estimated that this sediment load can be reduced to 11,711 tons/year, which is a 23% reduction in sediment load from streambank erosion.

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Attachment CA - Sediment & Habitat Database, Little Blackfoot TMDL Planning Area

Reach ID	Site	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Cross-Sectional Area	Bankfull Mean Depth	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Number of Pools per 1000 Feet	Mean Residual Pool Depth	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
DOG11-09	1	7/7/09	1	MR-0-3-U	E4	E4	1.26	1.0	<2%	15.5	23.5	1.51	10.2	2.3	135.5	8.7	44	2	11	3		8	1.5	3	0	5	25	0	0	0	140	>200
DOG11-09	1	7/7/09	2	MR-0-3-U	E4	E4	1.26	1.0	<2%	14.5	24.8	1.71	8.5	2.3	129.5	8.9	31	8	14								23	13	0	0	>200	>200
DOG12-04	1	7/7/09	1	MR-0-4-U	C4	E4	1.12	1.0	<2%	30.0	37.8	1.26	23.8	2.3	240.0	>8.0	38	1	10	3		6	1.7	1	0	2	25	0	0	0	23	13
DOG12-04	1	7/7/09	2	MR-0-4-U	C4	E4	1.12	1.0	<2%	22.9	32.1	1.40	16.4	2.5	272.9	>11.9											43	0	8	0	23	33
DOG12-04	1	7/7/09	3	MR-0-4-U	E4	E4	1.12	1.0	<2%	14.0	32.5	2.32	6.0	3.4	89.0	6.4	35	7	7	5							55	3	3	0	31	15
DOG12-04	1	7/7/09	4	MR-0-4-U	B4c	E4	1.12	1.0	<2%	31.0	38.6	1.25	24.9	2.0	51.0	1.6											40	8	0	0	26	0
DOG12-04	1	7/7/09	5	MR-0-4-U	F4	E4	1.12	1.0	<2%	19.0	22.8	1.20	15.8	2.3	24.0	1.3	58	1	4	3							63	0	28	0	19	0
DOG13-03	1	7/8/09	1	MR-0-4-U	B4	C4	1.01	3.6	<2%	25.7	32.0	1.25	20.6	1.7	45.7	1.8	53	2	4	3		2	0.8	1	0	1	40	0	0	8	0	0
DOG13-03	1	7/8/09	2	MR-0-4-U	B4	C4	1.01	3.6	<2%	24.0	31.8	1.33	18.1	2.1	33.5	1.4											23	0	3	0	0	0
DOG13-03	1	7/8/09	3	MR-0-4-U	F4b	C4	1.01	3.6	<2%	34.8	34.1	0.98	35.5	1.4	37.3	1.1	55	1	4	7							20	0	0	0	3	2
DOG13-03	1	7/8/09	4	MR-0-4-U	F4b	C4	1.01	3.6	<2%	25.3	34.4	1.36	18.6	1.9	31.3	1.2											30	0	5	0	0	4
DOG13-03	1	7/8/09	5	MR-0-4-U	F4b	C4	1.01	3.6	<2%	33.5	37.5	1.12	29.9	1.5	45.0	1.3	44	3	10	3							48	0	3	0	1	9
ELLI08-01	1	7/6/09	1	MR-2-2-C	E4	E4	1.21	1.1	2-<4%	9.5	8.5	0.89	10.7	1.4	35.6	3.7	5	38	53	53		32	0.8	62	2	70	10	10	0	45	0	0
ELLI08-01	1	7/6/09	2	MR-2-2-C	C4	E4	1.21	1.1	2-<4%	8.5	5.8	0.68	12.5	1.1	40.5	4.8											45	5	0	0	8	3
