APPENDIX C - CHIPPEWA CREEK SEDIMENT ASSESSMENT

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C1.0 INTRODUCTION

An assessment of sediment loading to Chippewa Creek was performed to facilitate development of sediment TMDLs for this 303(d) listed stream segment in the Judith Mountains TMDL project area. Chippewa Creek is a tributary to McDonald Creek and is located within the Box Elder HUC8 (10040204). The upper 3.8 miles of Chippewa Creek are listed as impaired for sediment and this segment of Chippewa Creek (MT40B002_040) is defined as Chippewa Creek from the headwaters to the confluence with Manitoba Gulch. This assessment included an evaluation of sediment loads associated with unpaved roads, uplands, and a mill tailings pile. A sediment and habitat evaluation of Chippewa Creek was also performed during this assessment to help better characterize existing conditions within the stream. This document describes the assessment approach and results for each source assessment category.

C2.0 METHODS

C2.1 Unpaved Roads Assessment

The road assessment employed GIS analysis, field data collection, and WEPP modeling to assess sediment loading from the unpaved road network to Chippewa Creek.

C2.1.1 GIS Analysis

Prior to field data collection, GIS data layers representing the road network, stream network, land ownership, and ecoregions were used to identify unpaved road crossings throughout the Chippewa Creek watershed. Through GIS analysis, five unpaved road crossings were identified within the Chippewa Creek watershed upstream of Manitoba Gulch.

C2.1.2 Field Data Collection

In October of 2010, a field assessment of unpaved roads was conducted by performing an inspection of sites where unpaved roads cross Chippewa Creek. A total of five unpaved road crossings were identified in the Chippewa Creek watershed, all of which were examined in the field. A complete assessment of potential sediment loading was conducted at three of the unpaved road crossings. At each assessed unpaved road crossing, a series of measurements were performed to define road design, maintenance level, condition, and sediment loading potential. Measurements included the length, gradient, and width of road contributing sediment from each side of a stream crossing. Additional information was collected describing road design, road surface type, soil type, rock content, traffic level, and the presence of any Best Management Practices (BMPs). Information collected at each assessed unpaved road crossing was used to estimate sediment loading with the WEPP:Road model.

C2.1.3 WEPP Modeling

Sediment loading to Chippewa Creek from unpaved road crossings was estimated using the WEPP:Road soil erosion model (http://forest.moscowfsl.wsu.edu/fswepp/). WEPP:Road is an interface to the Water Erosion Prediction Project (WEPP) model developed by the USDA Forest Service and other agencies, and is used to predict runoff, erosion, and sediment delivery from forest roads. The WEPP:Road model predicts sediment yields based on specific soil, climate, ground cover, and topographic conditions. Field data collected from each field assessed unpaved road crossing provided the following input data necessary to run the WEPP:Road model:

- Road design: insloped, bare ditch; insloped, vegetated or rocked ditch; outsloped, rutted; outsloped unrutted
- Road surface: native, graveled, paved
- Traffic level: high, low, none
- Soil texture: clay loam, silt loam, sandy loam, loam
- Rock content
- Gradient, length and width of the road, fill and buffer
- Climate data
- Years to simulate

C2.2 Sediment and Habitat Assessment

The sediment and habitat assessment was performed at two monitoring sites along Chippewa Creek in October of 2010. Sediment and habitat data was collected following the approach described in *Longitudinal Field Methods for the Assessment of TMDL Sediment and Habitat Impairments*(Montana Department of Environmental Quality, 2009). Field monitoring sites were selected in low-gradient portions of Chippewa Creek where sediment deposition is likely to occur. Monitoring sites were assessed progressing upstream and a monitoring site length of 500 feet was utilized since the bankfull width was less than 10 feet (Montana Department of Environmental Quality, 2009). Each monitoring site was divided into five equally sized study cells in which a series of sediment and habitat measurements were performed. Study cells were numbered 1 through 5 progressing in an upstream direction. At each monitoring site, the following measurements were performed:

- Channel form and stability measurements
  - Channel cross-sections
  - Floodprone width measurements
  - Water surface slope

- Fine sediment measurements
  - Riffle pebble count
  - Riffle grid toss

- Instream habitat measurements
  - Channel bed morphology
  - Residual pool depth
  - Pool habitat quality
  - Large woody debris (LWD) quantification

- Riparian health measurements
  - Riparian greenline assessment
  - Proper functioning condition (PFC) assessment

C2.3 Sediment Contributions from Mill Tailings

Sediment loading from the mill tailings pile was assessed based on field observations, GIS analysis and modeling. Field observations were performed during site visits in August and October of 2010 and May of 2011 and included field photographs and notes. GIS analysis using color aerial imagery from 2009 was used to estimate the size of the mill tailings pile. In GIS, the “inner perimeter” of the tailings pile was digitized to represent the main sediment source area for the mill tailings pile, which covers approximately 0.66 acres. The “outer perimeter” was also digitized to document the complete extent of mill tailings at this site, which covers approximately 2.67 acres. For the “inner perimeter”, the width running parallel to Chippewa Creek was estimated at 180 feet, while a length of 160 feet was estimated from aerial imagery in GIS. Sediment loading was then evaluated using WEPP Hillslope with the filter strip application enabled (http://milford.nserl.purdue.edu/wepp/filter.php).

