APPENDIX D - SEDIMENT DATA COLLECTION METHODS AND SUMMARIES OF MONITORED WATERBODIES WITH NO TMDL WRITTEN

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D1.0 INTRODUCTION

This appendix summarizes sediment and habitat data collected and analyzed for the stream segments evaluated in the Red Rock TPA. Nineteen stream segments in the Red Rock TPA were evaluated for sediment impairments based on existing impairment listings, reconnaissance, and input from local stakeholders (**Table D-1 and Figure D-1**). Of the 19, 18 were found to be impaired and TMDLs were written (see **Section 6** in the main TMDL document for summary information on these 18 stream segments). One stream segment (Bloody Dick Creek) was found not impaired by sediment and is summarized within this Appendix. Most of the 18 segments have a habitat alteration impairment, which is a non-pollutant impairment commonly associated with sediment impairment (**Table D-1**). TMDLs are limited to pollutants, but implementation of land, soil, and water conservation practices to reduce pollutant loading will inherently address some non-pollutant impairments. Such approaches are highlighted in Montana DEQ's Nonpoint Source Management Plan (DEQ, 2017)

Table D-1. Stream Segments Evaluated for Sediment Impairment

Stream Segment	Segment (Assessment Unit) ID	Sediment TMDL Developed
Bean Creek	MT41A004_140	Yes*
Big Sheep Creek	MT41A003_150	Yes*
Bloody Dick Creek	MT41A003_100	No
Corral Creek	MT41A004_040	Yes*
East Fork Clover Creek	MT41A004_050	Yes
Fish Creek	MT41A004_030	Yes*
Horse Prairie Creek	MT41A003_090	Yes*
Long Creek	MT41A004_070	Yes*
Jones Creek	MT41A004_130	Yes*
Medicine Lodge Creek	MT41A003_010	Yes*
Muddy Creek	MT41A003_020	Yes*
O'Dell Creek	MT41A004_080	Yes*
Peet Creek	MT41A004_090	Yes*
Price Creek	MT41A004_010	Yes*
Sage Creek	MT41A003_140	Yes*
Red Rock Creek	MT41A004_110	Yes
Selway Creek	MT41A003_110	Yes*
Tom Creek	MT41A004_100	Yes*
Trail Creek	MT41A003_080	Yes*

*Non-pollutant listing(s) associated with sediment impairment on the 2020 303(d) List