ELLI08-01	1	7/6/09	3	MR-2-2-C	E4	E4	1.21	1.1	2-<4%	7.0	7.3	1.04	6.7	1.3	46.0	6.6	13	12	37	33							5	5	0	0	0	0
ELLI08-01	1	7/6/09	4	MR-2-2-C	E4	E4	1.21	1.1	2-<4%	8.3	7.5	0.90	9.2	1.2	43.3	5.2											20	5	0	0	0	0
ELLI08-01	1	7/6/09	5	MR-2-2-C	E4	E4	1.21	1.1	2-<4%	6.0	7.0	1.16	5.2	1.4	56.0	9.3	17	10	25	18							25	0	0	10	3	3
ELLI08-02	1	7/6/09	1	MR-2-2-C	E4	E4	1.36	1.5	2-<4%	6.0	6.8	1.14	5.3	1.4	63.0	10.5	13	22	26	21	71	22	0.8	18	0	38	25	0	0	20	30	15
ELLI08-02	1	7/6/09	2	MR-2-2-C	C4	E4	1.36	1.5	2-<4%	9.5	6.8	0.72	13.2	1.2	54.5	5.7											45	5	0	30	20	35
ELLI08-02	1	7/6/09	3	MR-2-2-C	E4	E4	1.36	1.5	2-<4%	8.3	6.5	0.78	10.6	1.5	33.3	4.0	20	4	21	33							45	0	0	25	13	21
ELLI08-02	1	7/6/09	4	MR-2-2-C					2-<4%																		40	0	0	0	40	20
ELLI08-02	1	7/6/09	5	MR-2-2-C	B4c	E4	1.36	1.5	2-<4%	11.5	8.4	0.73	15.8	1.6	19.5	1.7	18	2	23	46							35	0	0	20	43	25
LBR24-03	1	7/10/09	1	MR-0-4-U	B3	C3b	1.11	3.2	<2%	47.0	85.2	1.81	25.9	2.3	97.0	2.1	68	4	6	1	87	2	1.7	9	1	11	70	5	0	10	>200	>200
LBR24-03	1	7/10/09	2	MR-0-4-U	C3b	C3b	1.11	3.2	<2%	35.8	64.2	1.79	20.0	2.4	265.8	7.4											68	5	0	3	>200	>180
LBR24-03	1	7/10/09	3	MR-0-4-U	C3b	C3b	1.11	3.2	<2%	48.2	75.7	1.57	30.7	2.6	383.2	>8.0	85	3	7	1	51						55	10	0	8	>200	>200
LBR24-03	1	7/10/09	4	MR-0-4-U	C3b	C3b	1.11	3.2	<2%	33.0	59.7	1.81	18.2	2.6	151.0	4.6											33	23	0	30	>200	>200
LBR24-03	1	7/10/09	5	MR-0-4-U	C3b	C3b	1.11	3.2	<2%	28.8	58.6	2.03	14.2	2.7	238.8	8.3	72	4	5	1							88	5	0	5	>200	>120
LBR26-06	1	7/8/09	1	MR-0-5-U	C3	C4	1.28	1.4	<2%	78.5	152.9	1.95	40.3	3.1	288.5	>3.7	84	3	3	3	51	5	2.5	8	5	40	55	0	0	3	>200	>200
LBR26-06	1	7/8/09	2	MR-0-5-U	C3/4	C4	1.28	1.4	<2%	71.4	135.6	1.90	37.6	2.7	346.4	>4.8											40	0	0	53	>200	>190
LBR26-06	1	7/8/09	3	MR-0-5-U					<2%																		48	0	0	5	>200	66
LBR26-06	1	7/8/09	4	MR-0-5-U	C4	C4	1.28	1.4	<2%	67.5	128.9	1.91	35.3	3.3	427.5	>6.3	38	5	7	8	78						55	0	0	15	>200	103
LBR26-06	1	7/8/09	5	MR-0-5-U	C3	C4	1.28	1.4	<2%	62.3	134.6	2.16	28.8	3.0	307.3	>4.9	78	0	4	1	51						63	0	0	8	>200	40
