Appendix D

Supplemental Sediment Assessment

Framework Water Quality Restoration Plan and Total Maximum Daily Loads (TMDLs) for the Lake Helena Watershed Planning Area:

Volume II – Final Report

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Prepared for the Montana Department of Environmental Quality

Prepared by the U.S. Environmental Protection Agency,
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1.0 INTRODUCTION

Twenty stream segments in the Lake Helena Watershed have been placed on Montana's 303(d) list for suspected water quality impairments due to sediment. Data analyzed for the Volume I report indicated that sediment TMDL development was necessary for 17 of the 20 listed segments (Table 1-1). The Generalized Watershed Loading Function (GWLF) model was chosen to simulate sediment and nutrient loads from large-scale land uses in the Lake Helena watershed. Additional and/or complimentary sediment assessment methodologies were implemented to account for site-specific and in-stream sediment sources that GWLF was unable to account for during the modeling process. These included:

- *Remote sensing using GIS and air photos*. These assessments were complimentary to the GWLF analysis, which was conducted at a sub-watershed scale. The results from the remote sensing analysis allowed for the identification and delineation of specific source areas to facilitate future restoration efforts, and were also used as a means to validate the GWLF generated results.
- *Stream bank erosion assessments*. GWLF did not account for sediment loading from stream bank erosion. Therefore, the results of this assessment were added to the sediment loads generated by GWLF to develop the total sediment loading for each assessment unit.
- *Analysis of sediment loading from abandoned mines*. GWLF did not account for sediment loading from abandoned mines. Therefore, the results of this assessment were added to the sediment loads generated by GWLF to develop the total sediment loading for each assessment unit where abandoned mines constituted a potential sediment source.
- *Culvert failure analysis*. The results from this analysis have not been incorporated into the total sediment loads estimated for each assessment unit. Potential culvert failures represent a potential future source of sediment. These results have been incorporated into the allocation component of the TMDL process presented in Appendix A of Volume II.
- *WEPP:Road modeling analysis*. The decision to implement this modeling exercise was related to scale issues associated with the GWLF model. GWLF functions at a watershed or sub watershed scale, but the input parameters lack the detail to model site-specific road related sediment loading. In order to assist in the identification of road sediment source areas, site specific road data was collected and modeled using WEPP:Road. The results will be used to guide future restoration activities and have been compared to the results generated by GWLF for validation purposes and as one means to assess potential uncertainty.

This report summarizes the additional sediment assessment methodologies, assumptions and results for the sediment-listed watersheds.

Table 1-1. Water Quality Status of Suspected Sediment Impaired Water Bodies and Required TMDLs in the Lake Helena Watershed.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Clancy Creek, MT41I006_120	Sediment	Impaired	A TMDL will be written.
Corbin Creek, MT41I006_090	Sediment	Impaired	A TMDL will be written.
Golconda Creek, MT41I006_070	Sediment	Not impaired	A TMDL will not be written.
Jackson Creek, MT41I006_190	Sediment	Not impaired	A TMDL will not be written.
Jennie's Fork, MT41I006_210	Sediment	Impaired	A TMDL will be written.
Lump Gulch, MT41I006_130	Sediment	Impaired	A TMDL will be written.
Middle Fork Warm Springs Creek, MT41I006_100	Sediment	Impaired	A TMDL will be written.
North Fork Warm Springs Creek, MT41I006_180	Sediment	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_060	Sediment	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_050	Sediment	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_040	Sediment	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_030	Sediment	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_020	Sediment	Impaired	A TMDL will be written.
Sevenmile Creek, MT41I006_160	Sediment	Impaired	A TMDL will be written.
Skelly Gulch, MT41I006_220	Sediment	Impaired	A TMDL will be written.
Spring Creek, MT41I006_080	Sediment	Impaired	A TMDL will be written.
Tenmile Creek, MT41I006_141	Sediment	Not impaired	A TMDL will not be written.
Tenmile Creek, MT41I006_142	Sediment	Impaired	A TMDL will be written.
Tenmile Creek, MT41I006_143	Sediment	Impaired	A TMDL will be written.
Warm Springs Creek, MT41I006_110	Sediment	Impaired	A TMDL will be written.

2.0 SEDIMENT SOURCES – REMOTE QUANTIFICATION

Remote sediment source quantification for the 303(d) sediment impaired streams was conducted with a GIS using digital orthophotos and topographic maps. Source assessment of streams within the Helena area was conducted on 1-foot resolution, true color orthophotos taken in 2004. Many of the headwater streams were assessed on 1-meter resolution, black and white orthophotos taken between 1995 and 1998. GIS layers for roads, railways, mines, and the GPS positions of the 2003 and 2005 field source assessments were also incorporated to aid the analysis.

The 303(d) sediment impaired streams were broken into reaches on the basis of land ownership, topography, and land use. The 17 sediment impaired stream segments were broken into a total of 93 reaches (Figure 2-1). For each stream reach, observations were recorded for the following variables: reach length, length of reach with road encroachment (left and right banks), valley length, length of reach with rip-rap (left and right banks), valley slope, jetties, channel sinuosity, dikes, channel slope, percent of reach affected by mining, bankfull width, and land use.

Qualitative information was also recorded for observations such as degree of channelization, number of road crossings, and overall channel condition. Measurements were made in a GIS using the measure tool. Stream length was measured along the center of the channel, while stream sinuosity was derived from the center channel length divided by the valley length. Channel slope was derived from the valley slope divided by the stream sinuosity. Elevation ranges for slope measures were taken from the USGS 1:24,000 digital topographic maps. Road encroachment measured the length of stream reach where a road or railway was located adjacent to the stream (within 100 feet), and was either altering the natural stream course and/or restricting access to the floodplain. A GIS calculation was performed that tabulated the length of roads and railways within 100 feet of each reach. Percent of each reach affected by mining, so as to disrupt the channel course, was either directly measured or estimated based on field knowledge of the streams and the location of mines. Other characteristics, such as rip-rap, jetties, dikes, and land use were inferred from the photos, and are representative of features that were visible at the scale of the photo. GPS positions from the 2003 and 2005 field source assessments were used to help tabulate rip-rap, jetties, and dikes.

An historical analysis of channel alterations was conducted for a portion of Prickly Pear Creek, from just above the confluence with Beavertown Creek to Montana City. This area corresponded with portions of segments MT41I006_060 and MT41I006_040, and all of segment MT41I006_050. Stereo-pair, black and white aerial photos taken in 1956 at a scale of 1:12,000 were obtained from the Montana Department of Transportation. The photographs represented channel condition before the construction of Interstate 15. The historical photographs were analyzed and compared to metrics from recent photographs. Photo measurements were made using a digitizing planimeter. In order to compare channel metrics to those measured from the orthophotos, the historical measurements were normalized using the ratio between the valley lengths of the 1956 photos and the recent orthophotos.

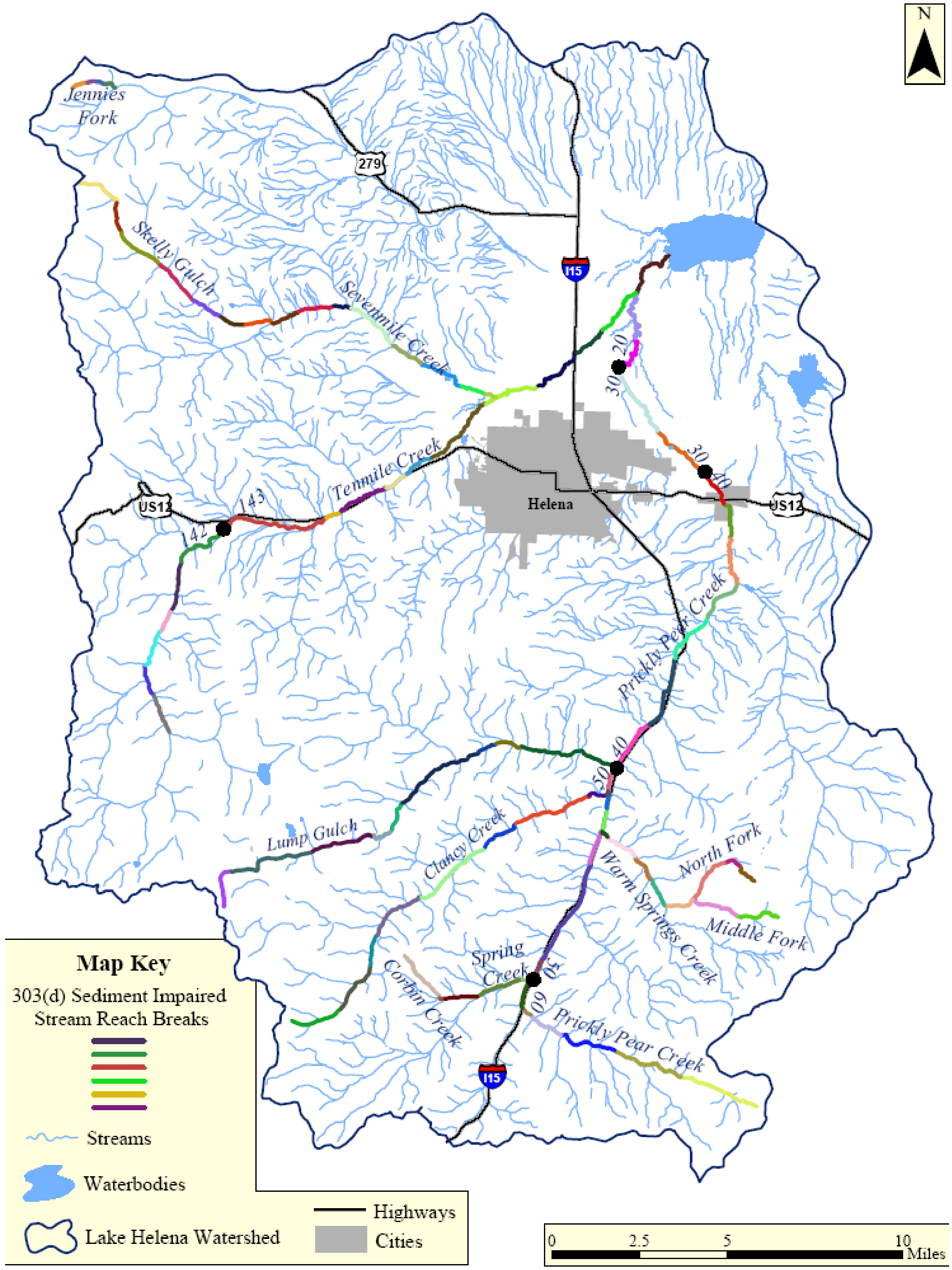

Figure 2-1. Source Assessment Reach Breaks of the Lake Helena 303(d) Sediment Impaired Streams

2.1 Sediment from Streambank Instability

Streambank erosion is an inherent part of channel evolution and can contribute significant quantities of sediment to stream system sediment loads based on a combination of climatic and physiographic features. However, anthropogenic impacts, such as grazing, mining, timber harvest, road encroachment, riparian vegetation removal, and/or channel alterations can result in elevated rates of streambank erosion. The intent of this analysis was to provide an estimate of sediment loads from streambank erosion within the listed watersheds. Modeled sediment load was allocated into two source categories: anthropogenic or natural.

Due to the size of the Lake Helena TPA and the large number of listed stream miles, a coarse filter approach was used to estimate the sediment load related to stream bank instability. Bank Erosion Hazard Index (BEHI) assessments were conducted on eroding streambanks within representative intra-segment reaches. Eroding streambanks were surveyed by Land & Water/PBS&J personnel during the preliminary source assessment in August, 2003, and March, 2005 during the sediment source assessment. Results from sampled reaches were averaged and extrapolated to the full perennial stream length within a listed stream segment's watershed. The BEHI assessments were based on a slightly modified version of the Rosgen (1996) method to characterize stream bank conditions into numerical indices of bank erosion potential.

The modified BEHI methodology evaluated a stream bank's inherent susceptibility to erosion as a function of six factors, including:

1. The ratio of stream bank height to bankfull stage.
2. The ratio of riparian vegetation rooting depth to stream bank height.
3. The degree of rooting density.
4. The composition of stream bank materials.
5. Stream bank angle (i.e., slope).
6. Bank surface protection afforded by debris and vegetation.

To determine annual sediment load from eroding stream banks in each BEHI category, bank retreat rates developed by Rosgen (2001) were utilized (Table 2-1). The rate of erosion was then multiplied by the area of eroding bank (square feet) to obtain a volume of sediment per year, and then multiplied by the sediment density (average bulk densities were 1.41 g/cm^3 within granitic parent material, and 1.31 g/cm^3 outside of the batholith, USDA, 1998) to obtain a mass of sediment per year.

Table 2-1. Bank Retreat Rates Used for Banks of Varying Severity of Erosion

Bank Erosion Hazard Condition	Retreat Rate from Rosgen 2001 (ft/yr) – used for A and B channels	Retreat Rate from Rosgen 2001 (ft/yr) – used for C channels
Low	0.045	0.09
Moderate	0.17	0.34
High	0.46	0.7
Severe	0.82	1.2

Total sediment load from eroding streambanks of each sediment-listed stream was generated by averaging intra-segment (reach) sediment loads (on a percentage stream length basis), and applying this value to the entire perennial stream length within the segment. For this purpose, each listed segment was divided into approximately 5 assessment reaches (actual number reaches varied from 2 to 10) based on homogeneity of land use, vegetation and geomorphic character. Each listed reach outside the Helena National Forest boundary was visited, and BEHI measurements were conducted where eroding streambanks were observed. Representative eroding streambanks were surveyed using the BEHI methodology. The survey results were extrapolated to an identified percentage of the reach (or segment) length. Total extrapolated eroding, and non-eroding, streambank lengths were calculated through direct observation during the source assessment, and/or through the aerial photo assessment.

For example, if the BEHI analysis resulted in an average segment sediment load of 0.02 tons/foot/year from a segment's surveyed eroding streambank; the total channel length is 3 miles, and the condition of the surveyed eroding streambank represented 20% of the total channel length. (This 20% example relates to total eroding streambanks from river right and river left.) The 0.02 tons/foot/year is extrapolated to the entire eroding perennial streambank length of the segment; i.e., 20% of 3 miles (15,840 ft.) of streambank is 3168 feet; applying the unit based sediment load of 0.02 tons (0.02 x 3168 ft) results in a total sediment load from eroding streambanks from this theorized segment of 63.4 tons/yr.