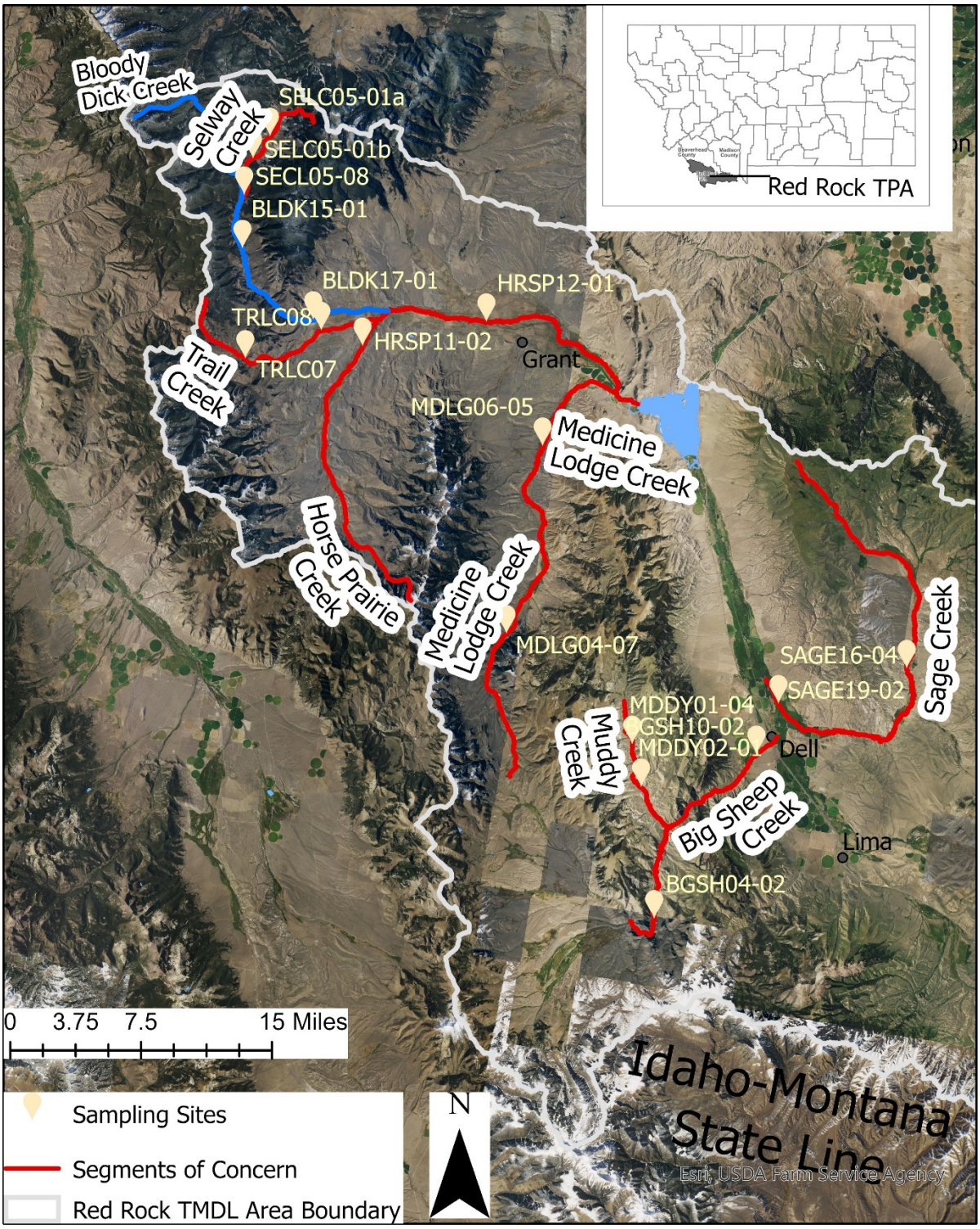

Figure D-1. Stream segments and associated sample sites to the west of Sage Creek evaluated in this document