C2.4 USLE Assessment

Upland sediment loading from hillslope erosion was modeled using a Universal Soil Loss Equation (USLE) based model which was combined with a sediment delivery ratio (SDR) to predict the amount of sediment delivered into Chippewa Creek. The USLE based model was implemented as a watershed-scale, raster-based, GIS model using ArcView GIS software. Details and data sources of each factor in the model are described in subsequent sections of this report.

C2.4.1 Modeling Approach

The USLE model requires five landscape factors which are combined to predict upland soil loss, including a rainfall factor (R), soil erodibility factor (K), length and slope factors (LS), a cropping factor (C), and a management practices factor (P). The general form of the USLE equation has been widely used for upland sediment erosion modeling and is presented as (Brooks et al., 1997):

$$A = RK(LS)CP \text{ (in tons per acre per year)}$$

The **R-factor** characterizes the effect of raindrop impact and runoff rates associated with a rainstorm. It is a determined using the kinetic energy of a rainfall event (measured in hundreds of ft-tons per acre per year) and the maximum 30-minute rainfall intensity (inches per hour) for an area. The total kinetic energy of a rain event is obtained by multiplying the kinetic energy per inch of rainfall by the depth of rainfall during each intensity period.

The **K-factor** is a soil erodibility factor that quantifies the susceptibility of soil to erosion. It is a measure of the average soil loss (tons per acre per hundreds of ft-tons per acre of rainfall intensity) from a particular soil in continuous fallow, and has been derived from previous experimental data.

The **LS-factor** is a function of the slope and flow length of the eroding slope or cell. For the purpose of computing the LS-factor, slope is defined as the average land surface gradient per cell. The flow length refers to the distance between where overland flow originates and runoff reaches a defined channel or depositional zone. The equation used for calculating the length and slope factor (LS) was provided by Lim, et al. (2005) using a method developed by Moore and Burch (1986b; 1986a). The equation used to calculate LS is provided below; where A is flow length multiplied by cell size, and Θ is slope angle in degrees.

$$LS = \left(\frac{A}{22.13}\right)^{0.4} * \left(\frac{\sin\Theta}{0.0896}\right)^{1.3}$$

The **C-factor** is a crop management value that represents the ratio of soil erosion from a specific cover type compared to the erosion that would occur on a clean-tilled fallow under identical slope and rainfall. The C-factor integrates a number of variables that influence erosion including vegetative cover, plant litter, soil surface, and land management. The original C-factor of the USLE was experimentally determined for agricultural crops and has since been modified to include rangeland and forested cover.

The **P-factor** or conservation practice factor is a function of the interaction of the supporting land management practice and slope. It incorporates the use of erosion control practices such as strip-cropping, terracing and contouring, and is applicable only to agricultural lands. Values of the P-factor compare straight-row farming practices with that of certain agriculturally based conservation practices. This factor was set to one for this analysis based on existing practices within the watershed.

Results from the USLE equation were combined with a sediment delivery ratio (SDR) to predict the amount of sediment delivered to streams. The sediment delivery ratio was derived within the model for each cell based on the relationship between the distance from the delivery point to the stream and the percent of eroded sediment delivered to the stream.

C2.4.2 Data Sources

The following sections describe the data sources used to obtain the appropriate spatial data required for this model. The results of each specific parameter are shown graphically.

R-Factor

The rainfall and runoff factor grid was prepared by the Spatial Climate Analysis Service (SCAS) of Oregon State University at 4 km grid cell resolution. For the purposes of this analysis, the SCAS R-factor grid was projected to Montana State Plane Coordinates (NAD83, meters), resampled to a 10m analytic cell size and clipped to the extent of the Chippewa Creek watershed to match the project's standard grid definition. The R-Factor for the Chippewa Creek watershed is presented in **Figure C2-1**.

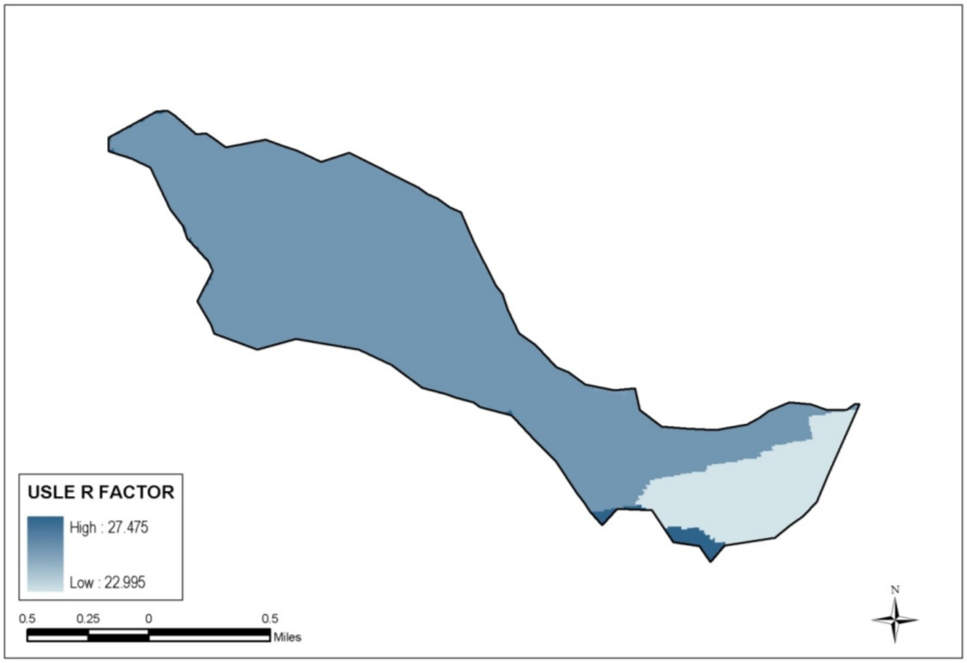

Figure C2-1. USLE R-Factor for the Chippewa Creek Watershed.