Additionally, the total sediment load related to eroding streambanks was divided between naturally occurring erosion, and that which appeared to be anthropogenically induced. This allocation was determined through observations made during field reconnaissance and by aerial photo assessments. Land uses adjacent to, or in some cases upstream from, eroding streambanks were surveyed. The majority of land uses found to contribute to eroding streambanks included channel encroachment or sinuosity reductions related to transportation infrastructure, which includes interstate highways, city/county roads, forest roads, and rail-roads; riparian vegetation reduction caused by grazing in or near the riparian zones; and historic mining activities. Based on these assessment results, percentages of eroding bank lengths were generated and allocated to natural or anthropogenic sources within each segment.

The watershed scale estimates of streambank erosion are based on extrapolation from field surveys conducted on representative listed stream segment reaches. The extrapolation methodology likely overestimates the total amount of streambank erosion. Additionally, due to constraints posed by physical infrastructure, and access conflicts, it may not be practical or possible to restore all areas of human-caused streambank erosion to reference levels. Therefore, this load reduction is likely an overestimate.

2.2 Reference Streambank Erosion

Reference level sediment loads were developed as target values for anthropogenically related streambank erosion sediment loads. Reference BEHI values, stratified by Rosgen (1996) stream type were developed from the Beaverhead-Deerlodge National Forest field measurement database, which is composed of survey data collected across the Beaverhead-Deerlodge National Forest.

The Beaverhead-Deerlodge has systematically conducted stream reach surveys of representative reaches throughout southwest Montana since 1991. This survey data has been synthesized in a single database. Numerous habitat, hydraulic and morphometric parameters (including BEHI) were collected at each survey site. Data collection is based on the Rosgen (1996) stream classification system. Though the majority of surveyed stream reaches were impacted by a variety of anthropogenic influences, a database of reference conditions, stratified by Rosgen stream type, was distilled from the overall database. These reference database values were used to establish the reference BEHI conditions for the Lake Helena

TMDL analysis area. Reference BEHI scores are as follows: A channels = 21.06, B channels = 20.49, C channels = 20.32, and E channels = 18.77 (Bengeyfield, 1999).

Modeled reference sediment loads used the same BEHI sediment load model that was used to model the existing condition scenario (section 1.2.1 above). Reference BEHI values were incorporated into the model with a reduced length of eroding streambank in order to calculate reference sediment yield. Reference BEHI values for segments composed of multiple stream types were generated by averaging the BEHI values of the relevant stream types. Based on the construction of the model, changing these two parameters resulted in the generation of the reference sediment load from eroding streambanks.

Reference values and the portion of the total load considered “natural” are not analogous and therefore the values of the two sediment load categories vary. Calculated reference sediment load values will be used as targets for sediment load reduction from anthropogenically related eroding streambanks. Reference is defined as conditions that would be found in the absence of any anthropogenic activity within the watershed. Natural is defined as existing streambank erosion with no directly attributable source land-use. Due to the nature of the channel alteration/modification assessment, an inherent margin of error is introduced into this survey. Additionally, using reference values as reduction targets may overestimate sediment load reduction due potential lack of access, or constraints posed by physical infrastructure.

3.0 ABANDONED MINE RELATED SEDIMENT

Sediment loads associated with abandoned mining were calculated for sites throughout the Lake Helena watershed. Potential sediment source locations were delineated from the High Priority Abandoned Hardrock Mine Sites, and Abandoned and Inactive Mines of Montana, as well as the National Hydrography Dataset GIS data layers. Potential sediment source delineation criteria were as follows: mine sites within 300 feet of stream, or mines within 1000 feet of stream in areas where slopes are greater than 30 percent.

This GIS exercise generated 223 mines deemed to be potential sediment sources. These mines were cross-referenced with Montana Bureau of Mines and Geology (MBMG) reports, and the Montana State Bureau of Abandoned Mines. Available MBMG documents reported that 12 of the Abandoned-Inactive mines were probable sediment sources. Additionally, records of High Priority Abandoned Hardrock Mine Sites from the Montana State Bureau of Abandoned Mines indicated that eighteen (18) additional mine sites were probable sediment sources. The MBMG and Bureau of Abandoned Mine reports contained CAD drawings of the mine sites with areas and volumes of tailings and waste rock piles.

Area based sediment loads for waste rock piles were obtained from a report produced by CDM, for USEPA, for use in the Upper Tenmile Creek Mining Area Superfund site. CDM used RUSLE version 1.06 to generate sediment yield of 27 tons/acre/year from nose slopes, and 16 tons/acre/year from side slopes of waste rock piles in loamy-sand textured soil. Sediment delivery ratios were generated based on methodology described in *Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE) Version 1.06 on Mined Lands, Construction Sites, and Reclaimed Lands* (Toy and Galetovic, 1999).
Five of the High Priority Abandoned Mine sites were reported to be reclaimed. The level of reclamation, and associated reduction in sediment production was field-assessed in the summer of 2005 at each of the five sites. Of the five mine sites, only one (Alta) was not fully vegetated and continued to generate sediment. Pre- and post-reclamation sediment loads were calculated for reclaimed mine scenarios.

4.0 POTENTIAL SEDIMENT LOADING RISK FROM CULVERT FAILURE

Culvert failure is typically a result of run-off or stream flow ponding behind the culvert inlet. Ponding may result from debris obstructing run-off/stream flow conveyance, or the installation of an undersized culvert. Historically, most culverts were sized to convey a twenty-five (25) year discharge event (B. Stuart, personal communication). This return interval has been determined to be inadequately short, and has resulted in numerous undersized culverts on the landscape. Culverts currently being installed are typically sized to convey at least a 100-year discharge event. The large numbers of undersized culverts on the landscape have resulted in an increased probability of sediment loading from culvert fill material during catastrophic culvert failure. Surveys indicate that many of the culverts within the Lake Helena TPA are undersized (B. Stuart, personal communication) and at increased risk of failure.

A culvert hazard analysis was conducted by the Helena National Forest in the Poorman Creek watershed in 1996. Poorman Creek is not within the Lake Helena TPA; however, the similarity in age of the forest road infrastructure justifies the extrapolation of analysis results to forest roads within the Lake Helena TPA (B. Stuart, personal communication). Culverts dimensions were surveyed and risk of failure was qualitatively rated as high, moderate, or low. On a percentage basis, the Poorman Creek culvert hazard analysis reported: high risk of culvert failure = 45%, moderate risk of culvert failure = 30%, low risk of culvert failure = 25%. The corresponding percentages were extrapolated and applied to the Lake Helena TPA.

4.1 Additional Roads Assessment Using WEPP:Road

An alternative road sediment analysis was conducted in addition to the GWLF modeling. This secondary modeling effort utilized the WEPP:Road module developed by the Rocky Mountain Research Station, USFS. The decision to implement this modeling exercise was related to scale issues associated with the GWLF model. GWLF is well-suited for estimating sediment loads at the watershed scale, but the input parameters lack the detail to model site specific road related sediment loading. In order to assist in the identification of road sediment source areas, site specific road data was collected and modeled using WEPP:Road.

A stratified random sample was conducted in each sediment listed watershed. All stream-road crossings within each listed watershed were identified, and assigned a unique numeric identifier through GIS. (Only roads available on the most recent GIS roads layer were used, it is likely that roads are present on the landscape that were not captured by the GIS roads layer.) Random numbers were assigned to each road crossing, and then ranked in ascending order. The sampling protocol required that 10% of all road crossings within each sediment listed watershed would be visited and surveyed. The requisite number of crossings were surveyed in each watershed by Land & Water/PBS&J personnel during the spring of 2005.

WEPP uses the RockClime climate generator to model weather events over a thirty year period. A single RockClime climate station was developed and used for the entire sampling area. This station was “located” at 5415 feet and “received” 14.3 inches of precipitation annually. The analysis area was divided into two soil types, sandy loam and loam. The soil type used to model an individual watershed was based on that watershed’s underlying geology. Sandy loam soils were used for watersheds in granitic geologies, and loam soils were used in watersheds in the northern Lake Helena watershed, outside of the batholith.

5.0 SEDIMENT MODELING RESULTS

This section summarizes the results of the additional sediment source assessment modules.

5.1 Remote sediment source quantification

The remote sediment source quantification of current stream conditions for the sediment impaired streams represents a refinement to the measurements and observations assembled for the original *Preliminary Source Assessment* (Appendix C), of the *Volume I – Watershed Characterization and Water Quality Status Review* (2004). The results of this current remote survey were used in conjunction with field work conducted in the summer of 2003 and the spring of 2005 to generate sediment loads and to estimate the degree of channel alterations. In many instances channel alterations, such as length of rip-rap, are underestimated due to lack of visibility on the orthophotos. See Tables 5-1 to 5-3 for the results of the aerial sediment source assessment.

The historical analysis of channel alterations along Upper Prickly Pear Creek was conducted to differentiate the effects of channel alterations due to historical placer mining from the construction of Interstate 15. The most notable channel change for this portion of Prickly Pear Creek was the replacement of channel encroachment from placer tailing piles to encroachment from the interstate and secondary roads (Table 5-4). On average, segments MT41I006_060 and MT41I006_050 had a loss of sinuosity at 9% and 8% respectively. This loss of sinuosity coincided with an average increase in channel slope of 8% and 4% for the corresponding reaches. The surveyed portions of segments MT41I006_060, MT41I006_050, and MT41I006_040 had an average gain in bankfull width of 59%, 34%, and 13%, respectively. The portion of segment MT41I006_060 surveyed had an overall loss of encroachment for both the left and right banks due to the removal of tailings piles and relocation of the channel. But both segment MT41I006_050 and the portion of MT41I006_040 surveyed had an overall increase in left and right bank encroachment due to the interstate and secondary road development. As an example, one reach of segment MT41I006_050 went from 4 road crossings in 1956 to 12 in 1995. Although channel pattern may never recover to undisturbed conditions, the riparian vegetation appears to have rebounded in many of the reaches surveyed. See Tables 5-5 to 5-7 for the results of the historical aerial assessment.

Table 5-1. Summary of Channel Changes on Upper Prickly Pear Creek since 1956

303(d) Segment	Reach_ID	Sinuosity Δ	Channel Slope Δ	Bankfull Width Δ	Left Bank Encroachment Δ*	Right Bank Encroachment Δ*
MT41I006_060	60_R5	-9%	NC	64%	0%	-100%
MT41I006_060	60_R6	-9%	8%	53%	-83%	-85%
MT41I006_060	**Average**	**-9%**	**8%**	**59%**	**-42%**	**-92%**
MT41I006_050	50_R1	-9%	10%	96%	-100%	-2%
MT41I006_050	50_R2	-25%	22%	3%	-26%	-57%
MT41I006_050	50_R3	NC	NC	43%	75%	21%
MT41I006_050	50_R4	-8%	0%	30%	1080%	67%
MT41I006_050	50_R5	10%	-17%	25%	217%	43%
MT41I006_050	50_R6	NC	NC	9%	-72%	-42%
MT41I006_050	**Average**	**-8%**	**4%**	**34%**	**195%**	**5%**
MT41I006_040	40_R1	NC	NC	49%	-50%	-48%
MT41I006_040	40_R2	NC	NC	-22%	34%	131%
MT41I006_040	40_R3	NC	NC	12%	100%	100%
MT41I006_040	**Average**	**NC**	**NC**	**13%**	**28%**	**61%**

NC = No Change
*Measures for the specified reaches on recent photos were made for all forms of encroachment, not just roads (i.e. placer tailings piles)