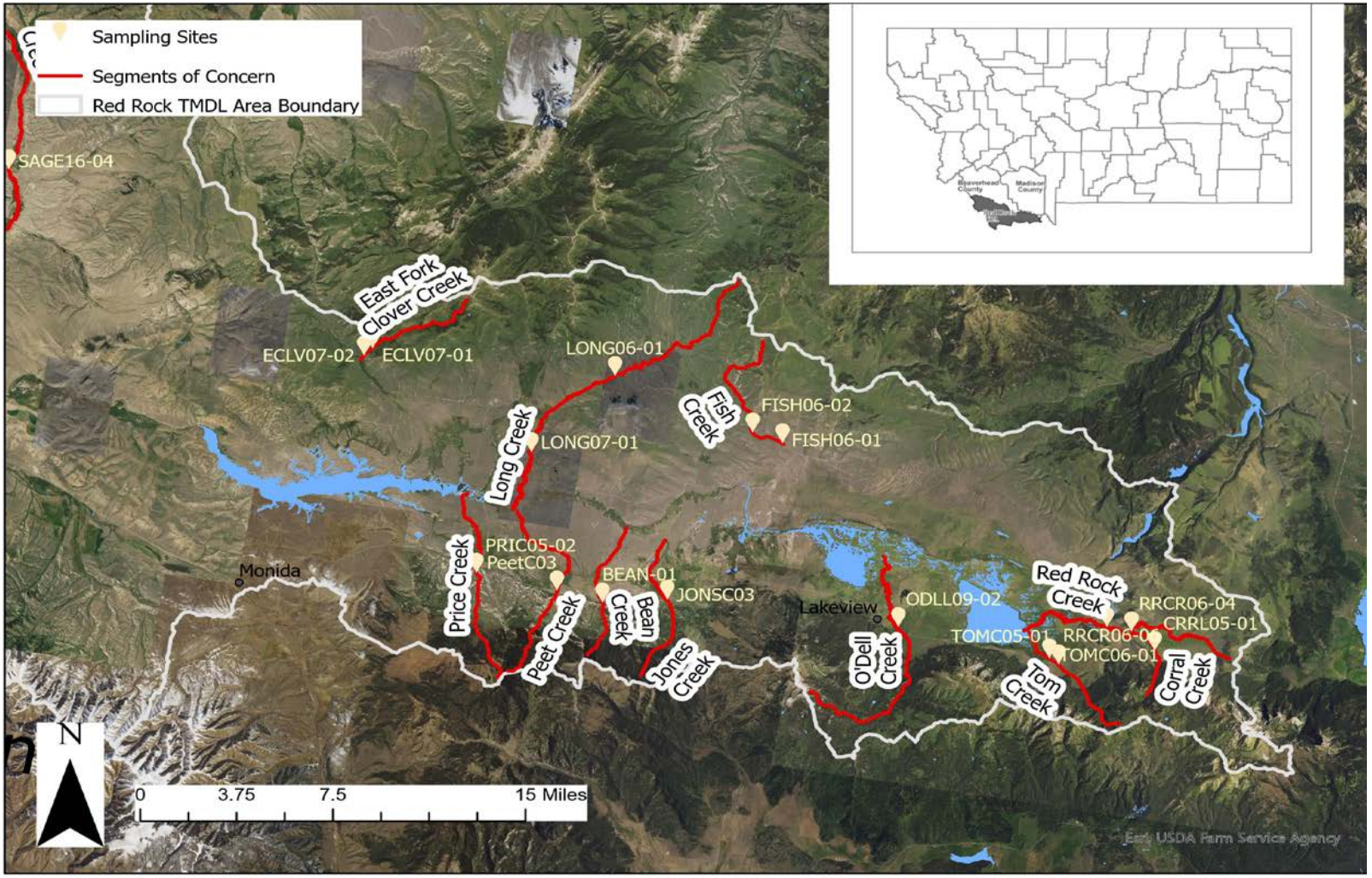

Figure D-2. Stream segments and associated sampling sites to the east of Sage Creek evaluated in this document.

D2.0 DEQ SEDIMENT AND HABITAT ASSESSMENT

To aid in TMDL development, the DEQ performed field measurements of channel morphology and riparian and instream habitat parameters during the summers of 2017 and 2018. A total of 33 sites were primarily assessed as part of the sediment assessment (**Figure D-1** & **Figure D-2**). However, additional sites and aerial photographs additional locations were investigated to support the sediment assessment and evaluate habitat impairments as described in **Section 6**.

D2.1 AERIAL ASSESSMENT REACH STRATIFICATION

Prior to field data collection, DEQ completed a stream stratification process on stream segments in the Madison TPA. The stratification methodology can be found in *Sediment – Habitat Reach Stratification and Riparian Assessment Procedure* (DEQ, 2015). The reason for this stratification is that the inherent differences in landscape controls between stream reaches often prevents a direct comparison from being made between the physical attributes of one stream reach to another. By initially stratifying waterbody segments into stream reaches having similar landscape controls, it is possible to make broad comparisons between similar reaches with regards to observed versus expected channel morphology. Likewise, when land use is used as an additional stratification category (e.g. grazed vs. non-grazed sub-reaches), sediment and habitat parameters for impaired stream reaches can be more readily compared to reference reaches that meet the same geomorphic stratification criteria.

D2.1.1 Stream Reaches

Waterbody segments are delineated by a water use class designated by the State of Montana, e.g. A-1, B-3, C-3 (Administrative Rules of Montana Title 17 Chapter 30, Sub-Chapter 6). Although a waterbody segment is the smallest unit for which an impairment determination is made, the stratification approach described in this document initially stratifies individual waterbody segments into discrete assessment reaches that are delineated by landscape controls including Ecoregion, Strahler stream order, valley gradient, and valley confinement. These attributes represent main factors influencing stream morphology, which in turn influence sediment transport and deposition. Relevant geographic data layers were acquired from the U.S. Geological Survey (USGS), the U.S. Environmental Protection Agency (USEPA) and the Montana State National Resource Information System (NRIS) database.

Once stream reaches have been stratified, reaches are further divided based on the surrounding vegetation and land-use characteristics as observed in the color aerial imagery using GIS. The result is a series of stream reaches and sub-reaches delineated by landscape and land-use factors. Stream reaches with similar landscape factors can then be compared based on the character of surrounding land-use practices.

For ease of labeling, each listed stream in the assessment was assigned an abbreviation based on the stream name. These labels were used in the individual stream reach classification. **Table D-2** shows the abbreviations developed for each waterbody.