LBR27-06	1	7/9/09	1	MR-0-5-U	C3/4	C4	1.62	2.0	<2%	110.6	203.7	1.84	60.1	3.6	650.6	>5.9						5	3.2	9	2	18	30	0	0	15	60	14
LBR27-06	1	7/9/09	2	MR-0-5-U					<2%																		48	0	0	8	43	31
LBR27-06	1	7/9/09	3	MR-0-5-U	C3	C4	1.62	2.0	<2%	91.0	183.5	2.02	45.1	3.2	591.0	6.5	70	0	0	1	32						45	0	0	3	9	56
LBR27-06	1	7/9/09	4	MR-0-5-U	C4	C4	1.62	2.0	<2%	50.0	146.6	2.93	17.1	4.3	650.0	>13.0	50	4	5	10	44						50	0	0	15	29	11

Reach ID	Site	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Cross-Sectional Area	Bankfull Mean Depth	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Number of Pools per 1000 Feet	Mean Residual Pool Depth	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
LBR27-06	1	7/9/09	5	MR-0-5-U					<2%																		33	0	0	10	19	20
LBR30-05	1	7/9/09	1	MR-0-5-U	B4c	C4	1.03	2.0	<2%	62.9	154.8	2.46	25.6	3.9	130.9	2.1	58	2	3	2		3	2.4	8	0	8	23	0	5	50	11	0
LBR30-05	1	7/9/09	2	MR-0-5-U	B3/4c	C4	1.03	2.0	<2%	79.0	203.4	2.58	30.7	3.3	156.0	2.0											30	28	50	48	4	0
LBR30-05	1	7/9/09	3	MR-0-5-U	C3	C4	1.03	2.0	<2%	79.2	139.3	1.76	45.0	3.2	195.2	2.5	70	0	4	1	51						45	3	30	60	8	0
LBR30-05	1	7/9/09	4	MR-0-5-U					<2%																		5	8	23	58	4	0
LBR30-05	1	7/9/09	5	MR-0-5-U	B3c	C4	1.03	2.0	<2%	83.7	170.0	2.03	41.2	3.0	153.7	1.8	72	1	1								30	3	20	30	33	0
SNOW08-01	1	7/14/09	1	MR-4-1-U	E4b	E4b	1.15	2-<4%	4-<10%	5.8	5.8	1.00	5.8	1.7	19.8	3.4	19	7	9	10		15	0.6	55	0	55	75	0	0	15	10	5
SNOW08-01	1	7/14/09	2	MR-4-1-U	E4b	E4b	1.15	2-<4%	4-<10%	5.9	6.4	1.09	5.4	1.4	13.9	2.4											80	0	0	55	0	0
SNOW08-01	1	7/14/09	3	MR-4-1-U	E4b	E4b	1.15	2-<4%	4-<10%	5.2	5.0	0.97	5.4	1.2	19.2	3.7	15	8	15	10							45	0	0	30	10	0
SNOW08-01	1	7/14/09	4	MR-4-1-U	E4b	E4b	1.15	2-<4%	4-<10%	8.0	7.8	0.97	8.2	1.4	108.0	13.5	20	2	5								15	0	0	15	0	5
SNOW18-05	1	7/9/09	1	MR-0-2-U	E4	E4	3.18	0.9	<2%	11.1	13.7	1.24	9.0	2.0	30.1	2.7	15	6	16	27		21	1.5	1	1	7	8	0	0	0	23	30
SNOW18-05	1	7/9/09	2	MR-0-2-U	E4	E4	3.18	0.9	<2%	8.0	12.2	1.53	5.2	1.8	39.6	5.0											48	0	0	20	20	38
SNOW18-05	1	7/9/09	3	MR-0-2-U	E4	E4	3.18	0.9	<2%	12.6	16.5	1.31	9.6	2.0	229.6	>18.2	11	20	25	24							33	0	0	5	23	40