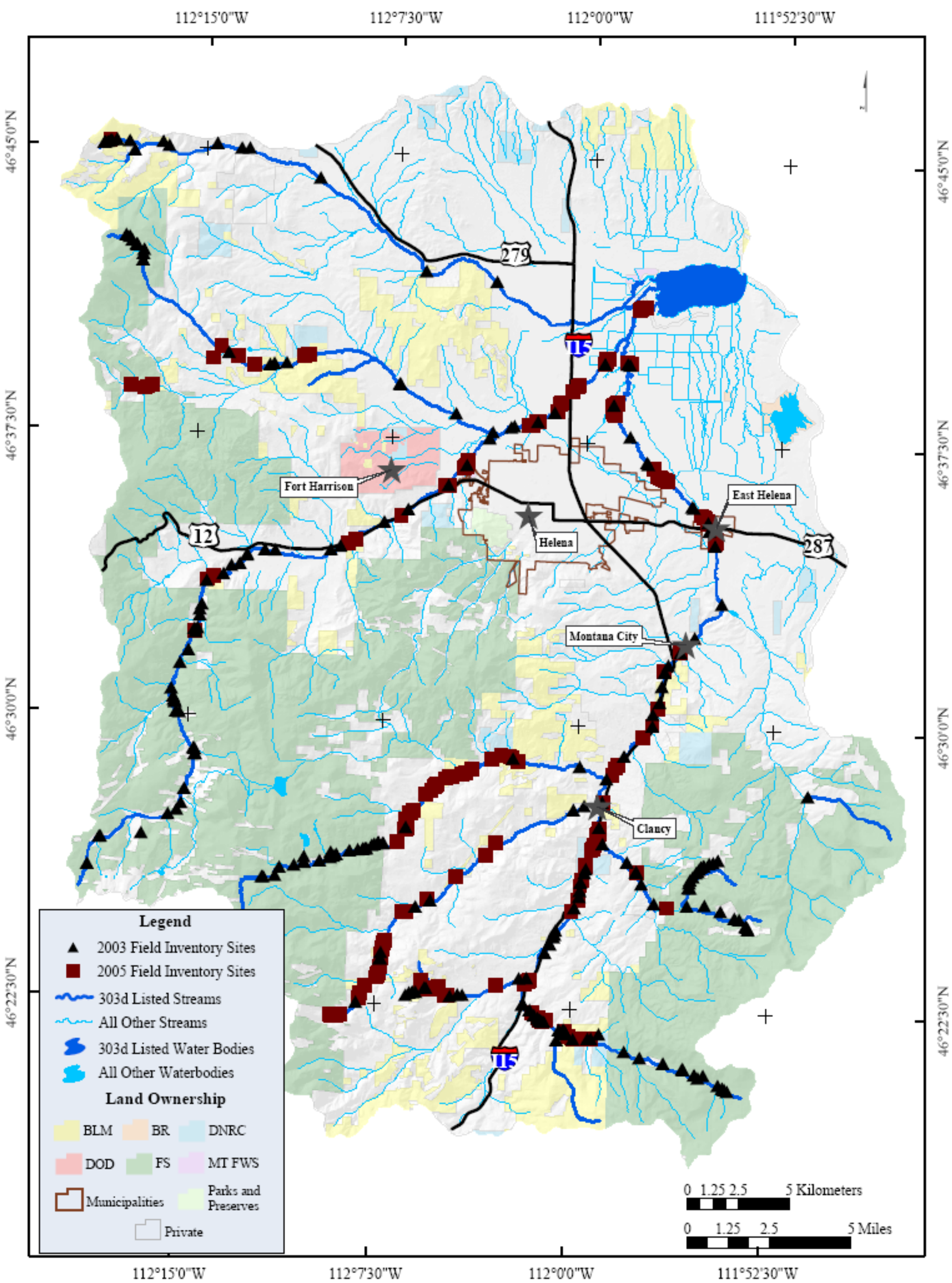

Figure 5-1. Locations of the 2003 and 2005 Field Survey Source Assessment Sites

Table 5-2. Aerial Sediment Source Assessment: 303(d) Channel Form

303(d) Segment	Photo Year & Source	Reach ID	Reach Length (ft)	Elevation ∆ (ft)	Valley Length	Valley Slope	Sinuosity	Channel Slope	Bankfull Width (ft)
MT41I006_060	1998 - BW Ortho	60_R1	12880	1235	12570	9.8%	1.0	9.6%	~5
MT41I006_060	1998 - BW Ortho	60_R2	12157	665	11203	5.9%	1.1	5.5%	~10
MT41I006_060	1998 - BW Ortho	60_R3	9611	485	9172	5.3%	1.0	5.0%	~10
MT41I006_060	1995 - BW Ortho	60_R4	6014	155	5651	2.7%	1.1	2.6%	~10
MT41I006_060	1995 - BW Ortho	60_R5	1645	30	1583	1.9%	1.0	1.8%	25.0
MT41I006_060	1995 - BW Ortho	60_R6	4706	65	4489	1.4%	1.0	1.4%	26.8
MT41I006_090	1995 - BW Ortho	CRB_R1	8996	1040	8488	12.3%	1.1	11.6%	~5
MT41I006_090	1995 - BW Ortho	CRB_R2	873	45	837	5.4%	1.0	5.2%	~10
MT41I006_090	1995 - BW Ortho	CRB_R3	5056	188	4852	3.9%	1.0	3.7%	~10
MT41I006_080	1995 - BW Ortho	SPR_R1	7764	142	7372	1.9%	1.1	1.8%	~10
MT41I006_080	1995 - BW Ortho	SPR_R2	1315	35	1296	2.7%	1.0	2.7%	~10
MT41I006_050	1995 - BW Ortho	50_R1	3996	42	3829	1.1%	1.0	1.1%	23.5
MT41I006_050	1995 - BW Ortho	50_R2	16577	183	17728	1.0%	0.9	1.1%	18.5
MT41I006_050	1997 - BW Ortho	50_R3	5456	45	5364	0.8%	1.0	0.8%	18.3
MT41I006_050	1997 - BW Ortho	50_R4	4082	40	3573	1.1%	1.1	1.0%	23.2
MT41I006_050	1997 - BW Ortho	50_R5	3225	17	2998	0.6%	1.1	0.5%	19.0
MT41I006_050	1997 - BW Ortho	50_R6	3853	23	3516	0.7%	1.1	0.6%	22.3
MT41I006_100	1997 - BW Ortho	MFWS_R1	7300	690	7221	9.6%	1.0	9.5%	~10
MT41I006_100	1997 - BW Ortho	MFWS_R2	7599	477	7447	6.4%	1.0	6.3%	~10
MT41I006_180	1997 - BW Ortho	NFWS_R1	3653	495	3483	14.2%	1.0	13.6%	~5
MT41I006_180	1997 - BW Ortho	NFWS_R2	2814	185	2725	6.8%	1.0	6.6%	~5
MT41I006_180	1997 - BW Ortho	NFWS_R3	7953	567	7564	7.5%	1.1	7.1%	~10
MT41I006_180	1997 - BW Ortho	NFWS_R4	5155	200	4828	4.1%	1.1	3.9%	~15
MT41I006_110	1997 - BW Ortho	WS_R1	5704	90	4491	2.0%	1.3	1.6%	~20
MT41I006_110	1997 - BW Ortho	WS_R2	5543	88	4263	2.1%	1.3	1.6%	~20
MT41I006_110	1997 - BW Ortho	WS_R3	6572	90	5053	1.8%	1.3	1.4%	~25
MT41I006_110	1997 - BW Ortho	WS_R4	1361	10	1335	0.7%	1.0	0.7%	~15
MT41I006_120	1995 - BW Ortho	CL_R1	8671	1220	8317	14.7%	1.0	14.1%	~10
MT41I006_120	1995 - BW Ortho	CL_R2	9388	335	8519	3.9%	1.1	3.6%	~15
MT41I006_120	1995 - BW Ortho	CL_R3	4873	235	4680	5.0%	1.0	4.8%	~10

Table 5-2. Aerial Sediment Source Assessment: 303(d) Channel Form

303(d) Segment	Photo Year & Source	Reach ID	Reach Length (ft)	Elevation ∆ (ft)	Valley Length	Valley Slope	Sinuosity	Channel Slope	Bankfull Width (ft)
MT41I006_120	1995 - BW Ortho	CL_R4	10634	350	9514	3.7%	1.1	3.3%	~15
MT41I006_120	1995 - BW Ortho	CL_R5	13552	235	12854	1.8%	1.1	1.7%	~20
MT41I006_120	1995 - BW Ortho	CL_R6	7154	95	6509	1.5%	1.1	1.3%	~20
MT41I006_120	1995 - BW Ortho	CL_R7	13000	195	12332	1.6%	1.1	1.5%	~20
MT41I006_120	1997 - BW Ortho	CL_R8	3522	40	2702	1.5%	1.3	1.1%	~20
MT41I006_120	1997 - BW Ortho	CL_R9	473	10	473	2.1%	1.0	2.1%	~15
MT41I006_130	1995 - BW Ortho	LG_R1	6537	540	6425	8.4%	1.0	8.3%	~5
MT41I006_130	1995 - BW Ortho	LG_R2	15415	900	13941	6.5%	1.1	5.8%	~10
MT41I006_130	1995 - BW Ortho	LG_R3	10411	410	9785	4.2%	1.1	3.9%	~10
MT41I006_130	1995 - BW Ortho	LG_R4	3824	90	3096	2.9%	1.2	2.4%	~15
MT41I006_130	1995 - BW Ortho	LG_R5	4809	205	4430	4.6%	1.1	4.3%	~15
MT41I006_130	1995 - BW Ortho	LG_R6	15931	585	14313	4.1%	1.1	3.7%	~15
MT41I006_130	1995 - BW Ortho	LG_R7	3507	80	3060	2.6%	1.1	2.3%	~20
MT41I006_130	1995 - BW Ortho	LG_R8	4485	70	4173	1.7%	1.1	1.6%	~15
MT41I006_130	1995 - BW Ortho	LG_R9	17057	130	14534	0.9%	1.2	0.8%	~20
MT41I006_040	1995 - BW Ortho/2004 C Ortho	40_R1	9307	65	8346	0.8%	1.1	0.7%	31.5
MT41I006_040	2004 C Ortho	40_R2	12238	55	11370	0.5%	1.1	0.4%	20.6
MT41I006_040	2004 C Ortho	40_R3	9908	40	8082	0.5%	1.2	0.4%	27.7
MT41I006_040	2004 C Ortho	40_R4	7641	60	7279	0.8%	1.0	0.8%	24.8
MT41I006_040	2004 C Ortho	40_R5	9220	55	7107	0.8%	1.3	0.6%	32.2
MT41I006_040	2004 C Ortho	40_R6	5667	40	5407	0.7%	1.0	0.7%	38.0
MT41I006_040	2004 C Ortho	40_R7	5371	42	4748	0.9%	1.1	0.8%	28.0
MT41I006_030	2004 C Ortho	30_R1	2235	3	1817	0.2%	1.2	0.1%	16.2
MT41I006_030	2004 C Ortho	30_R2	9244	65	8434	0.8%	1.1	0.7%	28.4
MT41I006_030	2004 C Ortho	30_R3	16236	62	10956	0.6%	1.5	0.4%	24.9
MT41I006_020	2004 C Ortho	20_R1	10860	21	5500	0.4%	2.0	0.2%	28.4
MT41I006_020	2004 C Ortho	20_R2	13928	27	7786	0.3%	1.8	0.2%	27.5
MT41I006_020	2004 C Ortho	20_R3	11297	10	8241	0.1%	1.4	0.1%	35.4
MT41I006_142	1995 - BW Ortho/2004 C Ortho	142_R1	6878	175	6395	2.7%	1.1	2.5%	~20
MT41I006_142	1995 - BW Ortho	142_R2	4774	125	4431	2.8%	1.1	2.6%	~20

Table 5-2. Aerial Sediment Source Assessment: 303(d) Channel Form

303(d) Segment	Photo Year & Source	Reach ID	Reach Length (ft)	Elevation Δ (ft)	Valley Length	Valley Slope	Sinuosity	Channel Slope	Bankfull Width (ft)
MT41I006_142	1995 - BW Ortho/2004 C Ortho	142_R3	6567	130	5734	2.3%	1.1	2.0%	~25
MT41I006_142	2004 C Ortho	142_R4	3815	75	3608	2.1%	1.1	2.0%	~25
MT41I006_142	2004 C Ortho	142_R5	7773	140	7175	2.0%	1.1	1.8%	~25
MT41I006_142	2004 C Ortho	142_R6	10915	175	9718	1.8%	1.1	1.6%	~25
MT41I006_143	2004 C Ortho	143_R1	17580	245	15874	1.5%	1.1	1.4%	~25
MT41I006_143	2004 C Ortho	143_R2	2576	35	2447	1.4%	1.1	1.4%	~25
MT41I006_143	2004 C Ortho	143_R3	9062	90	7623	1.2%	1.2	1.0%	~30
MT41I006_143	2004 C Ortho	143_R4	3813	32	3733	0.9%	1.0	0.8%	~25
MT41I006_143	2004 C Ortho	143_R5	5199	58	4569	1.3%	1.1	1.1%	~25
MT41I006_143	2004 C Ortho	143_R6	13572	109	11646	0.9%	1.2	0.8%	~25
MT41I006_143	2004 C Ortho	143_R7	12471	71	8384	0.8%	1.5	0.6%	~25
MT41I006_143	2004 C Ortho	143_R8	10850	55	7812	0.7%	1.4	0.5%	~25
MT41I006_143	2004 C Ortho	143_R9	6351	40	5131	0.8%	1.2	0.6%	~25
MT41I006_143	2004 C Ortho	143_R10	11162	35	7655	0.5%	1.5	0.3%	~25
MT41I006_220	1995 - BW Ortho	SG_R1	7719	800	7100	11.3%	1.1	10.4%	~10
MT41I006_220	1995 - BW Ortho	SG_R2	5084	380	4676	8.1%	1.1	7.5%	~10
MT41I006_220	1995 - BW Ortho	SG_R3	8445	450	7739	5.8%	1.1	5.3%	~10
MT41I006_220	2004 C Ortho	SG_R4	7980	395	7310	5.4%	1.1	4.9%	~10
MT41I006_220	2004 C Ortho	SG_R5	5745	58	4875	1.2%	1.2	1.0%	~10
MT41I006_220	2004 C Ortho	SG_R6	4234	119	3931	3.0%	1.1	2.8%	~10
MT41I006_220	2004 C Ortho	SG_R7	4546	103	4225	2.4%	1.1	2.3%	~10
MT41I006_160	2004 C Ortho	SVM_R1	5385	88	4484	2.0%	1.2	1.6%	~15
MT41I006_160	2004 C Ortho	SVM_R2	6591	87	5347	1.6%	1.2	1.3%	~20
MT41I006_160	2004 C Ortho	SVM_R3	3235	40	2661	1.5%	1.2	1.2%	~20
MT41I006_160	2004 C Ortho	SVM_R4	12624	125	8344	1.5%	1.5	1.0%	~20
MT41I006_160	2004 C Ortho	SVM_R5	8697	93	5487	1.7%	1.6	1.1%	~20
MT41I006_160	2004 C Ortho	SVM_R6	9513	84	6489	1.3%	1.5	0.9%	~20
MT41I006_160	2004 C Ortho	SVM_R7	4449	40	3861	1.0%	1.2	0.9%	~15
MT41I006_160	2004 C Ortho	SVM_R8	1958	20	1539	1.3%	1.3	1.0%	~15
MT41I006_210	1995 - BW Ortho	JF_R1	2579	335	2481	13.5%	1.0	13.0%	~5

Table 5-2. Aerial Sediment Source Assessment: 303(d) Channel Form

303(d) Segment	Photo Year & Source	Reach ID	Reach Length (ft)	Elevation Δ (ft)	Valley Length	Valley Slope	Sinuosity	Channel Slope	Bankfull Width (ft)
MT41I006_210	1995 - BW Ortho	JF_R2	1612	225	1561	14.4%	1.0	14.0%	~10
MT41I006_210	1995 - BW Ortho	JF_R3	1284	85	1146	7.4%	1.1	6.6%	~10
MT41I006_210	1995 - BW Ortho	JF_R4	1956	43	1872	2.3%	1.0	2.2%	~10