Table D-2. Waterbody naming key

Waterbody	Label Abbreviation
Bean Creek	BEAN
Big Sheep Creek	BGSH
Bloody Dick Creek	BLDK

Table D-2. Waterbody naming key

Waterbody	Label Abbreviation
Corral Creek	CRRL
East Fork Clover Creek	ECLV
Fish Creek	FISH
Horse Prairie Creek	HRSP
Long Creek	LONG
Jones Creek	JONS
Medicine Lodge Creek	MDLG
Muddy Creek	MDDY
O'Dell Creek	ODLL
Peet Creek	PEET
Price Creek	PRIC
Sage Creek	SAGE
Red Rock Creek	RRCR
Selway Creek	SELC
Tom Creek	TOMC
Trail Creek	TRLC

D2.1.2 Reach Types

For the purposes of this report, a "reach type" is defined as a unique combination of Ecoregion, valley gradient, Strahler stream order, and valley confinement, and is designated using the following naming convention based on the reach type identifiers (**Table D-3; Table D-4**):

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

Table D-3. Reach Type Identifiers

Watershed Characteristic	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
	fifth order	5
Confinement	confined	C
	unconfined	U

Table D-4. Monitoring sites assessed for sediment

Reach Type	waterbody	Monitoring Sites
MR-0-2-U	Tom Creek	TOMC06-01

Table D-3. Reach Type Identifiers

Watershed Characteristic	Stratification Category	Reach Type Identifier
MR-0-3-U	Hell Roaring Creek, Long Creek, Muddy Creek, O Dell Creek, Price Creek, Trail Creek	LONG06-01, LONG07-01, MDDY01-04, MDLG04-07, ODLL09-02, PRIC05-02, TRCC07
MR-0-4-U	Bloody Dick Creek, Horse Prairie Creek, Muddy Creek, Red Rock Creek, Sage Creek, Selway Creek, Trail Creek	BLDK15-01, BLDK17-01, HRSP11-0b, MDDY02-01, RRCR06-04, RRCR06-06, Sage16-04a, SECL06-08, SELC05-01a, SELC05-01b, TRLC08
MR-0-5-U	Big Sheep Creek, Horse Prairie Creek, Medicine Lodge Creek, Sage Creek	BGSH04-02, BGSH10-02, HRSP12-01 , MDLG06-05, SAGE19-02
MR-2-2-U	East Fork Clover Creek, Fish Creek, Tom Creek	ECLV 07-01, ECLV 07-02, FISH06-01, TOMC05-01
MR-0-1-U	Corral Creek	CRRL 05-01

D2.2 FIELD WORK

Substrate character and stream habitat conditions were evaluated by performing a stream channel assessment in tributaries listed in **Table D-4**. Longitudinal surveys including pebble counts, grid toss, cross sections, pool data collection, riparian greenline surveys, and eroding streambank measurements were performed at each of the selected monitoring sites during the summers of 2017 and 2018; following methods presented in *The Montana Department of Environmental Quality Sediment Assessment Method: Considerations, Physical and Biological Parameters, and Decision Making* (Kusnierz et al., 2013) and *Field Methodology for Sediment and Habitat Source Assessment* (DEQ, 2012) .

Field assessment reaches were selected in relatively low-gradient portions of the listed streams to facilitate the evaluation of sediment loading impacts. The monitoring locations were chosen to represent various reach characteristics, land-use categories, and human-caused influences, but their representativeness relative to other reaches of the same slope, order, confinement and ecoregion, as well as ease of access, were also considered. There was a preference toward sampling those reaches where human influences would most likely lead to impairment conditions, since it is a primary goal of sediment TMDL development to further characterize sediment impairment conditions. Thus, it is not a random sampling design intended to sample stream reaches representing all potential impairment and non-impairment conditions. Instead, it is a targeted sampling design that aims to assess a representative subset of reach types, while ensuring that reaches within each 303(d) listed waterbody with potential sediment impairment conditions are incorporated into the overall evaluation.

D2.2.1 Sediment and Habitat field Methods

Field monitoring sites were assessed progressing in an upstream direction and the length of the monitoring site was based on the bankfull channel width.

After a minimum site length was determined, DEQ identified pools, riffles, and pool-forming woody debris; mapped the site; and set up an “EMAP” reach for collecting biological samples. The crew then performed channel form and instream sediment and habitat measurements:

Channel Form and Stability Measurements

- Field Determination of Bankfull

- Channel Cross-sections
    - Bankfull Width
    - Channel Bed Morphology
    - Width/Depth Ratio
    - Floodprone Width
    - Entrenchment Ratio
- Water Surface Slope

Fine Sediment Measurements

- Sitewide Riffle Pebble Count
- Pool Tail Grid Toss

In-stream Habitat Measurements

- Residual Pool Depth

General Site Information

- Notes
- GPS Coordinates
- Photographs

An in-depth description of the methods are available in *The Montana Department of Environmental Quality Sediment Assessment Method: Considerations, Physical and Biological Parameters, and Decision Making* (Kusnierz et al., 2013).