K-Factor

Polygon data for the K-factor were obtained from the NRCS Soil Survey Geographic database (SSURGO). The K-factor for the Chippewa Creek watershed is presented in **Figure C2-2.**

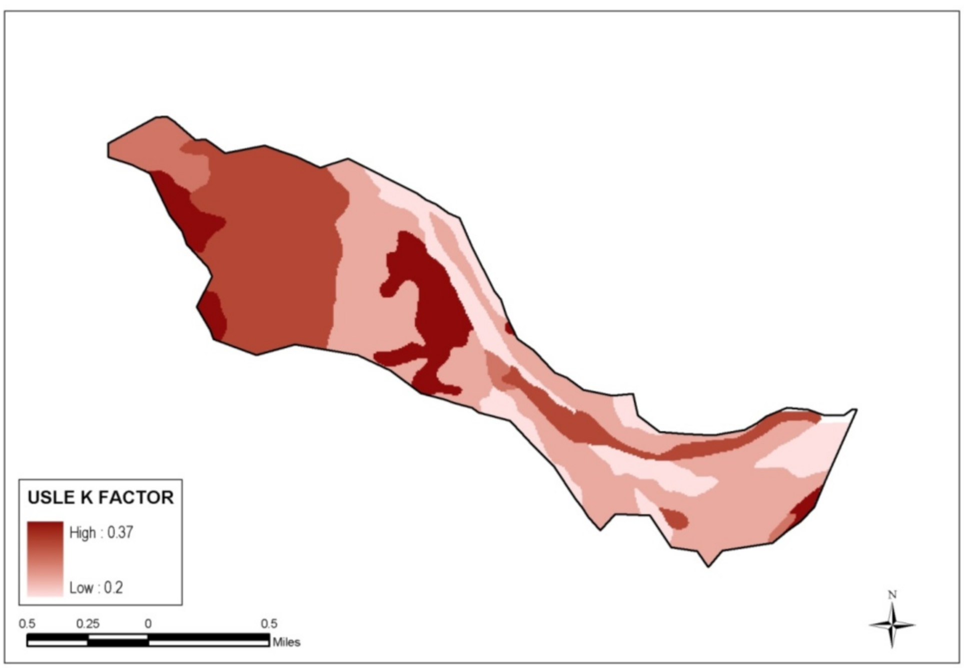

Figure C2-2. USLE K-Factor for the Chippewa Creek Watershed.

Digital Elevation Model (DEM)

The digital elevation model (DEM) of the Chippewa Creek watershed is the base layer used for developing the LS factor. The USGS 30m DEM for the Chippewa Creek watershed was used for this analysis. The DEM was interpolated to a 10m analytic grid cell to render the delineated stream network more representative of the actual size of Chippewa Creek watershed streams and to minimize resolution dependent stream network anomalies. The resulting interpolated 10m DEM was subjected to standard hydrologic preprocessing, including filling of sinks to create a positive drainage condition for all areas of the watershed. Results of the DEM for the Chippewa Creek watershed are presented in **Figure C2-3**.

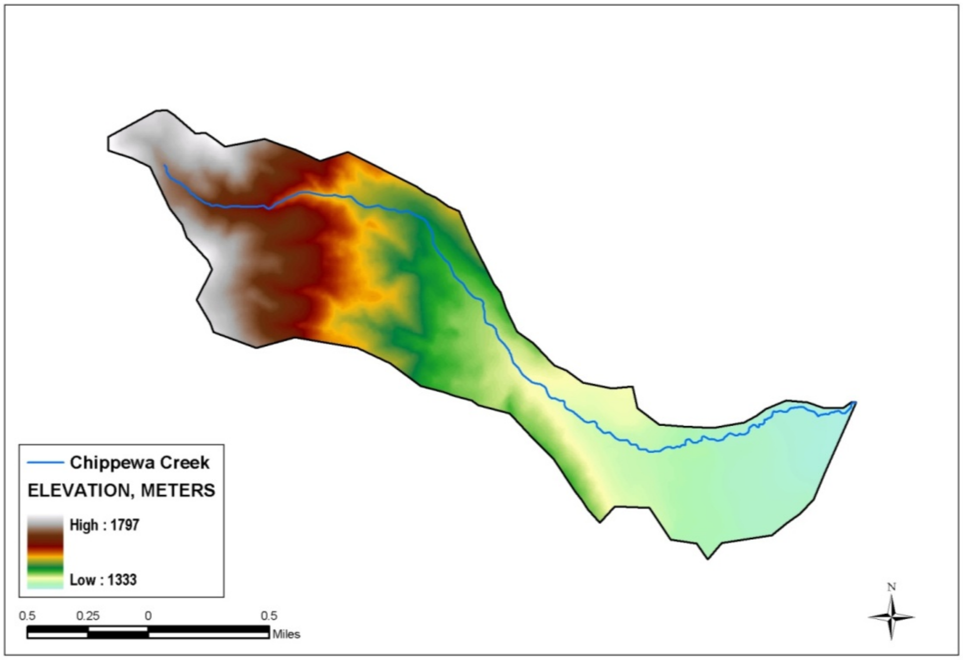

Figure C2-3. DEM for the Chippewa Creek Watershed.