SNOW18-05	1	7/9/09	4	MR-0-2-U	E4	E4	3.18	0.9	<2%	12.0	20.5	1.71	7.0	2.2	232.0	>19.3											13	0	0	0	28	20
SNOW18-05	1	7/9/09	5	MR-0-2-U	E4	E4	3.18	0.9	<2%	12.5	17.0	1.36	9.2	2.0	28.5	2.3	13	5	16	5							18	0	0	5	27	23
SPOT01-01	1	7/14/09	1	MR-2-2-U	C4	B4	1.08	1.8	2-<4%	17.3	16.1	0.93	18.5	1.3	42.5	2.5	53	4	6	10		20	1.0	53	7	85	10	0	0	65	>198	>200
SPOT01-01	1	7/14/09	2	MR-2-2-U	B4c	B4	1.08	1.8	2-<4%	16.1	13.6	0.85	19.0	1.2	23.3	1.4											8	0	0	30	193	>200
SPOT01-01	1	7/14/09	3	MR-2-2-U	C4	B4	1.08	1.8	2-<4%	15.6	14.1	0.90	17.3	1.4	174.6	11.2	12	20	35	3							10	0	0	28	153	>200
SPOT01-01	1	7/14/09	4	MR-2-2-U	C4	B4	1.08	1.8	2-<4%	17.9	16.0	0.89	20.1	1.3	54.9	3.1											18	3	0	40	105	>200
SPOT01-01	1	7/14/09	5	MR-2-2-U	E4	B4	1.08	1.8	2-<4%	11.7	14.4	1.23	9.5	1.9	37.7	3.2	31	8	14	5							15	3	0	50	108	>200
SPOT12-02	1	7/8/09	1	MR-0-3-U					<2%													8	1.7	0	0	5	3	0	0	0	>153	>200
SPOT12-02	1	7/8/09	2	MR-0-3-U	B4	E4	1.90	2.2	<2%	20.8	25.6	1.23	16.9	2.0	45.8	2.2	40	0	5	6	54						8	0	0	0	>200	>200
SPOT12-02	1	7/8/09	3	MR-0-3-U	B4	E4	1.90	2.2	<2%	30.3	28.0	0.93	32.8	2.3	41.3	1.4	53	2	4	5							8	0	0	5	>200	>200
SPOT12-02	1	7/8/09	4	MR-0-3-U	C4b	E4	1.90	2.2	<2%	17.0	20.3	1.20	14.2	1.7	232.0	>13.6											10	0	0	3	>200	>200
SPOT12-02	1	7/8/09	5	MR-0-3-U	C4b	E4	1.90	2.2	<2%	20.6	28.2	1.37	15.0	2.0	220.6	>10.7	43	1	5	3							5	0	0	0	>200	>200
TELE04-01	1	7/6/09	1	MR-4-3-U	B3	B3	1.07	3.0	4-<10%	19.5	25.4	1.30	15.0	2.1	42.5	2.2	64	4	7	7		10	1.4	11	3	25	53	8	0	20	>183	>200
TELE04-01	1	7/6/09	2	MR-4-3-U	B3	B3	1.07	3.0	4-<10%	20.0	31.7	1.59	12.6	2.1	40.0	2.0											43	8	0	45	>200	>200
TELE04-01	1	7/6/09	3	MR-4-3-U	F3b	B3	1.07	3.0	4-<10%	22.0	32.1	1.46	15.1	2.0	29.0	1.3	64	1	5	5							30	10	0	33	>188	>200
TELE04-01	1	7/6/09	4	MR-4-3-U	F3b	B3	1.07	3.0	4-<10%	22.0	26.0	1.18	18.6	1.8	39.0	1.8											30	3	0	35	>200	>200
TELE04-01	1	7/6/09	5	MR-4-3-U	B3	B3	1.07	3.0	4-<10%	27.0	24.0	0.89	30.3	1.9	62.0	2.3	121	2	3	3							25	0	0	30	>200	>200
TELE10-02	1	7/7/09	1	MR-0-3-U	B4c	E4	1.25	1.5	<2%	19.8	21.2	1.07	18.5	1.8	39.8	2.0	43	2	14	5		9	1.5	0	0	4	65	20	0	5	>200	>200