Table 5-3. Aerial Sediment Source Assessment: 303(d) Channel Alterations

303(d) Segment	Photo Year & Source	Reach ID	Length of Road w/in 100 ft of Reach (GIS, ft)	Length of Railway w/in 100 ft of Reach (GIS, ft)	Left Bank Length of Reach w/ Road Encroachment (ft)	Right Bank Length of Reach w/ Road Encroachment (ft)	Left Bank Length of RipRap (ft)	Right Bank Length of RipRap (ft)	Jetties	Dikes	Percent affected by Mining
MT41I006_060	1998 - BW Ortho	60_R1	2742.3			4520					
MT41I006_060	1998 - BW Ortho	60_R2	0.0			837					~10%
MT41I006_060	1998 - BW Ortho	60_R3	3325.7		368	4626					
MT41I006_060	1995 - BW Ortho	60_R4	2896.1			3163		60			
MT41I006_060	1995 - BW Ortho	60_R5	186.3								45%
MT41I006_060	1995 - BW Ortho	60_R6	769.7		596	579					12%
MT41I006_090	1995 - BW Ortho	CRB_R1	504.4								5%
MT41I006_090	1995 - BW Ortho	CRB_R2	681.0		873						100%
MT41I006_090	1995 - BW Ortho	CRB_R3	2731.9	199 - too high	1276						
MT41I006_080	1995 - BW Ortho	SPR_R1	579.8		659						100%
MT41I006_080	1995 - BW Ortho	SPR_R2	1328.8		976	505					41%
MT41I006_050	1995 - BW Ortho	50_R1	840.3			823		120		1	100%
MT41I006_050	1995 - BW Ortho	50_R2	12660.4		9559	1486	405				78%
MT41I006_050	1997 - BW Ortho	50_R3	6083.4	4931 hand calc	5456	3449	500	500			
MT41I006_050	1997 - BW Ortho	50_R4	2776.6		1193	1396	378	351			
MT41I006_050	1997 - BW Ortho	50_R5	3564.9	428.7	1227	3225	2900	2900			
MT41I006_050	1997 - BW Ortho	50_R6	305.5	49.9	145	343					100%
MT41I006_100	1997 - BW Ortho	MFWS_R1	3228.6		1178	2952					23%
MT41I006_100	1997 - BW Ortho	MFWS_R2	5042.4			4519					
MT41I006_180	1997 - BW Ortho	NFWS_R1	1058.1	road probably far enough away to not impact stream except for about 550'							
MT41I006_180	1997 - BW Ortho	NFWS_R2	810.7			1367					
MT41I006_180	1997 - BW Ortho	NFWS_R3	2994.0			3782					
MT41I006_180	1997 - BW Ortho	NFWS_R4	2134.4			1210					~40%
MT41I006_110	1997 - BW Ortho	WS_R1	560.2								~40%
MT41I006_110	1997 - BW Ortho	WS_R2	1918.4			686					
MT41I006_110	1997 - BW Ortho	WS_R3	1215.0								
MT41I006_110	1997 - BW Ortho	WS_R4	1424.2		215	1186	135	135			~50%
MT41I006_120	1995 - BW Ortho	CL_R1	4944.6		4499						13%
MT41I006_120	1995 - BW Ortho	CL_R2	2178.1		360	1109	105	105			~20%
MT41I006_120	1995 - BW Ortho	CL_R3	3539.4			1542					~90%
MT41I006_120	1995 - BW Ortho	CL_R4	2974.3		386						13%
MT41I006_120	1995 - BW Ortho	CL_R5	2066.8								~90%
MT41I006_120	1995 - BW Ortho	CL_R6	801.9								~10%
MT41I006_120	1995 - BW Ortho	CL_R7	306.2		1009						~95%
MT41I006_120	1997 - BW Ortho	CL_R8	312.0	52.7							

Table 5-3. Aerial Sediment Source Assessment: 303(d) Channel Alterations

303(d) Segment	Photo Year & Source	Reach ID	Length of Road w/in 100 ft of Reach (GIS, ft)	Length of Railway w/in 100 ft of Reach (GIS, ft)	Left Bank Length of Reach w/ Road Encroachment (ft)	Right Bank Length of Reach w/ Road Encroachment (ft)	Left Bank Length of RipRap (ft)	Right Bank Length of RipRap (ft)	Jetties	Dikes	Percent affected by Mining
MT41I006_120	1997 - BW Ortho	CL_R9	527.6	492.4		473					
MT41I006_130	1995 - BW Ortho	LG_R1	0.0								
MT41I006_130	1995 - BW Ortho	LG_R2	1357.4		436						~25%
MT41I006_130	1995 - BW Ortho	LG_R3	1249.1								~35%
MT41I006_130	1995 - BW Ortho	LG_R4	1035.6								~30%
MT41I006_130	1995 - BW Ortho	LG_R5	1443.5		537	1003		78			~10%
MT41I006_130	1995 - BW Ortho	LG_R6	8545.9		7763						~5%
MT41I006_130	1995 - BW Ortho	LG_R7	199.7								
MT41I006_130	1995 - BW Ortho	LG_R8	2130.1		664	469	40	100			
MT41I006_130	1995 - BW Ortho	LG_R9	1704.9				90	90			
MT41I006_040	1995 - BW Ortho/2004 C Ortho	40_R1	1912.8	2345.4	3223	1829	525	901			~35%
MT41I006_040	2004 C Ortho	40_R2	5677.2	5445.4	4863	6021	4958	5392			
MT41I006_040	2004 C Ortho	40_R3	1017.9	941.8	785	350	1427	430			~45%
MT41I006_040	2004 C Ortho	40_R4	1740.6	955.4	1226	1829	581	581			~80%
MT41I006_040	2004 C Ortho	40_R5	0.0	1610.9	363	998	193	317			~40%
MT41I006_040	2004 C Ortho	40_R6	160.6	430.9	100	825	939	284		2	100%
MT41I006_040	2004 C Ortho	40_R7	1257.1	97.8	625	625	172	178		1	
MT41I006_030	2004 C Ortho	30_R1	483.4				141	111			
MT41I006_030	2004 C Ortho	30_R2	203.3		100	100				1	
MT41I006_030	2004 C Ortho	30_R3	1691.0		718	100	401	75		1	
MT41I006_020	2004 C Ortho	20_R1	248.1				247	210			
MT41I006_020	2004 C Ortho	20_R2	1325.7		653	888	800	1024			
MT41I006_020	2004 C Ortho	20_R3	0.0								
MT41I006_142	1995 - BW Ortho/2004 C Ortho	142_R1	1962.1		559	2265					12%
MT41I006_142	1995 - BW Ortho	142_R2	1325.9		1184	1738					~30%
MT41I006_142	1995 - BW Ortho/2004 C Ortho	142_R3	750.4		841	367					~10%
MT41I006_142	2004 C Ortho	142_R4	2210.2		80	1571					
MT41I006_142	2004 C Ortho	142_R5	4950.2		1481	1824					~5%
MT41I006_142	2004 C Ortho	142_R6	3231.8		527	2290					
MT41I006_143	2004 C Ortho	143_R1	862.5								
MT41I006_143	2004 C Ortho	143_R2	475.7		158	2254				1	

Table 5-3. Aerial Sediment Source Assessment: 303(d) Channel Alterations

303(d) Segment	Photo Year & Source	Reach ID	Length of Road w/in 100 ft of Reach (GIS, ft)	Length of Railway w/in 100 ft of Reach (GIS, ft)	Left Bank Length of Reach w/ Road Encroachment (ft)	Right Bank Length of Reach w/ Road Encroachment (ft)	Left Bank Length of RipRap (ft)	Right Bank Length of RipRap (ft)	Jetties	Dikes	Percent affected by Mining
MT41I006_143	2004 C Ortho	143_R3	816.6		308	962					
MT41I006_143	2004 C Ortho	143_R4	303.2			3813					
MT41I006_143	2004 C Ortho	143_R5	1313.3		252		450				
MT41I006_143	2004 C Ortho	143_R6	1153.5	529.2							
MT41I006_143	2004 C Ortho	143_R7	219.7				380	260	1		
MT41I006_143	2004 C Ortho	143_R8	1642.0		670	1704	225 (surveyed)				
MT41I006_143	2004 C Ortho	143_R9	0.0								
MT41I006_143	2004 C Ortho	143_R10	235.1								
MT41I006_220	1995 - BW Ortho	SG_R1	3568.7		854	879					
MT41I006_220	1995 - BW Ortho	SG_R2	0.0								20%
MT41I006_220	1995 - BW Ortho	SG_R3	1139.4		1042						
MT41I006_220	2004 C Ortho	SG_R4	2441.9			150					~3%
MT41I006_220	2004 C Ortho	SG_R5	1032.6		216	133					~3%
MT41I006_220	2004 C Ortho	SG_R6	4028.3		1081	101					
MT41I006_220	2004 C Ortho	SG_R7	3340.9	102.3	1083	118					
MT41I006_160	2004 C Ortho	SVM_R1	0.0	422.1	392	131					14%
MT41I006_160	2004 C Ortho	SVM_R2	0.0	766.0	1426	71					
MT41I006_160	2004 C Ortho	SVM_R3	0.0	915.7		313					
MT41I006_160	2004 C Ortho	SVM_R4	373.9	2586.8	105	1045					
MT41I006_160	2004 C Ortho	SVM_R5	994.9	360.6		190					
MT41I006_160	2004 C Ortho	SVM_R6	188.0		119	58				1	~10%
MT41I006_160	2004 C Ortho	SVM_R7	0.0								
MT41I006_160	2004 C Ortho	SVM_R8	0.0	215.8	125	125					
MT41I006_210	1995 - BW Ortho	JF_R1	3224.5		2216	832					6%
MT41I006_210	1995 - BW Ortho	JF_R2	944.8		72	342					
MT41I006_210	1995 - BW Ortho	JF_R3	693.8								
MT41I006_210	1995 - BW Ortho	JF_R4	208.1		150	150					

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_060	1998 - BW Ortho	60_R1	forest - recreation/habitat	Evergreen Forest	dense conifer forest, forest road is probably the only man caused sediment source - more ATV trails visible than in GIS layer
MT41I006_060	1998 - BW Ortho	60_R2	forest - recreation/habitat, some private houses near end of reach	mostly Evergreen Forest with some Grassland area near stream	dense conifer forest with some wetland areas in stream bottom, forest road and possibly development near end of reach man caused sediment sources, HNF documented some incision from historic mining, 1 road crossing
MT41I006_060	1998 - BW Ortho	60_R3	forest/private houses	Evergreen Forest	conifer forest with land ownership change to private, dispersed housing, 3 road crossings, road encroaches in narrow valley opening
MT41I006_060	1995 - BW Ortho	60_R4	forest/private houses	Evergreen Forest transitioning to Grassland	dispersed housing, 3 road crossings, road encroaches in narrow valley opening
MT41I006_060	1995 - BW Ortho	60_R5	pasture	Grassland	major alterations for dredge boat operation (40% of reach), braiding/split channel near end of reach, 1 road crossing
MT41I006_060	1995 - BW Ortho	60_R6	transportation corridor	Grassland/Wetland / Evergreen Forest	channel has been moved from 1956 location towards LB, beaver ponds/wetland area surround stream, dense riparian vegetation, Road crossings 2 (I15 and Jefferson City entry)
MT41I006_090	1995 - BW Ortho	CRB_R 1	occasional pasture	Grassland	intermittent stream, not much for man-caused sediment sources, some small mine spoil piles proximal to stream (Monte Christo, Horseshoe Claim, Chalcopyrite Mine) , 2 road crossings (private low use road)
MT41I006_090	1995 - BW Ortho	CRB_R 2	mine reclamation	Grassland	mine reclamation from Bertha mine has left riparian area barren, straightened channel, and armored banks (100% of reach altered), numerous road sediment delivery sites to upstream tributaries, H.P. mine: Alta in tributary HW
MT41I006_090	1995 - BW Ortho	CRB_R 3	occasional pasture with small town at end of stream	Grassland	riparian area continues to be barren, some road encroachment, channelization in town of Corbin (15% of reach), 4 road crossings (2 driveways)
MT41I006_080	1995 - BW Ortho	SPR_R 1	pasture, some dispersed housing	Grassland	mine reclamation from Corbin Flats mine has left riparian area barren and straightened channel into virtually a ditch (90% of reach)
MT41I006_080	1995 - BW Ortho	SPR_R 2	townsite, some pasture at beginning of reach	Grassland	reach is 100% channelized for flow through Jefferson City, 3 road crossings
MT41I006_050	1995 - BW Ortho	50_R1	transportation corridor	mostly Grassland, some Evergreen Forest and Wetland	reach is staring to gain some sinuosity, bermed at end of reach for flow through culvert under I15, dense riparian vegetation near end of reach, about 80% of reach still straight from channelization associated with placer mining/highway development

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_050	1995 - BW Ortho	50_R2	transportation corridor	mostly Grassland, some Evergreen Forest and Shrubland	virtually entire reach is channelized, rip rap probably an underestimate, some areas of meander bends with gravel bar deposits/split channel, 12 roads crossings (1- I15, others mostly driveways), reach confined between highway/frontage road and terrace (RB), minor road encroachment on RB, end of reach sinuous
MT41I006_050	1997 - BW Ortho	50_R3	transportation corridor	Com/Ind/Trans, Evergreen Forest, Grassland	entire reach confined between RR bed and I15, 100% channelized, lots of riprap documented in the field (amount calculated probably underestimate), 2 road crossings (I15), road encroachment for LB is mainly from old RR bed
MT41I006_050	1997 - BW Ortho	50_R4	transportation corridor/campground	Com/Ind/Trans, Evergreen Forest, Grassland/Shrubland	stream flowing between I15 and frontage road, "relatively unconfined" - 35% channelized -allowed to meander in sections, but campground developed on banks with riprap
MT41I006_050	1997 - BW Ortho	50_R5	transportation corridor/townsite	mostly Grassland, some Shrubland	stream is virtually a straight line, 100% channelized, between I15 and frontage/RR in town of Clancy, Clancy Creek enters here, only bends are for road crossings (3)
MT41I006_050	1997 - BW Ortho	50_R6	wetland/lumber yard	mostly Grassland, some Evergreen Forest and Shrubland	beginning and end of reach have been straightened (placer tailings as levees) 70% channelized, middle section is fairly sinuous, dense riparian vegetation especially near end of reach , some encroachment from lumber mill, 1 road crossing
MT41I006_100	1997 - BW Ortho	MFWS_R1	abandoned mines in HNF/old timber harvest on private inholdings in steep slope above	mostly Evergreen Forest	numerous abandoned mine sites within stream corridor and of tributaries (2 HP: Solar Silver and MFWS, White Pine area documented by HNF as problem), tailings preventing growth of vegetation in sections and identified as a sediment source, road encroaches on stream -4 road crossings (more shown than in GIS layer)/old timber harvest on private land in steep slopes above stream
MT41I006_100	1997 - BW Ortho	MFWS_R2	HNF rec/roaded	mostly Evergreen Forest	road encroaches on stream for most of reach - at least 2 road crossings (more shown than in GIS layer), breached mining dam documented by HNF
MT41I006_180	1997 - BW Ortho	NFWS_R1	HNF rec/roaded	mostly Evergreen Forest, some Grassland	reach was mostly burned over in 1988 fire, few older trees left in riparian corridor, 1 road crossing, mostly natural sediment sources, 1 abandoned mine shown -Willard Group (underground)
MT41I006_180	1997 - BW Ortho	NFWS_R2	rural housing (1)/transportation corridor	mostly Grassland/Shrubland, some Deciduous Forest	stream probably is intermittent until joining tributary at major aspect change, encroached by road for about half of reach length, road sediment delivery sites documented by HNF, small harvest on private property
MT41I006_180	1997 - BW Ortho	NFWS_R3	HNF rec/roaded	Evergreen Forest	road encroaches on stream for most of reach - 1 road crossing, numerous road sediment delivery sites documented by HNF