National Land Cover Dataset (NLCD)
The 2006 National Land Cover Dataset (NLCD) was obtained from USGS and is developed through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of nine federal agencies. This layer is used to establish USLE C-factors for the Chippewa Creek watershed. The NLCD is a categorized 30-meter Landsat Thematic Mapper image from 2006. The NLCD image was reprojected to Montana State plane projection/coordinate system, and resampled to the project standard 10-meter grid size. Results of the NLCD are presented in **Figure C2-4.**

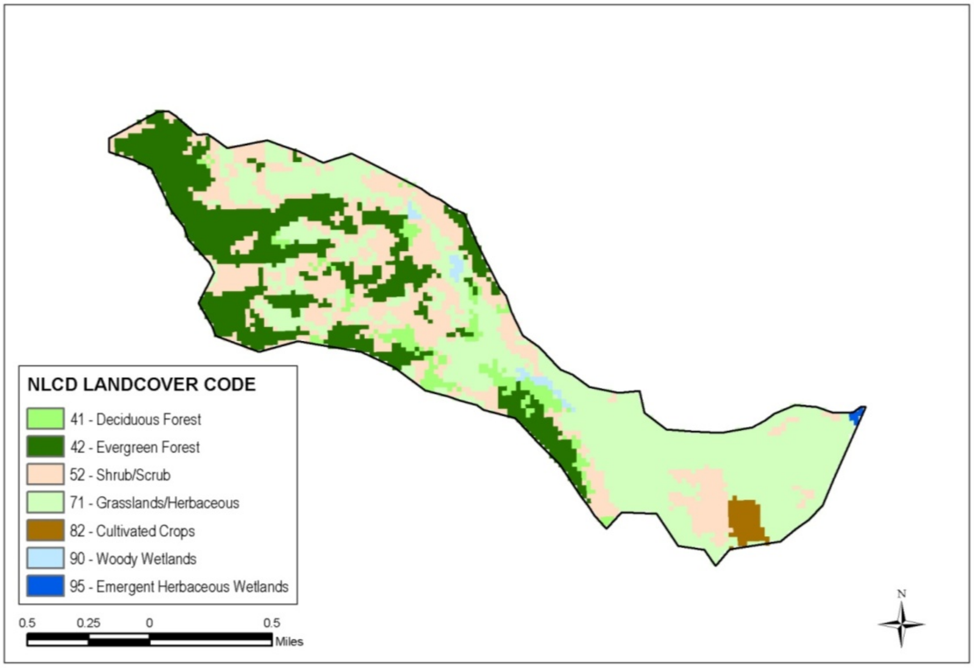

Figure C2-4. NLCD for the Chippewa Creek Watershed.

C-Factor Derivation

A classification scheme was used to assign USLE C-factors to the NLCD land-use types present in the Chippewa Creek watershed (**Table C2-1**) following the approach presented in Lower Clark Fork Tributaries Sediment TMDLs and Framework for Water Quality Restoration (Montana Department of Environmental Quality, 2010). This scheme was initially developed based on ground cover percentages established by the USDA Soil Conservation Service (1977), and has been refined based on present land cover conditions in the Chippewa Creek watershed. In order to estimate the potential sediment reduction that might be accomplished under a best management practices scenario, the model was also run using C-factors assigned to the desired condition. To determine C-factors for the desired conditions, existing condition C-factors for anthropogenic land-use types were changed to reflect the ground cover that best represents an improved land condition in the Chippewa Creek watershed. Land cover types identified as grasslands/ herbaceous and cultivated crops were conservatively changed to reflect a 10 percent and 20 percent increase, respectively, in ground cover over existing conditions, shown below in **Table C2-2**. It is acknowledged that land cover is variable within and across watersheds, and changes seasonally; the C-factors used for the model are intended to represent typical annual conditions at a coarse scale and the percent of improvement achievable via the implementation of BMPs.

Table C2-1. Chippewa Creek C-Factors for Existing and Desired Management Conditions.

NLCD Code	Description	Land Use Category	C-Factor	
			Existing Condition	Desired Condition
41, 42	Deciduous/ Evergreen/Mixed Forest	Natural Source	0.003	0.003
52	Shrub/Scrub	Natural Source	0.008	0.008
71	Grasslands/Herbaceous	Grazing	0.020	0.013
82	Cultivated Crops	Cropland	0.240	0.150
90	Woody Wetlands	Natural Source	0.003	0.003
95	Emergent Herbaceous Wetlands	Natural Source	0.003	0.003

Table C2-2. Percent Ground Cover for Existing and Desired Land Cover Types.

Land Cover	Existing % Ground Cover	Desired % Ground Cover
Grasslands/Herbaceous	75	85
Cultivated Crops	20	40

Sediment Delivery Ratio

USLE model results were combined with a sediment delivery ratio (**SDR**) to predict sediment delivery to streams. The SDR was derived for each grid cell based on the distance from the cell to the nearest stream. This distance-based relationship was established during development of the WARSEM road sediment model by integrating previous studies which evaluated sediment delivery down slope of forest roads (Dube et al., 2004). These studies determined that the percent of sediment delivered to streams decreases with distance from the stream based on the relationship shown in **Table C2-3**. This relationship has been applied in previous USLE models for TMDL development, and is considered to be a conservative estimate of sediment delivery from upland erosion.

Table C2-3. Sediment Delivery vs. Distance from Stream.