TELE10-02	1	7/7/09	2	MR-0-3-U	F4	E4	1.25	1.5	<2%	22.0	24.2	1.10	20.0	2.1	25.0	1.1											85	8	0	3	>200	>200
TELE10-02	1	7/7/09	3	MR-0-3-U	G4c	E4	1.25	1.5	<2%	17.7	27.5	1.55	11.4	2.1	21.7	1.2	29	4	24								63	0	0	13	>200	>200
TELE10-02	1	7/7/09	4	MR-0-3-U	B4	E4	1.25	1.5	<2%	21.0	23.6	1.12	18.7	1.9	36.0	1.7											75	5	0	13	>200	>200
TELE10-02	1	7/7/09	5	MR-0-3-U	C4	E4	1.25	1.5	<2%	17.0	21.7	1.28	13.3	1.7	52.0	3.1	62	1	5	5							58	5	0	10	>69	>158

Reach ID	Site	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Cross-Sectional Area	Bankfull Mean Depth	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Number of Pools per 1000 Feet	Mean Residual Pool Depth	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
THRE16-01	1	7/15/09	1	MR-2-3-U	E4	E4	1.48	1.3	2-<4%	13.9	16.2	1.17	11.9	1.7	153.9	11.1	26	12	23	2		19	1.0	0	0	13	43	3	0	45	>200	>200
THRE16-01	1	7/15/09	2	MR-2-3-U					2-<4%																		50	0	0	20	>200	>200
THRE16-01	1	7/15/09	3	MR-2-3-U	C4	E4	1.48	1.3	2-<4%	20.0	13.7	0.69	29.2	1.2	223.0	>11.2	26	19	22								43	0	0	25	>200	>200
THRE16-01	1	7/15/09	4	MR-2-3-U	C4	E4	1.48	1.3	2-<4%	14.5	11.5	0.79	18.4	1.9	44.5	3.1											15	0	0	5	>200	>200
THRE16-01	1	7/15/09	5	MR-2-3-U		E4	1.48	1.3	2-<4%	16.0	12.3	0.77	20.8	1.5			57	4	4								43	0	0	0	>200	>200
THRE17-01	1	7/15/09	1	MR-0-3-U	C3	E4	1.23	1.8	<2%	27.5	30.3	1.10	24.9	1.9	377.5	13.7	87	5	11	1		3	3.1	0	0	2	10	0	0	5	158	>200
THRE17-01	1	7/15/09	2	MR-0-3-U	C3/4	E4	1.23	1.8	<2%	23.0	34.5	1.50	15.3	2.2	224.0	9.7											8	0	0	3	>200	>200
THRE17-01	1	7/15/09	3	MR-0-3-U	C4	E4	1.23	1.8	<2%	22.0	25.5	1.16	19.0	2.0	222.0	10.1	43	6	7	1							3	5	0	0	>200	>200
TROU15-01	1	7/14/09	1	MR-2-2-U	B4	B4	1.10	2.2	2-<4%	12.4	9.2	0.75	16.6	1.2	27.4	2.2	29	6	16	5		9	0.8	8	1	10	68	0	0	5	44	35
TROU15-01	1	7/14/09	2	MR-2-2-U	B4	B4	1.10	2.2	2-<4%	10.1	7.9	0.78	12.9	1.2	15.1	1.5											68	0	0	3	39	39
TROU15-01	1	7/14/09	3	MR-2-2-U	F4b	B4	1.10	2.2	2-<4%	12.5	10.0	0.80	15.6	1.4	16.0	1.3	48	4	6	6							58	0	0	18	22	13
TROU15-01	1	7/14/09	4	MR-2-2-U	C4b	B4	1.10	2.2	2-<4%	10.7	9.1	0.85	12.5	1.2	47.7	4.5											58	0	0	0	23	50