D2.2.2 Bank Erosion and Greenline Field Methods

A separate field crew set up sites to perform greenline and bank erosion assessments, typically downstream from the in-stream assessment crew or in the same location as the in-stream crew when the in-stream crew had completed their monitoring. The bank data is used to estimate loading to streams from bank erosion, as well as give an indication of the causes of bank erosion and composition of sediment entering the streams. The greenline data helps establish the composition and condition of riparian vegetation along the streams and provides location information of healthy and degraded areas, and from where sources of riparian degradation are coming. More details regarding the greenline and bank erosion methodologies can be found in *Field Methodology for Sediment and Habitat Source Assessment* (DEQ, 2012). Sites used for the bank erosion assessment (**described in Appendix E**) showed high overlap with the sites used to evaluate sediment impairment.

Riparian Health Measurements

- Riparian Greenline Assessment

Bank Erosion

- Field Determination of Bankfull
- Bank Erosion Hazard Measurements
- Near Bank Stress
- Source Information

General Site Information

- Notes
- GPS Coordinates
- Photographs
- Slope

D2.3 Other Information Sources

. Other data sources listed below were also used to help characterize water quality and/or develop TMDL targets.

- DEQ Assessment Files
- US Forest Service Pacfish/Infish Biological Opinion (PIBO) Program Data
- DEQ reference site data
- Data and reports from DEQ and other agencies

D2.3.1 DEQ Assessment Files

The DEQ assessment files contain information used to make sediment impairment determinations. The assessment files include a summary of physical, biological, and habitat data collected and/or compiled by DEQ. The files also include information on sediment water quality characterization and potentially significant sources of sediment, as well as information on non-pollutant impairment determinations and associated rationales. DEQ staff can be contacted for information on where to find assessment files.

D2.3.2 US Forest Service PIBO Program Data

The US Forest Service PACFISH/INFISH Biological Opinion Effectiveness (PIBO) monitoring program annually collects sediment and habitat data from watersheds throughout the northwestern United States. Data collected from "reference" sites (minimally impacted by human activities) was used to develop the targets described in **Section 6**. The protocols for collection of this data are found in Archer et al. (2012) and are analogous to those used by DEQ when collecting sediment and habitat data.

D2.3.3 DEQ Reference Site Data

Data collected by DEQ at reference sites was used in conjunction with PIBO data to develop water quality targets. DEQ reference sites are located in watersheds with minimal human impacts (Suplee et al. 2005). The protocols for data collected from DEQ reference sites are found in Kusnierz et al. (2013).

D2.3.4 Data and Reports

Several other documents that provided historical context to sediment sources, described the sensitivity of watersheds to disturbance, provided information about current conditions or sources, and/or described restoration work that has taken place were also used to help evaluate conditions within the stream segments of concern. These documents were generally written by state and federal agencies, non-profits, and private entities.

D3.0 SUMMARY FOR SEDIMENT ASSESSED WATERBODIES WITH NO TMDL WRITTEN

Bloody Dick Creek (MT41A003_100), is not listed for sedimentation-siltation. This segment was evaluated in 2017 and met both sediment and habitat targets.

Physical Condition and Sediment Sources

In 2017, DEQ collected sediment, habitat, and riparian condition data from two sites on Bloody Dick Creek: BLDK15-01 and BLDK17-01 (**Table D-5**).

BLDK15-01
Site BLDK15-01 is about 4.5 miles below Selway Creek confluence, and has good aquatic and riparian habitat with minimal human disturbance. Robust riparian vegetation is dominated by willows, currant, prairie cordgrass, sedges and native forbs. All age classes of willows are apparent, with some willow seedlings observed on point bars and revegetating banks, although they exhibit signs of stress, possibly due to drought or lowered water table. The riparian buffer appears to minimize the effects of the adjacent unpaved road. The upland appears to have been grazed in the past causing loose soils and fewer willows, but no evidence of recent or current grazing. Channel morphology is relatively intact and stable and exhibits a well-defined pool-riffle sequence with no downcutting. Banks are mostly stable with little sloughing, or some slumping at sites of past cattle disturbance. Undercuts are vegetated and occur on outer bends only. Riffles are predominantly cobble with minimal fine sediment along channel margins only; small boulders are also common. Pools vary in size and depth but are generally large, deep and fast-flowing with large gravel and cobble. No fish passage barriers or flow alterations are present. Very little algae is present, but macrophytes were common.