Distance from Stream (ft)	Percent of Sediment Delivered to Stream
0	100
35	70
70	50
105	35
140	25
175	18
210	10
245	4
280	3
315	2
350	1

C3.0 RESULTS

C3.1 UNPAVED ROAD ASSESSMENT

Sediment inputs from unpaved road crossings were evaluated using the WEPP:Road model. The potential to reduce sediment loads from unpaved roads through the application of Best Management Practices (BMPs) was also evaluated by reducing contributing road segment lengths to 100 feet. For unpaved road crossings, contributing road segment lengths exceeding 100 feet were reduced to 100 feet on either side of the crossing. Out of the three assessed unpaved road crossings, only CHIP-X2 had a contributing road length of greater than 100 feet, with a measured contributing road length of 426 feet.

C3.1.1 WEPP Model Input Parameters

Road condition data collected in the Chippewa Creek watershed in October of 2010 was input directly into the WEPP:Road model following guidance outlined in *WEPP Interface for Predicting Forest Road Runoff, Erosion and Sediment Delivery Technical Documentation*, which is available on the Internet at http://forest.moscowfsl.wsu.edu/fswepp/docs/wepproaddoc.html. In addition to field collected data, the WEPP:Road model requires the selection of site-specific climate data to provide an estimate of mean annual precipitation. The WEPP:Road model contains 55 custom climate stations for Montana. Out of these 55 custom climate stations, the Roy 8 NE MT was selected. The mean annual precipitation at the Roy NE MT climate station is 13.74 inches. Precipitation data collected from 1971 to 2000 and compiled by the PRISM Group at Oregon State University (http://nris.mt.gov/nsdi/nris/precip71_00.html) indicates the Roy climate station is within the 14-16" precipitation zone, while the assessed unpaved road crossings along Chippewa Creek are in the 18-20" precipitation zone according to the PRISM data. Thus, the Roy 8 NE MT climate station data was modified in the WEPP:Road model to a mean annual precipitation of 18.50 inches by increasing both the mean annual precipitation and the number of wet days by 35%.

C3.1.2 Sediment Loads from Unpaved Roads

A total of three unpaved road crossings were assessed in the field for use in the WEPP:Road model, all of which were located on private lands and within the Non-calcareous Foothill Grasslands Level IV Ecoregion (**Figure C3-1**). The three assessed unpaved road crossings are described as follows:

CHIP-1X: Located on a small ranch access road. Perennial streamflow started just upstream of this site during field evaluations in both August and October of 2010

CHIP-2X: Located on the Maiden Road, which is within the city-county road system

CHIP-3X: Located on a small ranch access road a short distance upstream of the confluence of Chippewa Creek and Manitoba Gulch

From the three assessed unpaved road crossings, the estimated mean annual sediment load is 0.016 tons (**Table C3-1**). Through the application of BMPs, it is estimated that this load can be reduced to 0.006 tons, which is a 63% reduction in the mean annual sediment load. This reduction is primarily achieved by improving BMPs at CHIP-X2, which is located on the Maiden Road.

Table C3-1. Unpaved Road Crossing Sediment Loads.

Crossing ID	Mean Annual Sediment Load (Tons)	Mean Annual Sediment Load with BMPs (Tons)	Percent Reduction in Sediment Contributions
CHIP-X1	0.002	0.002	0%
CHIP-X2	0.014	0.003	77%
CHIP-X3	0.001	0.001	0%
Chippewa Creek	**0.016**	**0.006**	**63%**

As described below, the remaining two unpaved road crossings identified in GIS using color aerial imagery from 2009 were determined not to be sediment sources and were not included for evaluation in the WEPP:Road model. The uppermost unpaved road crossing in the Chippewa Creek watershed was located near the site of the abandoned mine. Field evaluation indicated there was no flowing water at this site and the road fill over the stream channel lacked a culvert, suggesting streamflow upstream of this site is relatively rare. The other unpaved road crossing not evaluated in the WEPP:Road model was located at a driveway between sites CHIP-X2 and CHIP-X3. At this crossing, Chippewa Creek has been converted to a pond and was not considered a source of sediment since the pond acts as a sediment trap.