TROU15-01	1	7/14/09	5	MR-2-2-U	C4b	B4	1.10	2.2	2-<4%	12.3	10.4	0.85	14.6	1.4	28.9	2.3	48	7	13	5							43	0	0	0	38	36
TROU17-04	1	7/10/09	1	MR-0-2-U	E4	E4	1.40	1.5	<2%	3.3	5.2	1.56	2.1	1.7	30.3	9.2	19	12	17	11		24	0.9	2	0	4	10	0	0	0	10	50
TROU17-04	1	7/10/09	2	MR-0-2-U	E4	E4	1.40	1.5	<2%	11.4	13.3	1.16	9.8	1.8	223.4	>19.6											30	0	0	0	20	75
TROU17-04	1	7/10/09	3	MR-0-2-U	E4	E4	1.40	1.5	<2%	11.1	11.1	1.00	11.1	1.5	223.1	>20.1	12	7	18	7							45	0	0	0	0	20
TROU17-04	1	7/10/09	4	MR-0-2-U	E4	E4	1.40	1.5	<2%	12.1	12.5	1.04	11.7	1.7	213.6	>17.7											5	0	0	0	0	50
TROU17-04	1	7/10/09	5	MR-0-2-U	C4	E4	1.40	1.5	<2%	14.5	9.9	0.68	21.3	1.2	191.5	13.2	31	7	12	3	68						10	0	0	0	0	50

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
DOG11-09	MR-0-3-U	1	1.2		
DOG11-09	MR-0-3-U	2	1.5		
DOG11-09	MR-0-3-U	3	1.7		
DOG12-04	MR-0-4-U	1	1.9		
DOG12-04	MR-0-4-U	2	2.2	Y	3
DOG12-04	MR-0-4-U	3	2.0		
DOG12-04	MR-0-4-U	4	1.2		
DOG12-04	MR-0-4-U	5	1.3		
DOG12-04	MR-0-4-U	6	1.4	Y	5
DOG13-03	MR-0-4-U	1	0.9		
DOG13-03	MR-0-4-U	2	0.6	Y	6.8
ELLI08-01	MR-2-2-C	1	0.7		
ELLI08-01	MR-2-2-C	2	0.7	Y	30
ELLI08-01	MR-2-2-C	3	0.7	Y	13
ELLI08-01	MR-2-2-C	4	1.1	Y	1
ELLI08-01	MR-2-2-C	5	1.0	Y	43
ELLI08-01	MR-2-2-C	6	0.9	Y	13
ELLI08-01	MR-2-2-C	7	0.8		
ELLI08-01	MR-2-2-C	8	0.7	Y	20
ELLI08-01	MR-2-2-C	9	0.9	Y	3
ELLI08-01	MR-2-2-C	10	0.3	Y	36
ELLI08-01	MR-2-2-C	11	0.7	Y	28
ELLI08-01	MR-2-2-C	12	0.8	Y	7
ELLI08-01	MR-2-2-C	13	1.1	Y	5
ELLI08-01	MR-2-2-C	14	1.3	Y	1
ELLI08-01	MR-2-2-C	15	0.7	Y	18
ELLI08-01	MR-2-2-C	16	0.9	Y	27
ELLI08-02	MR-2-2-C	1	0.7	Y	6
ELLI08-02	MR-2-2-C	2	0.5		
ELLI08-02	MR-2-2-C	3	0.6	Y	10
ELLI08-02	MR-2-2-C	4	0.5		
ELLI08-02	MR-2-2-C	5	1.1	Y	14
ELLI08-02	MR-2-2-C	6	0.8	Y	9
ELLI08-02	MR-2-2-C	7	1.6	Y	11
ELLI08-02	MR-2-2-C	8	0.7		
ELLI08-02	MR-2-2-C	9	0.8		
ELLI08-02	MR-2-2-C	10	0.8		
ELLI08-02	MR-2-2-C	11	1.0	Y	0
LBR24-03	MR-0-4-U	1	1.7		
LBR24-03	MR-0-4-U	2	1.6	Y	13.8
LBR24-03	MR-0-4-U	3	1.8		

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
LBR26-06	MR-0-5-U	1	2.9	Y	11
LBR26-06	MR-0-5-U	2	2.3	Y	1
LBR26-06	MR-0-5-U	3	2.1		