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_180	1997 - BW Ortho	NFWS_ R4	HNF rec/roaded, rural housing (1)	mostly Evergreen Forest, with Grassland near mouth	stream transforms from somewhat confined to fairly unconfined at mouth, some road encroachment, evidence of placer mining and minor grazing impacts observed in field
MT41I006_110	1997 - BW Ortho	WS_R1	rural housing	mostly Grassland, some Evergreen Forest, Wetland, and Shrubland	beginning of reach shows signs from placer mining with raw banks/tailing levees and areas of multiple channels, poor grazing practices and confined livestock area observed in field for about 1st half of reach, 3 road crossings -problem culvert documented at Woodland Park Loop (SF WS no roads)
MT41I006_110	1997 - BW Ortho	WS_R2	rural housing (smaller lots than reach 1)	mostly Grassland with Wetland, some Evergreen Forest and Shrubland	fairly dense riparian corridor interrupted at road crossings (at least 4), small section where mowing to stream edge, abandoned mine - Warm Springs Lode shown close to stream near end of reach
MT41I006_110	1997 - BW Ortho	WS_R3	rural housing	mostly Grassland, some Shrubland	fairly dense riparian corridor interrupted at road crossings (at least 3), poor grazing practices observed in field, Hot Springs near end of reach
MT41I006_110	1997 - BW Ortho	WS_R4	transportation corridor/nursing home	mostly Grassland, some Evergreen Forest, Wetland, and Shrubland	100% channelized section, stream is completely straightened, input from hot springs here, dense willow trees lining banks for most of reach, 2 road crossings, high priority abandoned mine site near end of reach - Alhambra Hot Springs
MT41I006_120	1995 - BW Ortho	CL_R1	HNF rec/roaded	mostly Evergreen Forest, some Grassland	numerous abandoned mine sites within stream corridor and of tributaries (1 HP: Crawley Camp), 3 spoils piles within or adjacent to stream are possible sediment sources, road encroaches on stream in areas some documented with GPS -3 road crossings/main road up drainage is not shown in GIS layer
MT41I006_120	1995 - BW Ortho	CL_R2	private lands with grazing/logging	mostly Grassland, some Evergreen Forest and Shrubland	road encroaches on stream in sections (1 crossing), beaver/wetland complex area at confluence with Kady Gulch - sinuosity/channel parameters not applicable, entire reach was probably once a beaver/wetland complex (evidence in field of old dams), mine spoil piles contributing sediment to stream near end of reach (GPS site - Ariadne Mine), recent timber harvest observed in field adjacent to riparian corridor on private lands -grazing also observed, reach ends at downstream boundary of Gregory Mine Site (H.P.)
MT41I006_120	1995 - BW Ortho	CL_R3	private lands with grazing/hist. mine areas	mostly Evergreen Forest, some Shrubland and Grassland	reach is downcut into confined valley bottom, evidence of old placer mining/altered stream course, county road is a problem in this reach - road blowouts and sediment delivery sites documented in field

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_120	1995 - BW Ortho	CL_R4	private lands with grazing/haying	mostly Grassland, some Evergreen Forest and Shrubland	stream relatively unconfined for most of reach, one section of placer mining (~1354'), grazing causing bank erosion observed in beginning of reach and mid section of reach (BEHI), haying in open meadows, evidence of old beaver dams, few sites where roads delivers sediment (1 crossing - priv.), end of reach property with concentrated farm activities - foul and livestock with ponds/Quartz Creek enters here - harvests visible and H.P. ab. mine: Argentine
MT41I006_120	1995 - BW Ortho	CL_R5	private lands old placer piles, some rural subdivision development	mostly Grassland, some Evergreen Forest and Shrubland	about 90% of reach flows within large 'placer terraces' that contribute sediment in some sections (Clancy Creek Placer, steep slopes make it difficult for vegetation to re-establish), stream re-establishing sinuosity and stabilized banks in sections where viewed, end of reach BLM land -impoundment with unknown purpose, 2 road crossings (1 documented sediment delivery site)
MT41I006_120	1995 - BW Ortho	CL_R6	private lands with grazing/haying	mostly Grassland, some Evergreen Forest and Shrubland	stream relatively unconfined for most of reach, grazing causing bank erosion observed within reach (BEHI), haying in open meadows, evidence of old beaver dams, road is not a sediment source in reach
MT41I006_120	1995 - BW Ortho	CL_R7	private lands old placer piles, some rural subdivision development/grazin g	mostly Grassland and Evergreen Forest, some Shrubland	about 95% of reach flows within large 'placer terraces' that may contribute sediment in some sections - coarser substrate than upper placer reach (Clancy Creek Placer cont.?), 2 road crossings, grazing observed in field
MT41I006_120	1997 - BW Ortho	CL_R8	townsite, some pasture/hay fields	mostly Grassland	stream is relatively unconfined and sinuous, school track near floodplain and haying downstream, 1 road crossing in town
MT41I006_120	1997 - BW Ortho	CL_R9	transportation corridor	Grassland	100% channelized section, stream is completely straightened
MT41I006_130	1995 - BW Ortho	LG_R1	HNF rec	Evergreen Forest	apparently pristine section, no sources observed
MT41I006_130	1995 - BW Ortho	LG_R2	HNF rec/roaded/mine sites	Evergreen Forest with Transitional Area	Lots of disturbance in reach spanning from mining dams and rock walls lining stream banks to timber harvest and associated road network (all on HNF), 3 road crossings (1 not in GIS layer), Frohner Basin drainage enters here with 4 HP mines: Frohner (2 sites), General Grant, and Nellie Grant
MT41I006_130	1995 - BW Ortho	LG_R3	HNF rec/private inholding (extraction)	Grassland and Evergreen Forest	stream flows through private inholding within HNF, timber harvest along private boundary, 6 road crossings documented by the HNF (not in GIS), mining and grazing impacts recorded by HNF

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_130	1995 - BW Ortho	LG_R4	private housing	mostly Evergreen Forest, some Shrubland and Grassland	first half of reach is a wetland complex, second half of stream downcuts through canyon, 4 road crossings
MT41I006_130	1995 - BW Ortho	LG_R5	transportation corridor in forest setting	mostly Evergreen Forest, some Grassland and Shrubland	roads are problematic sediment source from this reach practically to mouth - numerous delivery sites documented in field even where not encroaching on floodplain, sediment delivery from Corral Gulch Rd, perched culvert at Corral Gulch entry, 1 road crossing
MT41I006_130	1995 - BW Ortho	LG_R6	transportation corridor in forest setting/rural home sites near end of reach	mostly Evergreen Forest, some Grassland and Shrubland	roads are problematic sediment source - numerous delivery sites documented in field even where not encroaching on floodplain, private road not in GIS is a big sediment source in few areas, timber harvest in riparian area, at least 5 road crossings
MT41I006_130	1995 - BW Ortho	LG_R7	rural housing/pasture	mostly Grassland and Evergreen Forest	stream pulls away from road here mostly unconfined in meadow, some delivery at road crossings, grazing impacts, at least 3 road crossings, sediment input from new development draining to stream
MT41I006_130	1995 - BW Ortho	LG_R8	transportation corridor in forest setting	mostly Evergreen Forest, some Grassland and Wetland	stream is more confined again with road sediment inputs (2 crossings), beaver dams in one section with massive amount of sands trapped behind dam
MT41I006_130	1995 - BW Ortho	LG_R9	meadow with haying/grazing and rural housing	mostly Grassland, some Evergreen Forest and Shrubland	reach is relatively unconfined in meadow, variable riparian buffer widths, some areas of beaver dams, irrigation diversions, straightened near end of reach (1650'), 6 road crossings (more than in GIS)
MT41I006_040	1995 - BW Ortho/2004 C Ortho	40_R1	transportation corridor (I15 and RR, frontage roads)	mostly Evergreen Forest with Grassland, some Wetland and Shrubland	stream is straightened (90% channelized) and confined mainly by railroad (lumber area and pond near end of reach), fairly stable streambanks viewed in field, but riparian vegetation density is variable, gaining sinuosity where not encroached by roads, detached point bars and split channel visible in areas, 2 crossings (1 RR), some of encroachment from old RR bed
MT41I006_040	2004 C Ortho	40_R2	transportation corridor (I15 and RR, frontage roads)/subdivisions upslope	Grasslands adjacent to Transportation Corridor and Shrubland	major channelized section (95%), stream is heavily rip-rapped and downcut, very narrow corridor for shade producing vegetation, stream is trying to gain sinuosity, 4 road crossings (1RR), some of encroachment from old RR bed

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_040	2004 C Ortho	40_R3	wetland riparian area surrounded by rural homesites/transportation lanes	mostly Wetland	reach is relatively unconfined, fairly dense riparian buffer, stream widens, 1 irrigation diversion, straightened near end of reach probably placered (4180') 45% channelized, 4 road crossings (1 RR, 1 I15), old RR bed with some encroachment
MT41I006_040	2004 C Ortho	40_R4	wetland riparian area surrounded by transportation lanes/Ash Grove roadside park on RB	mostly Wetland	stream has been straightened probably by construction of railroad and placer mining (95% channelized), confined between railroad and highway, 2 road crossings (1hwy) and 1 footbridge, encroachment mostly from secondary roads not in GIS
MT41I006_040	2004 C Ortho	40_R5	wetland riparian area surrounded by transportation lanes/agriculture near end of reach	mostly Wetland, some Grassland and Deciduous Forest	stream gains sinuosity but still straightened in sections by railroad and probably for agricultural use or ASARCO, areas of split channels and detached point bars, very poor density of riparian vegetation around agricultural operation, 2 crossings (RR), sections where beaver dams have been removed, encroachment from RR bed
MT41I006_040	2004 C Ortho	40_R6	mostly Wetland, adjacent to defunct smelting operation	Wetland and Commercial/Industrial/Transportation	channel has been completely altered for ASARCO operation and was likely moved further East of original channel location, dam on segment as well as large slag piles that lose rubble to stream, flow leaves channel near beginning to supply cooling pond, 736' of slag = rip-rap on LB, 1 road crossing, large beaver dam viewed in field below dam, encroachment from RR bed and road crossing
MT41I006_040	2004 C Ortho	40_R7	townsite and agricultural fields after town	Low Intensity Residential, Wetland and Grassland	channel flows through E. Helena and is mostly leveed in town, irrigation diversion before end of reach and channel is split just before end of reach (for flood control?) about 60% channelized, 4 road crossings (1 RR, 1 Hwy)
MT41I006_030	2004 C Ortho	30_R1	agricultural farmstead	Grasslands	altered reach, at least 2 channels, measured channel which holds flow for most of year (LB), may be forced to flow in LB channel for irrigation diversion, 60% channelized, 2 road crossings (1 driveway, 1 Hwy), reach ends at irrigation diversion
MT41I006_030	2004 C Ortho	30_R2	agriculture and gravel pit to RB (open water assoc)	Grasslands and Pasture with Quarry on RB	altered reach that has been straightened and leveed in many areas with almost total removal of riparian vegetation, 95% channelized, many gravel bar deposits, HVID canal crosses stream here at siphon, gravel pit operations mainly on RB but looks like older pits on LB as well, 2 road crossings (1 Hwy), reach ends at Canyon Ferry Road

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_030	2004 C Ortho	30_R3	agriculture and rural homesites	Grasslands and Pasture with some Deciduous Forest	reach starts to gain sinuosity with 'less' disturbance in riparian area, lots of deposition visible in reach with channel splitting in many areas, bank erosion problematic for ~25% of reach, 3 road crossings (2 Hwy), 'Stanisfield Lake' wetland to RB near end of reach, 2 irrigation drains enter reach after sample site (appear to lower water table -begin in fields), reach ends at WWTP discharge
MT41I006_020	2004 C Ortho	20_R1	agriculture and rural homesites	Grasslands	reach maintains sinuosity but with notable disturbance in riparian area, bank erosion problematic for ~45% of reach, lots of deposition visible in reach with channel splitting in many areas, 1 road crossing - 4 secondary crossings (bridges), many areas of potential non-point nutrient sources adjacent to stream, 3 flow inputs to stream (Stanisfield Lake drainage, a spring creek that flows through a confined pasture area, irrigation drains/lateral), reach ends at irrigation inflow
MT41I006_020	2004 C Ortho	20_R2	agriculture and rural homesites/Police training academy	Grasslands and Pasture with Crops adjacent	reach maintains sinuosity and disturbance in riparian area continues, deposition still visible in reach, bank erosion problematic for ~30% of reach, 3 road crossings, some areas of potential non-point nutrient sources adjacent to stream, inflow from irrigation lateral and Tenmile Creek, reach ends at Tenmile Creek, about 15% of reach channelized for Sierra Rd crossing and Police Academy, sewage lagoons at Police Academy
MT41I006_020	2004 C Ortho	20_R3	agriculture with 1 rural homesite	Grasslands, some Crops adjacent and Wetland near lake	reach less sinuous and wider from Tenmile inflow, very little riparian vegetation, bank erosion problematic for ~30% of reach, deposition visible in reach, 2 road crossings (secondary), reach ends at Lake Helena, about 20% of reach channelized to avoid irrigation canal
MT41I006_142	1995 - BW Ortho/2004 C Ortho	142_R1	townsite/transportation corridor within forest	Evergreen Forest with some Grassland and Shrubland	reach begins at City's water diversion structure, loss of water likely to affect water quality and sediment transport, encroached by road in areas, high priority AB mine sites close to stream: Valley Forge/Susie, drainage from Upper Valley Forge would enter in this reach, clearing of forest visible for Ab mine - Lee Mtn., 1 road crossing (secondary rd), about 35% channelized for diversion and flow through Rimini
MT41I006_142	1995 - BW Ortho	142_R2	HNF rec/roaded/mine sites	Evergreen Forest	reach surrounded by forest but still encroached by road, many sediment delivery sites documented by the HNF as well as incision from historical mining, potentially 2 road crossings (1 Minnehaha Ck, 1 not in GIS - old mining road?)
MT41I006_142	1995 - BW Ortho/2004 C Ortho	142_R3	HNF rec/roaded (campground)	Evergreen Forest with some Grasslands and Shrubland	reach continues to be encroached by road in areas, valley bottom is wider than upper reaches and channel splits in a few areas, HNF documented channelization from hist. mining, 2 road crossings (main Rimini Rd)