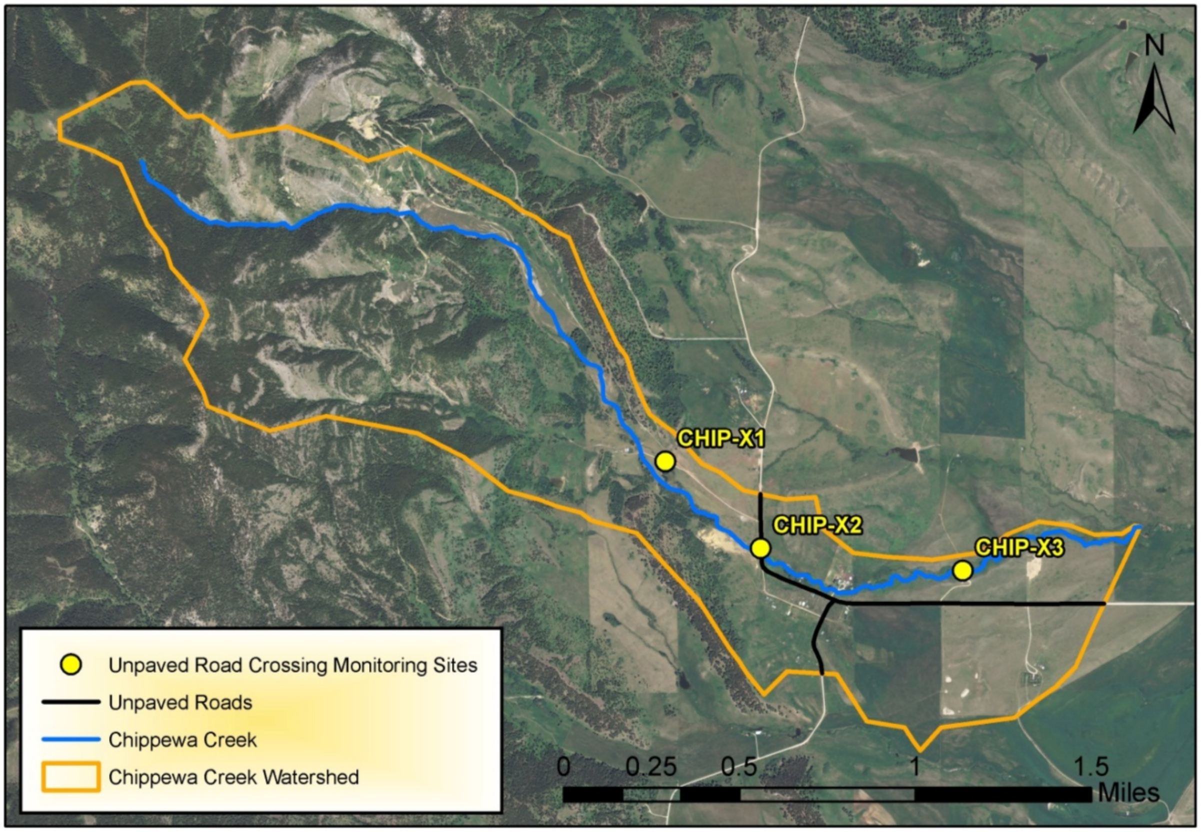

Figure C3-1. Unpaved Road Crossings in the Chippewa Creek Watershed.

C3.2 Sediment and Habitat Assessment

A sediment and habitat assessment was performed at two monitoring sites along Chippewa Creek: CHIP-01 and CHIP-02 (**Figure C3-2**). CHIP-01 was located just upstream of the Maiden Road crossing, while CHIP-02 was located between the Maiden Road crossing and the Black Butte Road crossing. At CHIP-01, there is a mill tailings pile adjacent to the river right streambank with clear evidence that sediment eroding from the mill tailings pile is delivered to the stream channel. In addition, CHIP-01 is also used for livestock grazing, which has led the channel to become overwidened in places. The CHIP-02 monitoring site is also utilized by livestock, which has led the channel to become overwidened at cattle access points. Both monitoring sites along Chippewa Creek are slightly entrenched, with one small headcut observed within the CHIP-02 monitoring site. Pool tail-outs were 100% comprised of fine sediment and lacked spawning potential. The potential stream type for both monitoring sites is E4, though existing conditions more closely resemble a B4c stream type, particularly at the CHIP-01 monitoring site. A summary of the results for the Chippewa Creek sediment and habitat assessment are presented in **Table C3-2**, with the complete dataset presented in **Attachment CB**.

Table C3-2. Summary of Chippewa Creek Sediment and Habitat Assessment Data.

Monitoring Site	Potential Rosgen Stream Type	Channel Form (median)		Fine Sediment (mean)			Instream Habitat			Riparian Health	
		W/D Ratio	Entrenchment Ratio	Riffle Pebble Count		Grid Toss % <6mm	Risidual Pool Depth (feet) (mean)	Frequency #/mile		% Greenline Shrubs (mean)	PFC Assessment
				% <6mm	% <2%	Riffle		Pool	LWD		
CHIP-01	E4	8.6	1.7	35	24	25	0.4	42	21	22	NF
CHIP-02	E4	8.9	2.5	31	28	29	0.4	74	74	46	FAR

PFC = Proper Functioning Condition; FAR = Functional – At Risk; NF = Nonfunctional