LBR26-06	MR-0-5-U	4			
LBR26-06	MR-0-5-U	5	3.0		
LBR26-06	MR-0-5-U	6	2.1	Y	7
LBR26-06	MR-0-5-U	7	1.3		
LBR26-06	MR-0-5-U	8	3.6		
LBR26-06	MR-0-5-U	9	3.4	Y	0
LBR26-06	MR-0-5-U	10	2.0		
LBR27-06	MR-0-5-U	1	4.3	Y	1
LBR27-06	MR-0-5-U	2	3.5	not recorded	0
LBR27-06	MR-0-5-U	3	4.7	Y	0
LBR27-06	MR-0-5-U	4	2.9		
LBR27-06	MR-0-5-U	5	2.4	Y	0
LBR27-06	MR-0-5-U	6	3.0	not recorded	6
LBR27-06	MR-0-5-U	7	4.0	Y	1
LBR27-06	MR-0-5-U	8	2.2		
LBR27-06	MR-0-5-U	9	1.9	Y	0
LBR30-05	MR-0-5-U	1	0.9		
LBR30-05	MR-0-5-U	2	1.7		
LBR30-05	MR-0-5-U	3	2.2		
LBR30-05	MR-0-5-U	4	3.0		
LBR30-05	MR-0-5-U	5	4.4		
LBR30-05	MR-0-5-U	6	1.9		
SNOW08-01	MR-4-1-U	1			
SNOW08-01	MR-4-1-U	2			
SNOW08-01	MR-4-1-U	3			
SNOW08-01	MR-4-1-U	4	0.5	Y	5
SNOW08-01	MR-4-1-U	5	0.8	Y	21
SNOW08-01	MR-4-1-U	6	0.4	Y	22
SNOW18-05	MR-0-2-U	1	1.6	Y	16
SNOW18-05	MR-0-2-U	2	2.3	Y	10
SNOW18-05	MR-0-2-U	3	1.4	Y	5
SNOW18-05	MR-0-2-U	4	1.1	Y	2
SNOW18-05	MR-0-2-U	5	1.3		
SNOW18-05	MR-0-2-U	6	1.2	Y	1
SNOW18-05	MR-0-2-U	7			
SNOW18-05	MR-0-2-U	8	1.0		
SNOW18-05	MR-0-2-U	9	1.8	Y	29
SNOW18-05	MR-0-2-U	10	2.0		

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
SNOW18-05	MR-0-2-U	11	1.5	Y	5
SNOW18-05	MR-0-2-U	12	0.8	N	52
SNOW18-05	MR-0-2-U	13	1.8	N	54
SNOW18-05	MR-0-2-U	14	1.1	Y	4
SNOW18-05	MR-0-2-U	15	1.4	Y	7
SNOW18-05	MR-0-2-U	16	1.4	Y	3
SNOW18-05	MR-0-2-U	17	1.8	Y	3
SNOW18-05	MR-0-2-U	18	1.3	Y	17
SNOW18-05	MR-0-2-U	19	1.6	Y	10
SNOW18-05	MR-0-2-U	20	1.4	Y	5
SNOW18-05	MR-0-2-U	21	2.1	Y	18
SPOT01-01	MR-2-2-U	1	1.2	Y	14
SPOT01-01	MR-2-2-U	2	0.6	Y	8
SPOT01-01	MR-2-2-U	3	0.8	Y	3
SPOT01-01	MR-2-2-U	4	0.6	Y	4
SPOT01-01	MR-2-2-U	5	1.2	Y	7
SPOT01-01	MR-2-2-U	6	1.1	Y	6
SPOT01-01	MR-2-2-U	7	1.6	Y	8
SPOT01-01	MR-2-2-U	8	0.7	Y	7
SPOT01-01	MR-2-2-U	9	0.6		
SPOT01-01	MR-2-2-U	10	0.5	Y	3
SPOT01-01	MR-2-2-U	11	1.2	Y	6
SPOT01-01	MR-2-2-U	12	1.1		
SPOT01-01	MR-2-2-U	13	0.6	Y	5
SPOT01-01	MR-2-2-U	14	0.9	Y	8
SPOT01-01	MR-2-2-U	15	0.7		
SPOT01-01	MR-2-2-U	16	0.8		
SPOT01-01	MR-2-2-U	17	0.8		
SPOT01-01	MR-2-2-U	18	1.3	Y	12
SPOT01-01	MR-2-2-U	19	1.5		
SPOT01-01	MR-2-2-U	20	1.2	Y	14
SPOT12-02	MR-0-3-U	1	2.1	Y	5
SPOT12-02	MR-0-3-U	2	1.9	Y	9