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_142	2004 C Ortho	142_R4	HNF rec/roaded	Evergreen Forest	reach is confined and encroached by Rimini road in areas, HNF documented road sediment delivery site, 1 road crossing (cmpgrd), about 40% channelized for Rimini Road
MT41I006_142	2004 C Ortho	142_R5	transportation corridor/rural homes	Grasslands at base of Evergreen Forest	stream continues to be encroached by road in areas with exposed banks visible where encroachment is severe, valley bottom widens again, 3 road crossings (1 Rimini Rd), sediment delivery sites documented by HNF, about 30% channelized for Rimini Road
MT41I006_142	2004 C Ortho	142_R6	transportation corridor/rural homes	Grasslands, Evergreen Forest, and Shrubland	stream continues to be encroached by road in areas with exposed banks visible where encroachment is severe, transitional reach from forest to wider valley bottom opening - appears to gain flow where valley opens, 7 road crossings (1 Rimini Rd), sediment delivery sites documented by HNF and L&W, about 20% channelized for Rimini Road
MT41I006_143	2004 C Ortho	143_R1	agriculture and rural homesites	Pasture Hay, Grasslands, Wetland and some Crops	stream pulls away from road and riparian area changes to cottonwoods (where present), predominantly agricultural area with rural homes, riparian grazing observed in field and gravel pit operation near beginning of reach to RB, exposed banks visible and bank erosion likely an issue (~50% of reach), at least 3 animal feedlots located close to stream, approximately 5 irrigation diversions and 2 return flow canals, 5 road crossings (mostly secondary roads), probably channelized for irrigation purposes would expect stream to be more sinuous
MT41I006_143	2004 C Ortho	143_R2	transportation corridor/rural homes	Grasslands and Pasture Hay	short reach 100% channelized by Hwy 12 (GIS rd layer does not capture full extent), large wooded dike/dam observed for irrigation diversion, grazing observed
MT41I006_143	2004 C Ortho	143_R3	agricultural/rural homes	Pasture Hay, Wetland and LowIntensity Residential	reach mostly away from Hwy 12, meanders but cutoff observed in irrigated fields (forced?), beginning of reach flows through irrigated fields where grazing and bank erosion was observed (20% of reach), 1 diversion and 1 return flow, health of riparian vegetation variable with patches where absent in irrigated fields, mowing to edge of stream in Blue Cloud subdivision (end of reach), 2 road crossings, encroached by Hwy12 somewhat near end of reach, about 30% channelized from irrigation/hay fields and Hwy 12
MT41I006_143	2004 C Ortho	143_R4	transportation corridor/future rural homes/club	Grasslands and Wetland adjacent to Commercial/Industrial/Transportation	another short reach 100% channelized by Hwy 12 (GIS rd layer does not capture full extent), Broadwater Athletic Club adjacent to stream and observed lots for development just upstream (both LB), 1 road crossing, much of the stream appears to have levees on both banks from this point through much of the valley (to I15) - alters expected W/D ratio and entrenchment

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_143	2004 C Ortho	143_R5	rural homes/state nursery (defunct?)	Grasslands and Wetland adjacent to Commercial/Industrial/Transportation	reach pulls away from Hwy 12 again, but levees are present limiting stream's course, state nursery present here, riparian corridor fairly healthy not much for bank erosion with levees present, some rip-rap at house/pool close to stream and where road close to stream, 3 road crossings, levees channelize about 85% or more of reach
MT41I006_143	2004 C Ortho	143_R6	rural homes - subdivision/golf course	Grasslands, Wetland, and Recreational Grasses adjacent to Commercial/Industrial/Transportation, Crops and Low Intensity Residential	stream transitioning from mostly rural landuses to some urban influences with golf course and increasing housing density, rural land uses still present, levees observed along most of reach surveyed with minimal opportunity for bank erosion - probably about 80% or more of reach with levees, Schatt's diversion takes off at beginning of reach, fairly healthy riparian corridor with cottonwoods and willows present, 4 road crossings (1 RR) and 4 golf cart crossings (1 is ford?)
MT41I006_143	2004 C Ortho	143_R7	agricultural/rural homes	Wetland surrounded by Pasture/Hay and Crops	fairly unconfined reach surrounded by predominantly agricultural land uses, areas of riparian vegetation removal likely causing problems for bank erosion for at least 20% of reach, Sevenmile enters near beginning of reach just after meander cutoff (natural?), levees not as prominent, bank erosion and areas of concrete rip-rap observed in 2003 and 2005 survey, Spring Creek also enters here near end of reach (West side City of Helena Stormwater discharge enters Spring Creek) Spring Creek is channelized for irrigation use as well as to fill pond near Tenmile Ck (RB), 1 road crossing, reach ends at HVID canal siphon, 1 jetty for 1921 diversion, at least 2 irrigation diversions, about 40% of reach or more probably channelized for irrigation/hay practices
MT41I006_143	2004 C Ortho	143_R8	agricultural/subdivisions	Grasslands adjacent to Low Intensity Residential, Crops, and Commercial/Industrial/Transportation	most of reach appears to have been channelized and leveed (70% or more), areas of exposed banks likely causing problems for bank erosion for at least 15% of reach, notable subdivisions in lands just upslope from stream corridor but fair amount of hay fields/rural land use along stream, 4 road crossings including I15, appears to be an HVID canal spillway at beginning of reach where siphon travels under stream u/s of McHugh Ln, stormwater runoff from Tenmile Creek Estates appears to be channelized (2 'canals') to flow into creek and captured for irrigation diversion just u/s of I15 crossing

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_143	2004 C Ortho	143_R9	mostly agricultural/subdivision to South	Deciduous Forest adjacent to Crops and Low Intensity Residential	best potential for reference reach in valley segment surveyed, relatively unconfined with cottonwoods, fish habitat structure present but grazing management practices needed and lack of summer flows problematic, at least 1 irrigation diversion, bank erosion problematic for about 10% of reach, about 30% of reach probably channelized for irrigation/hay practices
MT41I006_143	2004 C Ortho	143_R10	mostly agricultural/with few rural homes	Grasslands and Crops	reach ends at Prickly Pear Creek, lack of riparian vegetation notable from upstream reach, 2 road crossings, encroachment noticeable from private driveway, beaver dam observed in field as well as decadent and dying cottonwoods, HVID lateral spillway just after Sierra Rd, animal confinement lots near stream by ranch house, bank failure notable in field affects ~45% of reach, about 40% of reach or more probably channelized for irrigation/hay practices
MT41I006_220	1995 - BW Ortho	SG_R1	HNF rec/roaded	mostly Evergreen Forest, some Shrubland and Grassland	steep reach near old harvest units with at least 5 road crossings from harvest roads (more than shown in GIS), grazing impacts - road sediment delivery sites and a mine dump documented by HNF, stream is probably intermittent for upper 1/2 of reach, reach ends at tributary confluence
MT41I006_220	1995 - BW Ortho	SG_R2	HNF rec	mostly Evergreen Forest, some Shrubland	steam continues along steep valley bottom slightly less confined, dense riparian vegetation, HNF documented channel alterations from placer mining - stream incised but banks are vegetated
MT41I006_220	1995 - BW Ortho	SG_R3	probably seasonal grazing	mostly Evergreen Forest with some Wetlands	reach leaves HNF, few sources observable other than possibly some road sediment input, reach ends at road crossing below confluence with East Skelly Gulch, possible grazing impacts, dense riparian vegetation, up to 3 road crossings and some encroachment from secondary roads not in GIS layer
MT41I006_220	2004 C Ortho	SG_R4	probably seasonal grazing and low density(very) rural residential	mostly Evergreen Forest, some Shrubland	dense riparian vegetation with more opening of valley bottom and wetlands - probably a few beaver dams present, possible grazing impacts, some natural terrace erosion observed in field, RB road is well above stream to not be a sediment source for much of length (GIS overestimate), much of land is subdivided and currently for sale, reach ends at road crossing- 2 road crossings (incl. stream ford at end of reach), extreme close-up reveals that stream is more sinuous than able to be digitized, old mine shaft near end of reach and some placer piles (vegetated) visible in field - many prospects visible on topos in uplands near end of reach

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_220	2004 C Ortho	SG_R5	wetlands surrounded by low density rural residential	Wetland adjacent to Evergreen Forest and shrubland	dense riparian vegetation with a large beaver complex for much of reach (channel measures difficult to apply here), for much of the stream viewed riparian area in 'reference condition', about 150' of stream disturbed in beginning of reach for pipeline swath with no regrowth of woody vegetation, GIS overestimates road length affecting stream, 1 road crossing - bridge adjacent to upper reach's stream ford, Hamilton Gulch enters in this reach and probably contributes sediment from the RR berm (photos and GPS point), placer tailings visible in field for parts of reach - many prospects continue to be visible on topos in uplands
MT41I006_220	2004 C Ortho	SG_R6	riparian surrounded by low density rural residential	Wetland and Evergreen Forest at base of Grasslands	dense riparian vegetation continues, valley bottom is naturally constricted, some minor grazing impacts and road sediment delivery observed in field, 4 road crossings (mostly driveways), small pond on stream for water diversion at 1st road crossing
MT41I006_220	2004 C Ortho	SG_R7	BLM rec/roaded primary entryway to low density private subdivision	Wetland with some Evergreen Forest at base of Grasslands	most of reach is on BLM property, Skelly Gulch Road is a definite sediment source here exacerbated by beaver dams causing stream to pond and flood road, about 1/5 of reach is within a few feet of road with road berm as separator between stream and road in some areas, channel measures difficult to apply in beaver complex, culvert at Austin Rd is plugged with debris and sediment -water barely trickles through with aide of an overflow culvert
MT41I006_160	2004 C Ortho	SVM_R 1	wetland/occasional grazing allotment adjacent to RR	Wetland at base of Grasslands	reach begins at confluence of Greenhorn Ck. and Skelly Gulch, sediment appears to be problematic even at headwaters, suspect stream is still recovering from alterations for RR and historic placer mining, likely a beaver-wetland complex before alterations -remnant dams and hummocky terrain observed in field with fines as major bank component, stream is incised for most of length, minor encroachment from RR, disturbance visible for small portion of reach from placer mining on RB, sediment delivery from roads documented with GPS in field from ephemeral gully -appears to have moved a lot of load during runoff events, 1 RR crossing
MT41I006_160	2004 C Ortho	SVM_R 2	wetland/occasional grazing allotment adjacent to RR	Wetland at base of Grasslands/Shrubl and/ Evergreen Forest	reach has encroachment from RR (more than captured by GIS as stream course is different than NHD), reach ends at RR crossing

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_160	2004 C Ortho	SVM_R 3	some wetland adjacent to RR and rural homesite(grazing/haying)	Wetland at base of Grasslands/ Evergreen Forest	reach has some encroachment from RR, removal of woody vegetation on LB for haying/grazing for about 2/3 of reach length - bank erosion likely a problem ~10% of reach, end of reach is likely a beaver complex with split channels and dense willows (sinuosity and BF don't really apply), Park Creek enters near end of reach and likely delivers sediment during runoff events (ephemeral/intermittent stream) - gully visible in field, 1 irrigation diversion
MT41I006_160	2004 C Ortho	SVM_R 4	RR and rural homesites (grazing/haying)	narrow band of Wetland surrounded by Grasslands	reach is mostly single thread sinuous channel with agricultural activities in floodplain (narrow band of woody vegetation), has some encroachment from RR, bank erosion likely a problem ~40% of reach, at least 4 irrigation diversions, 3 feedlots somewhat close to stream, 1 main road crossing
MT41I006_160	2004 C Ortho	SVM_R 5	grazing and haying	narrow band of Wetland surrounded by Grasslands	reach is similar to upstream segment except not encroached by railroad, observed portion in field with F. Gruber where channel incision and bank erosion is major source of sediment with ~50% of reach with eroding banks, beaver dam remnants observed, reach begins at place of 2 irrigation diversions
MT41I006_160	2004 C Ortho	SVM_R 6	grazing and haying	narrow band of Wetland surrounded by Grasslands and Pasture/Hay	reach begins at irrigation diversion where headgate/dike checks channel incision upstream, thus this reach is severely incised and plagued by steep eroding banks, bank erosion is major source of sediment with ~85% of reach with eroding banks, viewed in field with F. Gruber, beaver dam remnants observed, channel is trying to recover, defunct Ft. Harrison Sewage lagoons near end of reach to RB with animal confinement lots adjacent to lagoons and stream, ~17% of reach has been channelized (possibly for placer mining?), feedlot close to stream at end of reach, 2 road crossings, at least 2 diversions
MT41I006_160	2004 C Ortho	SVM_R 7	grazing and haying	Pasture/Hay	short reach almost devoid of riparian vegetation, ends at entry of spring creek which may contribute nutrients from golf course (also receives irrigation water). High Priority AbMine -Franklin and SamGaty in Scratch Gravel Hills above stream may drain to this reach, majority of reach has been channelized (66%) for irrigation/haying purposes, multiple diversions, 2 road crossings, ~75% of reach with eroding banks
MT41I006_160	2004 C Ortho	SVM_R 8	grazing and haying with low density residential on outskirts	narrow band of Wetland surrounded by Pasture/Hay	short reach to mouth at Tenmile Creek, some rebound in sinuosity and woody vegetation present, channelization still evident (~50%), observed in field in 2003 with beaver dams, 1 RR crossing, ~65% of reach with eroding banks