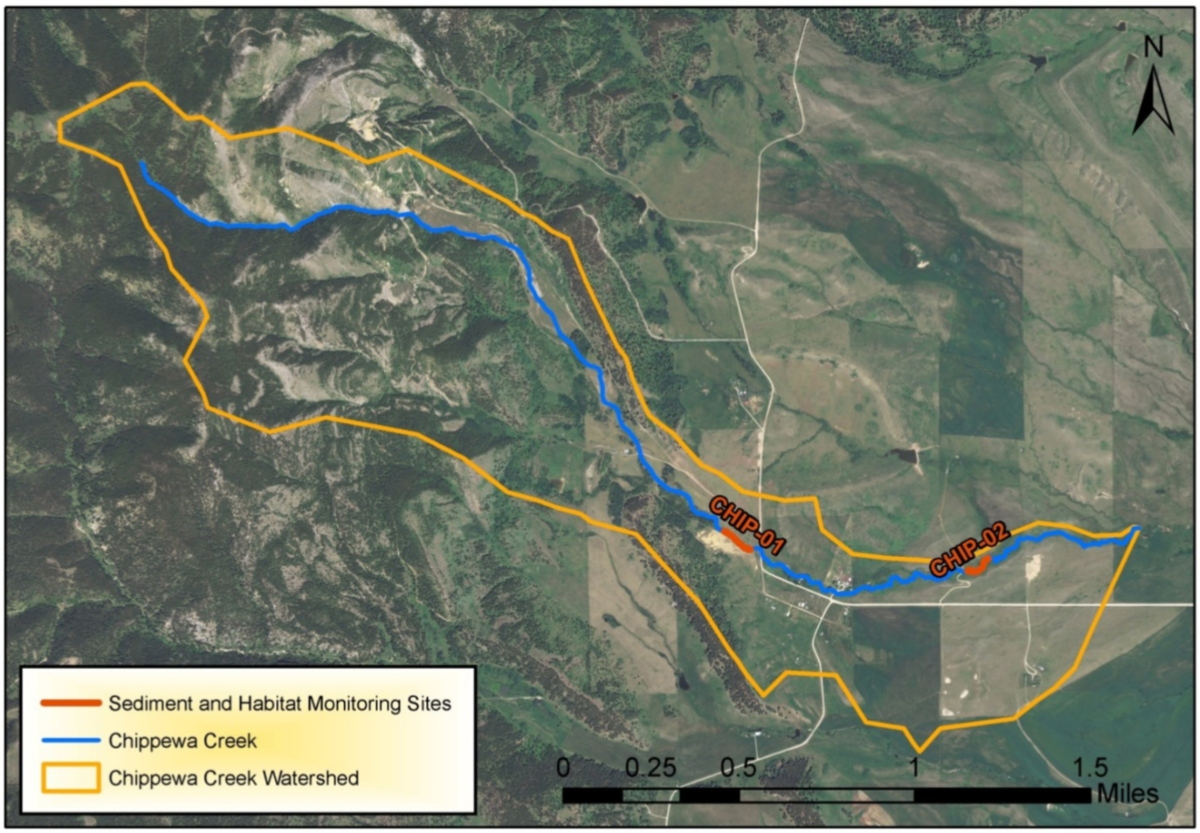

Figure C3-2. Chippewa Creek Sediment and Habitat Monitoring Sites.

C3.3 Sediment Contributions from Mill Tailings

During field assessment activities in 2010, three main sediment delivery points were identified along the mill tailings pile located adjacent to Chippewa Creek (**Figure C3-3**). Sediment loading from this mill tailings pile was assessed using WEPP Hillslope and the following model assumptions:

- Climate Station: ROY 8 NE

- Field Length (ft): 160
- Field Width (ft): 180
- Slope Shape: Convex
- Steepness: 15%
- Soil: FLASHER(LS)
- Management: fallow
- Simulation Years: 30
- Filter Strip Width (ft): 10
- Filter Strip Management: Fescue

The FLASHER(LS) soil was selected following advice from NRCS personnel, while the filter strip width and management parameters were based on field measurements and observations and were applied conservatively in order to provide an additional margin of safety. Based on this approach, it is estimated that 1.98 tons of sediment are delivered to Chippewa Creek annually from the mill tailings pile. Through remediation of this tailings pile and development of a riparian buffer along Chippewa Creek, sediment contributions from the mill tailings pile should be eliminated.

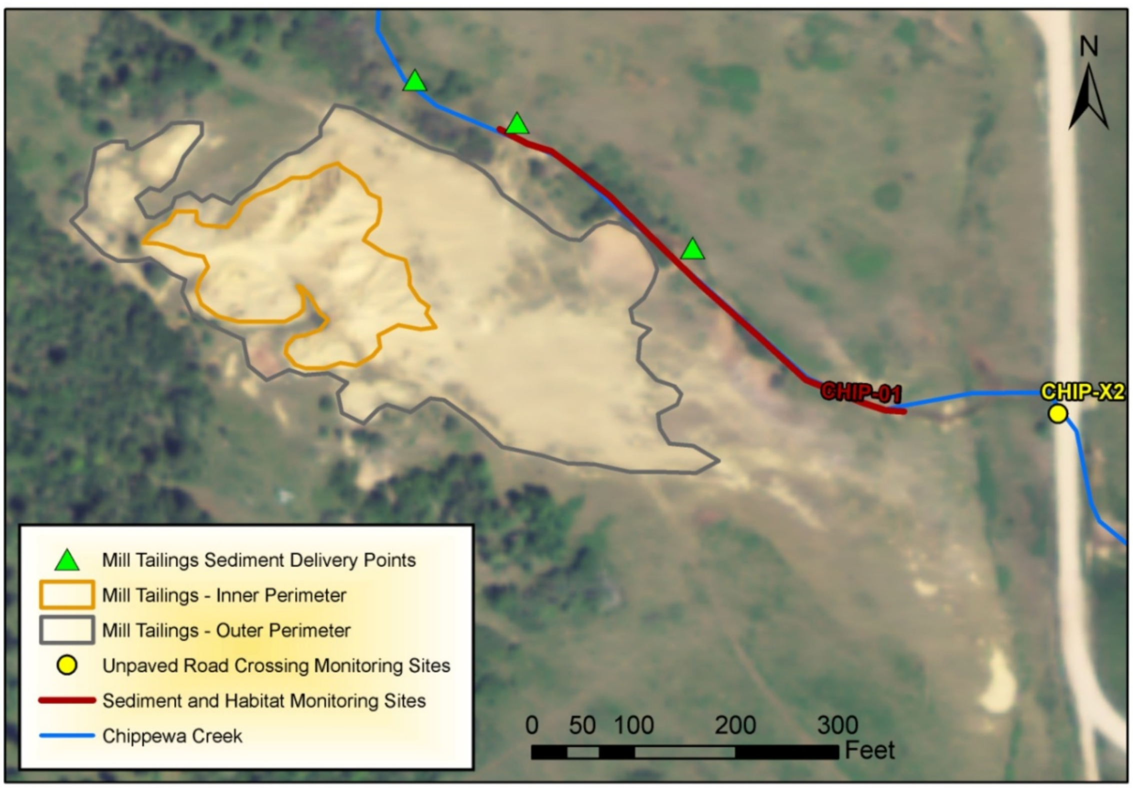

Figure C3-3. Mill Tailings along Chippewa Creek.