SPOT12-02	MR-0-3-U	3	1.8		
SPOT12-02	MR-0-3-U	4	2.0	Y	1
SPOT12-02	MR-0-3-U	5	2.0		
SPOT12-02	MR-0-3-U	6	0.9	Y	11
SPOT12-02	MR-0-3-U	7	1.6		
SPOT12-02	MR-0-3-U	8	1.4		
TELE04-01	MR-4-3-U	1	1.1		
TELE04-01	MR-4-3-U	2	0.8	Y	1
TELE04-01	MR-4-3-U	3	0.9		
TELE04-01	MR-4-3-U	4	0.9		

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
TELE04-01	MR-4-3-U	5	2.2		
TELE04-01	MR-4-3-U	6	0.9	Y	3
TELE04-01	MR-4-3-U	7			
TELE04-01	MR-4-3-U	8	1.5		
TELE04-01	MR-4-3-U	9	1.3		
TELE04-01	MR-4-3-U	10	2.7	Y	1
TELE10-02	MR-0-3-U	1	2.4	Y	9
TELE10-02	MR-0-3-U	2	1.0		
TELE10-02	MR-0-3-U	3	1.2		
TELE10-02	MR-0-3-U	4	1.9	Y	3
TELE10-02	MR-0-3-U	5	1.1		
TELE10-02	MR-0-3-U	6	1.3		
TELE10-02	MR-0-3-U	7	2.2	Y	0
TELE10-02	MR-0-3-U	8	1.1		
TELE10-02	MR-0-3-U	9	1.0		
THRE16-01	MR-2-3-U	1	0.6		
THRE16-01	MR-2-3-U	2	1.7		
THRE16-01	MR-2-3-U	3	1.0		
THRE16-01	MR-2-3-U	4	0.5		
THRE16-01	MR-2-3-U	5	0.5		
THRE16-01	MR-2-3-U	6	1.1	Y	1
THRE16-01	MR-2-3-U	7	0.7		
THRE16-01	MR-2-3-U	8	1.3		
THRE16-01	MR-2-3-U	9	1.4	Y	1
THRE16-01	MR-2-3-U	10	1.4		
THRE16-01	MR-2-3-U	11	1.0	Y	5
THRE16-01	MR-2-3-U	12	0.5		
THRE16-01	MR-2-3-U	13	1.0		
THRE16-01	MR-2-3-U	14	0.7		
THRE16-01	MR-2-3-U	15	1.6		
THRE16-01	MR-2-3-U	16	1.3		
THRE16-01	MR-2-3-U	17	1.5	Y	1
THRE16-01	MR-2-3-U	18	1.2		
THRE16-01	MR-2-3-U	19	0.7		
THRE17-01	MR-0-3-U	1	4.3	Y	10
THRE17-01	MR-0-3-U	2	1.8	Y	1
TROU15-01	MR-2-2-U	1	0.5		
TROU15-01	MR-2-2-U	2	0.7	Y	9
TROU15-01	MR-2-2-U	3	0.9		
TROU15-01	MR-2-2-U	4	0.8		
TROU15-01	MR-2-2-U	5	0.7	Y	11
TROU15-01	MR-2-2-U	6	0.6		

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
TROU15-01	MR-2-2-U	7	0.9		
TROU15-01	MR-2-2-U	8	1.0		
TROU15-01	MR-2-2-U	9	0.9		
TROU17-04	MR-0-2-U	1	0.5		
TROU17-04	MR-0-2-U	2			
TROU17-04	MR-0-2-U	3	1.3	Y	60
TROU17-04	MR-0-2-U	4	1.2	Y	32
TROU17-04	MR-0-2-U	5			
TROU17-04	MR-0-2-U	6	0.7	Y	62
TROU17-04	MR-0-2-U	7	1.1	Y	49
TROU17-04	MR-0-2-U	8	0.9	Y	4
TROU17-04	MR-0-2-U	9			
TROU17-04	MR-0-2-U	10	0.6	not recorded	9
TROU17-04	MR-0-2-U	11	0.7		
TROU17-04	MR-0-2-U	12	1.0		

Y = Spawning Gravels Present
N = Spawning Gravels Absent
Q = Questionable Spawning Gravels