Table 5-4. Aerial Sediment Source Assessment: 303(d) Channel Observations

303(d) Segment	Photo Year & Source	Reach ID	Land Use	MRLC Classification	Notes
MT41I006_210	1995 - BW Ortho	JF_R1	private ski area	Evergreen Forest and Grasslands	stream headwaters in mine shaft (HP AbMine: Bald Mountain) on Mt. Belmont, steep slopes and small channel, extensive road network and ski runs dominate riparian area and affect channel form, cistern captures flow at base of ski hill for snow making, stream flows under parking lot in culvert for ~284 feet, excessive ski area runoff observed during spring snow-melt causing sediment loading to stream, improperly sized culverts viewed in 2003 in at least 2 places, at least 3 road crossings, reach is mostly channelized (90%)
MT41I006_210	1995 - BW Ortho	JF_R2	private -seasonal grazing	Evergreen and Deciduous Forest surrounded by Grasslands	overstory riparian provides good canopy, some grazing impacts observed in field during 2003 causing bank erosion and loss of understory woody species in heavily browsed areas, old road that is rarely used affecting stream from past channelization (35%), 1 road crossing
MT41I006_210	1995 - BW Ortho	JF_R3	fringe of Marysville townsite	Grassland	short reach flows on edge of Marysville town, riparian area mostly sedges and grasses, 2 road crossings
MT41I006_210	1995 - BW Ortho	JF_R4	private forest	Evergreen and Deciduous Forest surrounded by Grassland and Shrubland	stream enters forest canopy again, few sources visible save for main road crossing before entering Silver Creek, topos and GIS show prospects/mine sites in uplands of reach

Table 5-5. Historical Aerial Sediment Source Assessment of Upper Prickly Pear Creek: Channel Form

303(d) Segment	PhotoYear & Source	Reach_ID	Reach Length	Elevation Δ	Normalized Reach Length	Valley Length	Normalized Valley Length Factor	Valley Slope	Normalized Valley Slope
MT41I006_060	1956 - BW HC	60_R5	2090	30	1712.5	1932	-0.18	0.016	0.019
MT41I006_060	1956 - BW HC	60_R6	4720	65	5066.5	4182	0.07	0.016	0.014
MT41I006_050	1956 - BW HC	50_R1	3854	42	4058.6	3636	0.05	0.012	0.011
MT41I006_050	1956 - BW HC	50_R2	18200	183	20397.6	15818	0.12	0.012	0.010
MT41I006_050	1956 - BW HC	50_R3	4942	45	5630.6	4708	0.14	0.010	0.008
MT41I006_050	1956 - BW HC	50_R4	4380	40	4383.7	3570	0.00	0.011	0.011
MT41I006_050	1956 - BW HC	50_R5	2196	17	3067.9	2146	0.40	0.008	0.006
MT41I006_050	1956 - BW HC	50_R6	4268	23	3988.9	3762	-0.07	0.006	0.007
MT41I006_040	1956 - BW HC	40_R1	8448	65	9368.5	7526	0.11	0.009	0.008
MT41I006_040	1956 - BW HC	40_R2	11624	55	12859.0	10278	0.11	0.005	0.005
MT41I006_040	1956 - BW HC	40_R3	8870	40	9877.0	7258	0.11	0.006	0.005

Table 5-6. Historical Aerial Sediment Source Assessment of Upper Prickly Pear Creek: Channel Features and Alterations

303(d) Segment	PhotoYear & Source	Reach_ID	Sinuosity	Normalized Sinuosity	Channel Slope	Normalized Channel Slope	Bankfull Width	All Left Bank Encroachment	All Right Bank Encroachment
MT41I006_060	1956 - BW HC	60_R5	1.1	1.1	0.014	0.018	15.2		331
MT41I006_060	1956 - BW HC	60_R6	1.1	1.1	0.014	0.013	17.5	3510	3813
MT41I006_050	1956 - BW HC	50_R1	1.1	1.1	0.011	0.010	12.0	1799	4059
MT41I006_050	1956 - BW HC	50_R2	1.2	1.2	0.010	0.009	17.9	15966	4317
MT41I006_050	1956 - BW HC	50_R3	1.0	1.0	0.009	0.008	12.8	3120	4523
MT41I006_050	1956 - BW HC	50_R4	1.2	1.2	0.009	0.009	17.8	162	1681
MT41I006_050	1956 - BW HC	50_R5	1.0	1.0	0.008	0.006	15.2	1017	2258
MT41I006_050	1956 - BW HC	50_R6	1.1	1.1	0.005	0.006	20.4	3989	3989
MT41I006_040	1956 - BW HC	40_R1	1.1	1.1	0.008	0.007	21.1	7401	6822
MT41I006_040	1956 - BW HC	40_R2	1.1	1.1	0.005	0.004	26.4	3640	4396
MT41I006_040	1956 - BW HC	40_R3	1.2	1.2	0.005	0.004	24.7		

Table 5-7. Historical Aerial Sediment Source Assessment of Upper Prickly Pear Creek: Channel Observations

303(d) Segment	PhotoYear & Source	Reach_ID	LU	Notes
MT41I006_060	1956 - BW HC	60_R5	cultivated field, possibly grazing at end of reach	irrigation diversion at beginning of reach, channel stays on RB side of valley instead of going to LB side today at I15 culverts, thin strip of riparian vegetation, 1 secondary road crossing
MT41I006_060	1956 - BW HC	60_R6	dredge/placer mining	extensive tailings piles fill valley bottom where interstate and frontage road are today, large dredge pond on RB, just downstream of confluence with Beavertown Creek, channel leading away from d. pond as well as multiple channels on LB, probably seeping through tailings piles, most of encroachment from tailings piles, riparian area around LB channels, 2 road crossings (1 placer mining road) - Winston Brothers Placer (GIS)
MT41I006_050	1956 - BW HC	50_R1	dredge/placer mining	continuation of tailings piles, stream has been straightened, no evidence of woody vegetation, looks like flow has been lost possibly at pond, encroachment mainly from tailings piles, 1 road crossing
MT41I006_050	1956 - BW HC	50_R2	dredge/placer mining	continuation of tailings piles, stream crosses tailings piles to RB side of valley where large berm is today, stream is eroding into terrace for approximately 610', encroachment mainly from tailings piles, gravel bar deposits and braiding evident, slope failure or headcutting on steep terrace where Primrose Lane is currently, 2 irrigation diversions visible in reach, *end of reach is 'free flowing' - very sinuous (1.6) woody vegetation, 4 road crossings (1 Hwy)
MT41I006_050	1956 - BW HC	50_R3	transportation corridor	stream is confined between railway bed and highway, some sinuosity in beginning of reach, 1 road crossing at end of reach
MT41I006_050	1956 - BW HC	50_R4	RB transportation corridor, LB rural housing/hay fields	stream is relatively unconfined on LB, but confined in sections on RB by roadway, it appears straightened compared to sinuous section of creek at the end of 50_R2, 1 road crossing (secondary)
MT41I006_050	1956 - BW HC	50_R5	mostly transportation corridor, some hay fields	stream is fairly straight, more confined between road and RR second half of reach, houses right on stream banks (RB) near end of reach (not there today), 1 road crossing 1 RR crossing
MT41I006_050	1956 - BW HC	50_R6	dredge/placer mining	placer diggings appear again, stream is split into two threads near beginning of reach, placer mounds are much smaller piles than upstream ones with piles oriented perpendicular to stream (horizontal piles upstream), piles must be fairly old with deciduous trees growing in them (most likely cottonwoods, similar to upstream mounds, but more trees present), 1 road crossing
MT41I006_040	1956 - BW HC	40_R1	dredge/placer mining transportation corridor	placer diggings continue, but width is not as wide as upstream section, tailings and railway confining stream, vegetation is becoming established along stream corridor, stream splits in 2 after road crossing, detached point bars and gravel bars visible, 2 road crossings (1 RR)
MT41I006_040	1956 - BW HC	40_R2	riparian between transportation corridor, hayfield in beginning of reach	section begins fairly sinuous but then becomes constricted between railway and highway, small section of placer diggings, fairly dense riparian corridor, stream is noticeably wider and downcut in sections, detached point bars visible in areas, 5 road crossings (2 RR, 1 hwy)

Table 5-7. Historical Aerial Sediment Source Assessment of Upper Prickly Pear Creek: Channel Observations

303(d) Segment	PhotoYear & Source	Reach_ID	LU	Notes
MT41I006_040	1956 - BW HC	40_R3	wetland riparian area at base of extractive lu	beginning of reach influenced by transportation corridor, dense riparian vegetation, stream appears to be straightened probably from placer mining - but riparian has recovered, diggings in hillslopes on RB side with some placer mounds visible, timber harvest evident on LB near end of reach, 4 road crossings (4 RR)

5.2 Sediment from Streambank Instability

As discussed in Section 1.2, stream bank erosion was determined to be a potentially significant source of sediment throughout the Lake Helena TPA. Average BEHI ratings for all sediment listed segments varied between “moderate” and “high” for all the listed segments, however intra-segment reach BEHI ratings varied between “low” and “very high” (Table 5-8). Intra-segment variability was a product of heterogeneous land ownership and land use. BEHI rating and reach location were well correlated. Segments with BEHI ratings of “high” were largely confined to higher order stream segments lower in the watershed. Higher ordered segments tend to have finer substrate, and a greater intensity of land use; both, of which result in increased streambank instability.

Sediment load from streambank erosion for the Lake Helena TPA was estimated to be 6162.1 metric tons/year. Of this total, 4815 tons/year were generated within the Prickly Pear watershed, and the remaining 1347 tons/year were generated within the Tenmile/Sevenmile watershed.

Estimated Streambank erosion sediment loads were divided between natural and anthropogenic causes based on field and aerial assessment. Of the total sediment load (6162.1 tons), 4725 tons, or approximately 77% was related to anthropogenic activities, the remaining 1438 tons, or approximately 23% was related to naturally occurring streambank erosion. The results of this analysis on a watershed basis are summarized below in Table 5-8.

Table 5-8. Sediment Loads from Eroding Streambanks by Source

Reach ID	Reach Anthropogenic Related Eroding Banks (%)	Anthropogenic Sediment Load (mt/yr)	Natural Sediment Load (mt/yr)	Total Existing Sediment Load (mt/yr)	Reference Sediment Load (mt/yr)
PP20	85%	516.6	91.2	607.8	49.3
PP30	85%	20.5	3.6	24.1	2.1
PP50	100%	142.4	0.0	142.4	4.0
PP60	55%	1134.7	928.4	2063.1	78.2
Corbin	90%	24.9	2.8	27.7	2.0
Spring	95%	76.8	4.0	80.8	0.7
Clancy	85%	1193.1	210.5	1403.6	221.4
Warm Sprs	60%	35.1	23.4	58.5	12.7
Lump	80%	325.4	81.3	406.7	81.3
Mid-Tenmile	95%	296.8	15.6	312.4	57.3
Lower Tenmile	95%	281.7	14.8	296.5	27.0
Skelly	45%	21.6	26.4	47.9	22.0
Sevenmile	95%	652.2	34.3	686.5	17.5
Jennies Fork	70%	2.7	1.2	3.9	1.5

Reference condition eroding streambank quantities were calculated based on data collected from reference stream segments, described in Section 1.2.2 above. The load reduction target value for anthropogenic streambank erosion is the segment reference level sediment load (Table 5-9).

Table 5-9. Collected Lake Helena BEHI data.

Sample Location Reach ID	Length of Eroding Bank (% of Reach Length)	Total Reach Eroding Bank Length (feet)	Bank Length (yds)	Bank Height (ft)	Bankfull Height (ft)	Root Depth (ft)	Root Density (%)	Bank Angle (degree)	Surface Protect (%)	BEHI Score	Average BEHI Rating	Average Sediment Load (mt/year) (from survey)
PP20	60.0%	6067.9	86	7.0	2.0	0.3	5	85	20	Very High		
PP20	40.0%	5368.4	40	6.0	2.5	2.0	12	60	30	High		
PP20	5.0%	550.2	18	4.0	2.5	1.0	18	40	1	High		
PP20	35.0%	12088.2	48	1.9	1.2	0.7	90	145	9	Very High		
PP20	35.0%	12088.2	48	1.4	0.8	1.2	90	79	9	Moderate	**32.19**	
PP20	35.0%	12088.2	48	1.5	0.9	1.5	90	69	9	Moderate	**High**	795.55
PP30	12.0%	1645.3	25	5.0	2.0	1.5	40	85	30	High		
PP30	12.0%	2984.3	25	2.1	0.3	0.7	40	40	23	High		
PP30	12.0%	2984.3	25	2.3	0.2	0.5	40	32	68	Moderate		
PP30	12.0%	2984.3	25	1.9	0.5	1.9	68	84	24	Moderate		
PP30	12.0%	2984.3	25	1.8	0.7	0.4	42	75	8	High		
PP30	12.0%	2984.3	25	1.5	1.0	0.7	24	86	8	High	**31.30**	
PP30	12.0%	2984.3	25	1.1	1.0	0.2	24	65	8	High	**High**	196.72
PP50	15.0%	2572.6	25	5.0	1.5	1.4	25	90	1	Very High		
PP50	10.0%	528.3	6.7	3.5	1.5	1.0	12	80	25	High		
PP50	5.0%	193.1	14	5.5	1.7	1.6	10	60	80	High		
PP50	10.0%	3713.0	15	1.2	0.7	0.3	63	72	23	Moderate		
PP50	10.0%	3713.0	15	1.0	0.6	0.4	90	90	42	Moderate	**29.78**	
PP50	10.0%	3713.0	15	1.2	0.8	0.6	90	75	32	Moderate	**Moderate**	149.43
PP60	22.0%	1280.4	5	9.0	1.8	2.1	30	80	1	High	**37.87 High**	469.19
Corbin	22.0%	3276.9	30	0.9	0.6	0.2	70	55	24	Moderate		
Corbin	22.0%	3276.9	30	0.8	0.6	0.1	70	14	24	Moderate	**26.91**	
Corbin	22.0%	3276.9	30	1.2	0.1	0.1	70	32	12	High	**Moderate**	93.93
Spring	22.0%	5784.6	30	1.0	0.8	0.2	95	90	12	Moderate		
Spring	22.0%	5784.6	30	0.3	0.2	0.1	90	9	24	Moderate	**23.91**	
Spring	22.0%	5784.6	30	0.9	0.5	0.4	90	48	12	Moderate	**Moderate**	87.25
Clancy	1.0%	85.9	2.7	2.5	0.8	0.8	15	60	25	High		
Clancy	70.0%	6984.6	6	5.0	1.5	2.0	45	65	70	Moderate		
Clancy	50.0%	3318.1	33.3	3.5	2.0	1.5	40	80	40	Moderate		
Clancy	40.0%	27072.7	14	1.2	0.5	0.8	90	4	21	Moderate		
Clancy	40.0%	27072.7	14	1.0	0.6	0.2	62	29	21	Moderate		
Clancy	40.0%	27072.7	14	1.2	0.7	1.0	90	24	42	Low		
Clancy	40.0%	27072.7	14	0.6	0.4	0.1	42	25	42	Moderate		

Table 5-9. Collected Lake Helena BEHI data.