BLDK17-01
BLDK17-01 is about 6.5 miles upstream from the mouth. The riparian area is dense and robust, consisting primarily of mature willows, alder, woods rose, sedges, and rushes; Canada thistle and cheatgrass were also common. Overall, the channel appears stable with a well-developed riffle-pool sequence and no evidence of bank failure. Substrate is largely cobble and gravel with fine sediment along channel margins only. Fish habitat is abundant with undercut banks, overhanging vegetation, woody debris, and deep pools. Hoof shear observed appears to be from wildlife. Riparian width and longitudinal continuity is optimal. Filamentous algae is abundant.

Additional data collection
Habitat and riparian condition were evaluated at an additional site, M01BDYDC03 about 1.5 miles upstream from site BLDK17-01, has riparian area comprised mostly of willows with other woody species including chokecherry, very large alder, and mature cottonwoods which we did not see at the previous sites. Grasses dominate the understory and it appears that heavier grazing occurs as fewer willows are present and pugging and hummocking is seen along channel margins, particularly where woody vegetation is absent. Substrate is predominantly cobble and gravel, without extreme sediment deposition. Channel sinuosity and riffle-pool sequence appears generally intact. Banks are stable where woody vegetation is intact although banks are receding due to hoof shear in some places. Some excess algal growth is observed.

Site M01BDYDC08, below Reservoir Lake, has riparian vegetation that is primarily vigorous willows with a mix of sedges, grasses (bluegrass) and forbs (lupine, buttercup, paintbrush, yarrow). The riparian zone experiences moderate grazing pressure but not apparently recent; no pugging or hoof shear observed but sagebrush is encroaching where willows are less dense. Woody vegetation appears somewhat limited in places due to grazing, unpaved roads, and campground/recreation access. Overall, the channel appears stable with adequate sinuosity and an apparent riffle-pool sequence, but there is some evidence of instability from lateral scour, enlarged point bars, old bank slumps that are revegetating, and some bank failure on less-vegetated outer banks. Channel substrate is primarily cobble and gravel with minimal accumulation of fine sediment along channel margins. Excess filamentous algal growth is apparent, with patches of dense macrophytes interspersed.

Comparison to Water Quality Targets

Since both sites are in the same slope category, the average was evaluated for all fine sediment parameters. The assessment indicates that Bloody Dick Creek is not impaired for fine sediment. All of the fine sediment parameters are within the reference range. Coarse sediment and instream habitat parameters were evaluated against reference data independently for each site because sites are in different bankfull width categories. Site BLDK15-01 width/depth ratio and pools count are within reference range, but residual pool depth is outside reference range (indicating pools are not as deep as desirable and may be filling with excess sediment). Site BLDK17-01 residual pool depth is within reference range but both width/depth ratio and pool count are outside reference range (indicating the channel is becoming shallower and wider and there are fewer pools as desirable). Entrenchment ratios are within expected range for stream type.

Table D-5. Existing sediment-related data for Bloody Dick Creek relative to targets.

Reach/ Site ID	Assessment Year	Mean BFW (ft)	Gradient (%)	Existing Stream Type	Riffle Pebble Count		Grid Toss	Channel Form		Instream Habitat	
					% <6mm	% <2mm	Pool % <6mm	W/D Ratio	Entrenchment Ratio	Residual Pool Depth (ft)	Pools / 1000 ft
BLDK15-01	2017	34.6	0.2	C	13	13	2	24.1	2.24	1.21	7.7
BLDK17-01	2017	23.3	1	C	19	19	1	18	2.68	2.01	9.5
Average	2017	28.9	0.6	C	16	16	1.5	21.0	2.46	1.61	8.6

Summary

The assessment indicates Bloody Dick Creek is not impaired for sediment or habitat. Zero of three fine sediment parameters differ significantly from reference condition. Overall the channel and banks appear stable although, in some places, the channel exhibits widening, pools are shallower than desirable, and some bank disturbance was noted; the primary source of disturbance appears to be livestock grazing in the riparian zone. The channel exhibits a well-developed riffle-pool sequence with cobble and gravel substrate and fine sediment along channel margins. Channel morphology is intact and is not downcutting. Implementation of Best Management Practices will continue to reduce sediment loads and improve riparian conditions.

D4.0 REFERENCES

Archer, Eric K., Rebecca A. Scully, Richard Henderson, Brett P. Roper, and Jeremiah D. Heitke. 2012. Effectiveness Monitoring for Streams and Riparian Areas: Sampling Protocol for Stream Channel Attributes. Unpublished paper on file at: http://www.fs.fed.us/biology/fishecology/new.html#pibo_reports.

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