Sample Location Reach ID	Length of Eroding Bank (% of Reach Length)	Total Reach Eroding Bank Length (feet)	Bank Length (yds)	Bank Height (ft)	Bankfull Height (ft)	Root Depth (ft)	Root Density (%)	Bank Angle (degree)	Surface Protect (%)	BEHI Score	Average BEHI Rating	Average Sediment Load (mt/year) (from survey)
Clancy	40.0%	27072.7	14	0.8	0.6	0.3	68	68	42	Moderate	**25.31**	
Clancy	40.0%	27072.7	14	1.1	0.5	0.6	90	120	90	Moderate	**Moderate**	412.22
Warm Sprs	8.0%	104.1	16	2.8	1.3	1.5	12	75	15	High		
Warm Sprs	8.0%	1370.5	16	4.6	1.0	0.2	22	36	12	High		
Warm Sprs	8.0%	1370.5	16	1.5	0.7	0.6	42	120	43	High	**32.71**	
Warm Sprs	8.0%	1370.5	16	1.3	0.8	0.4	42	57	42	Moderate	**High**	96.68
Lump	22.0%	17050.0	30	3.2	2.6	1.0	90	100	95	Moderate		
Lump	22.0%	17050.0	30	1.6	1.2	0.7	95	110	95	Moderate	**22.77**	
Lump	22.0%	17050.0	30	1.8	1.2	0.6	95	120	95	Moderate	**Moderate**	778.57
Mid-Tenmile	15.0%	1109.7	20	7.5	2.5	2.7	40	45	75	Moderate		
Mid-Tenmile	17.0%	6682.9	46.6	1.4	2.5	1.3	42	51	38	Low		
Mid-Tenmile	17.0%	6682.9	46.6	3.6	0.5	0.6	42	14	38	Moderate	**21.67**	
Mid-Tenmile	17.0%	6682.9	46.6	1.5	1.2	1.0	68	60	38	Low	**Moderate**	173.01
Low Tenmile	20.0%	2027.5	23	5.5	4.0	2.0	10	85	40	Moderate		
Low Tenmile	0.5%	64.7	55	5.5	2.2	1.0	8	90	10	Very High		
Low Tenmile	2.0%	200.7	60	3.5	1.0	1.7	30	68	1	High		
Low Tenmile	45.0%	2843.6	75	3.0	2.5	1.5	12	90	8	High		
Low Tenmile	17.0%	6682.9	53.25	1.7	0.7	0.6	90	50	38	Moderate		
Low Tenmile	17.0%	6682.9	53.25	1.8	1.2	0.7	90	120	22	High		
Low Tenmile	17.0%	6682.9	53.25	0.9	0.5	0.5	90	110	42	Moderate		
Low Tenmile	17.0%	14809.8	53.25	1.2	0.6	0.7	22	125	12	Very High		
Low Tenmile	17.0%	14809.8	53.25	3.8	0.6	2.3	12	77	9	High	**33.24**	
Low Tenmile	17.0%	14809.8	53.25	3.5	0.8	2.2	22	75	12	High	**High**	615.82
Skelly	22.0%	9065.0	30	1.4	0.5	1.4	68	135	90	High		
Skelly	22.0%	9065.0	30	0.5	0.2	0.5	68	20	90	Low	**22.00**	
Skelly	22.0%	9065.0	30	0.5	0.2	0.5	68	24	90	Low	**Moderate**	169.87
Sevenmile	22.0%	9811.7	30	2.7	1.3	1.9	68	140	7	Very High		
Sevenmile	22.0%	9811.7	30	4.0	1.2	0.9	68	56	7	High	**37.34**	
Sevenmile	22.0%	9811.7	30	1.7	0.9	0.8	68	120	7	High	**High**	1036.07
Jennies Fork	22.0%	1578.4	30	0.6	0.5	0.1	68	52	68	Low		
Jennies Fork	22.0%	1578.4	30	0.6	0.4	0.3	68	75	42	Moderate	**22.32**	
Jennies Fork	22.0%	1578.4	30	1.0	0.4	0.8	68	76	68	Moderate	**Moderate**	17.78

5.3 Abandoned Mine Related Sediment

GWLF does not have the capability to model sediment load associated with abandoned mines. Consequently abandoned mines were modeled with an alternative methodology, developed by CDM for USEPA for use in the Upper Tenmile Creek Superfund area. Tables below describe the sediment loads associated with each mine site determined to be a sediment source (Table 5-10), and on a watershed basis (Table 5-11). Five of the mines (Gregory, Alta, Bertha, Nellie Grant, and Corbin Flats) have been reclaimed in recent years, and correspondingly the associated sediment yield has decreased (Table 5-10, and 5-11). Reduction of mine specific sediment production was calculated by measuring the area of un-vegetated polygons (with laser rangefinder and/or measuring wheel), and applying an appropriate sediment delivery ratio to these areas, within the total mine site area. This un-vegetated area was subtracted from the total mine site area in order to calculate the total vegetated area, which are no longer generating detectable quantities of sediment. The difference in the pre- and post-reclamation vegetated area and sediment delivery ratio resulted in the post-reclamation sediment load reduction.

The total pre-reclamation sediment load from abandoned mines was 1097.8 tons/year, or 0.03% of the total Lake Helena sediment load; total post reclamation sediment load was 455.5 tons/yr, or 0.01% of total Lake Helena sediment load. Watershed wide, reclamation activities reduced abandoned mine related sediment yield by 642.3 ton/year, or 59% of pre-reclamation total sediment load. Based on data collected from the five reclaimed abandoned mine sites, the average decrease in percent sediment reduction from pre- to post-reclamation per mine was 79%. Consequently, the abandoned mines sediment reduction target was set at 79% of existing sediment load.

Table 5-10. Sediment Loads by Abandoned Mine Site

Mine	Watershed	Total Sediment Producing Area (ft2)	Pre-reclamation Sediment Load (t/yr)	Post-reclamation Sediment Load (t/yr)
CRAWLEY CAMP	Clancy Creek	No data		
GREGORY	Clancy Creek	77235	32.8	0.0
ALTA	Corbin Creek	39000	16.1	16.1
BERTHA	Corbin Creek	12510	4.4	0.06
BLACK JACK MINE	Corbin Creek	11768.75	4.6	N/A
NELLIE GRANT	Lump Gulch	5040	1.0	0.01
FROHNER MINE AND MILL	Lump Gulch	87120	44.1	N/A
YAMA GROUP MINE	Lump Gulch	33750	6.2	N/A
MIDDLE FORK WARM SPRINGS	Middle Fk. Warm Springs	27300	8.8	N/A
SOLAR SILVER	Middle Fk. Warm Springs	12000	4.9	N/A
NEWBURGH MINE / FLEMING MINE	Middle Fk. Warm Springs	205920.7	81.1	N/A
WARM SPRINGS TAILINGS ADIT	Middle Fk. Warm Springs	369453.2	98.7	N/A
WHITE PINE MINE	Middle Fk. Warm Springs	70638.6	31.9	N/A
ARMSTRONG MINE	Middle Tenmile Creek	46475	13.8	N/A
BEATRICE	Middle Tenmile Creek	7695	2.3	N/A
UPPER VALLEY FORGE	Middle Tenmile Creek	7590	2.2	N/A
COPPER GULCH	Prickly Pear above Spring Creek	19602	3.9	N/A
BLUEBIRD	Spring Creek	87914.98	47.0	N/A
CORBIN FLATS	Spring Creek	1742400	587.9	0.0
WASHINGTON	Spring Creek	61440	31.5	N/A
SALVAI / MT WASHINGTON MINE	Spring Creek	32065.3	10.9	N/A
MONITOR CREEK TAILINGS	Upper Tenmile Creek	10500	5.3	N/A
NATIONAL EXTENSION	Upper Tenmile Creek	12000	6.1	N/A
PETER	Upper Tenmile Creek	1150	0.6	N/A
RED MOUNTAIN	Upper Tenmile Creek	15675	6.2	N/A
RED WATER	Upper Tenmile Creek	4500	2.3	N/A
VALLEY FORGE/SUSIE	Upper Tenmile Creek	26700	10.4	N/A
WOODROW WILSON	Upper Tenmile Creek	600	0.3	N/A
BADGER	Warm Springs Creek	43877.5	19.7	N/A

Table 5-11. Sediment Loads from Abandoned Mine Sites by Sub-Watershed

Sub-watershed	Pre-reclamation Delivered Sediment Load (t/yr)	Post-reclamation Delivered Sediment Load (t/yr)	Reduction in Sediment Load from reclamation activities (%)
Clancy Creek	32.8	0.0	100%
Corbin Creek	25.1	4.7	81.3%
Spring Creek	677.4	89.5	86.8%
Lump Gulch	51.3	50.3	1.9%
Middle Fork Warm Springs	225.4	N/A	0.0%
Warm Springs Creek	19.7	N/A	0.0%
Prickly Pear above Spring Creek	3.9	N/A	0.0%
Silver Creek	12.5	N/A	0.0%
Middle Tenmile Creek	18.3	N/A	0.0%
Upper Tenmile Creek	31.2	N/A	0.0%
Total	1097.8	N/A	0.0%

5.4 Potential Sediment Loading Risk from Culvert Failure

Culvert survey data within the Lake Helena TPA was unavailable. Sediment loading related to potential culvert failure was based on a culvert hazard analysis conducted by Helena National Forest personnel within the Poorman Creek watershed. The average culvert fill volume associated with culvert failure was 842.6 $ft.^3$/per culvert (calculated from reported culvert fill dimensions). Based on a dry material density of 125 lbm/ft^3, the resultant average sediment load would be 52.7 tons per culvert failure.

In order to generate potential sediment loading from culvert failure within the Lake Helena TPA, all paved roads were assumed to utilize bridges for stream crossings, and all gravel/native surfaced roads were assumed to utilize culverts for road-stream crossings, and thus the focus of culvert failure. The results from this analysis are displayed on a listed segment basis in Table 2.12, below. Total potential sediment load from within the Lake Helena TPA was 18,642 tons. Watersheds with the greatest potential for sediment contributions were those with large numbers of graveled road stream crossings, which typically were located on county and Forest Service roads in more rural parts of the watersheds.

Available data suggest that approximately 45% of the culverts within the Lake Helena watershed are at a high risk of failure due to inappropriate culvert sizing. Sediment from culvert failure was not factored into the TMDL load allocation because it is a theoretical load. However, with the proper meteorological event this load could become a reality. It is presented in this appendix for reference purposes, and the hope that road related BMP upgrades will include culvert replacement and enlargement.

Table 5-12. Estimates of Sediment Loads from Culvert Failure

Watershed	Watershed Size (mi^2)	Miles of Roads	Road Density (mi/mi^2)	Road Erosion Sediment Load (metric tons/year)	Number of Stream Crossings[1]	Potential Culvert Failure Sediment Load (metric tons)
Prickly Pear MT411006_020	6.6	29.3	4.5	3.3	14	47.8
Prickly Pear MT411006_030	19.4	150.3	7.7	84.8	108	47.8
Prickly Pear MT411006_040	73.7	226.6	3.1	776.4	291	1672.0
Prickly Pear MT411006_050	25.4	63.8	2.5	237.9	81	1242.1
Prickly Pear MT411006_060	26.7	50.0	1.9	432.3	61	1003.2
Corbin Creek MT411006_090	2.7	8.1	3.0	87.5	12	286.6
Spring Creek MT411006_080	18.2	55.9	3.1	453.6	69	2102.0
Clancy Creek MT411006_120	33.0	53.5	1.6	418.9	79	571.8
North Fork Warm Springs MT411006_180	2.1	5.7	2.7	82.7	5	47.8
Middle Fork Warm Springs MT411006_100	3.4	2.5	0.7	48.7	5	238.9
Warm Springs MT411006_110	15.1	21.5	1.4	214.3	52	1003.2
Lump Gulch MT411006_130	43.4	106.4	2.5	852.2	124	2197.5
Middle Tenmile MT411006_142	38.6	58.2	1.5	438.8	78	1767.6
Lower Tenmile MT411006_143	76.2	253.0	3.3	327.7	244	668.8
Skelly Gulch MT411006_220	38.9	21.4	1.8	248.4	29	525.5
Sevenmile Creek MT411006_160	38.9	79.1	2.0	318.8	133	1194.3
Jennies Fork MT4110066_210	1.0	7.1	3.6	244.6	11	477.7

[1]Based on GIS road and stream layers. Some crossings that appear on GIS layers may not actually exist on the ground.

5.5 WEPP:Road, Additional Roads Assessment

Results from the WEPP:Road road sediment modeling analysis were highly variable. This result was not unexpected due to the variety of road configurations surveyed during the data collection phase. The majority of the modeled road sediment was related to a minority of unpaved road segments. This was confirmed during source assessment data collection, as a few isolated road segments produced the majority of the sediment. The combination of field source assessment and site specific modeling will assist with restoration priority development, as well as load reduction related to restoration/BMP implementation.

Total sediment load modeled by WEPP:Road was 225.5 metric tons, the majority of this sediment is related to three watersheds, upper Tenmile (70.4 mt), Sevenmile (54.9 mt), and Prickly Pear 40 (25.5 mt). Direct model comparisons between GWLF road output and WEPP:Road would be inappropriate due to differences in model scale and function. The WEPP generated data will only be used to set restoration priorities.

6.0 CONCLUSIONS

The results of the supplemental sediment source assessment modules will serve as a tool for setting restoration priorities within the Lake Helena watershed and have, in some cases, provided a means for validating results produced by GWLF. Efforts were made to reduce the uncertainty associated with the generated sediment loads via field verification, consultation with watershed experts, and implementation of established models and methodologies. However, given the size of the watershed and extent of sediment impairments, some level of uncertainty is unavoidable. It is anticipated that additional source assessment will likely be necessary prior to implementing future restoration activities. The GPS locations and photographs of field survey sites will be on file with the Montana Department of Environmental Quality, and represent areas within the watershed with documented erosion problems.

7.0 REFERENCES

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