C3.4 USLE Assessment

Sediment production results for the existing and desired upland conditions are provided below in **Table C3-3**. Results are presented by land –use type, and are further grouped by anthropogenic and natural sources. The total calculated upland sediment production in the Chippewa Creek watershed is 359.2 tons/year for the existing upland condition. Using the desired upland condition through the application of Best Management Practices, sediment production in the Chippewa Creek watershed was reduced to 288.5 tons/year.

Table C3-3. Results of USLE Model for the Chippewa Creek Watershed.

Land Use Type	Area (acres)	Percent of Watershed	Existing Condition Load (Tons/Year)	Desired Conditions Load (Tons/Year)	Percent Change from Existing
41 - Deciduous Forest	50	5%	5.1	5.1	0%
42 - Evergreen Forest	269	25%	52.0	52.0	0%
52 - Shrub/Scrub	279	26%	98.7	98.7	0%
71 - Grassland/Herbaceous	439	41%	192.4	125.5	35%
82 - Cultivated Crops	15	1%	10.2	6.4	38%
90 - Woody Wetlands	9	1%	0.7	0.7	0%
95 - Emergent Herbaceous Wetland	0.2	0%	0.0	0.0	0%
Total Anthropogenic	**454**	**43%**	**202.7**	**131.9**	**35%**
Total Natural	**608**	**57%**	**156.6**	**156.6**	**0%**
Total Watershed	**1062**	**100%**	**359.2**	**288.5**	**20%**

The USLE model results were combined with a sediment delivery ratio (SDR) to estimate sediment delivery to Chippewa Creek. Total calculated sediment delivered to Chippewa Creek for existing conditions is 42.6 tons/year. Using the desired conditions through the application of Best Management Practices, the sediment delivered to Chippewa Creek was reduced by 20% to 34.1 tons/year.

Table C3-4. Results of SDR Analysis for the Chippewa Creek Watershed.

Land Use Type	Area (acres)	Percent of Watershed	Existing Condition Load (Tons/Year)	Desired Conditions Load (Tons/Year)	Percent Change from Existing
41 - Deciduous Forest	50	5%	0.40	0.40	0%
42 - Evergreen Forest	269	25%	6.05	6.05	0%
52 - Shrub/Scrub	279	26%	11.75	11.75	0%
71 - Grassland/Herbaceous	439	41%	23.86	15.40	35%
82 - Cultivated Crops	15	1%	0.10	0.06	38%
90 - Woody Wetlands	9	1%	0.45	0.45	0%
95 - Emergent Herbaceous Wetland	0.2	0%	0.00	0.00	0%
Total Anthropogenic	**454**	**43%**	**24.0**	**15.5**	**35%**
Total Natural	**608**	**57%**	**18.6**	**18.6**	**0%**
Total Watershed	**1062**	**100%**	**42.6**	**34.1**	**20%**

C4.0 DISCUSSION

This assessment of sediment loading to Chippewa Creek included an evaluation of sediment loads from unpaved roads, uplands and a mill tailings pile, along with a sediment and habitat evaluation. Out of the five identified unpaved road crossings in the Chippewa Creek watershed, a total of three unpaved road crossings were assessed in the field for evaluation in the WEPP:Road model. From the three assessed unpaved road crossings, the estimated mean annual sediment load is 0.016 tons. Through the application of BMPs, it is estimated that this load can be reduced to 0.006 tons, which is a 63% reduction in the mean annual sediment load. An annual sediment load of 1.98 tons is estimated from the mill tailings pile based on the WEPP Hillslope model. Through remediation of this tailings pile and development of a riparian buffer along Chippewa Creek, sediment contributions from the mill tailings pile should be eliminated. The USLE model indicates uplands deliver 42.6 tons/year of sediment to Chippewa Creek under the existing conditions, while sediment delivery from uplands could be reduced by 20% to 34.1 tons/year through the improved application of Best Management Practices.

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ATTACHMENT CA - UNPAVED ROAD CROSSING FIELD DATA AND WEPP MODELED SEDIMENT LOADS

Location ID	Date	Latitude	Longitude	Estimated Mean Annual Precipitation (inches)	Soil Type	% Rock	Insloped/ Outsloped (Modeled Value)	Road Surface	Traffic Level	Years Modeled	Gradient CRL1 (%)	Length CRL1 (Feet)	Width CRL1 (Feet)	Gradient Fill (%)	Length Fill (Feet)	Gradient Buffer (%)	Length Buffer (Feet)	WEPP LOAD (lbs)	Gradient CRL1 (%)	Length CRL1 (Feet)	Width CRL1 (Feet)	Gradient Fill (%)	Length Fill (Feet)	Gradient Buffer (%)	Length Buffer (Feet)	WEPP LOAD (lbs)	MEAN ANNUAL LOAD (lbs)
											L	L	L	L	L	L	L	L	R	R	R	R	R	R	R	R	
CHIP-X1_CRL1	10/18/10	47.13419	-109.21225	18.50	Sand L	10	Outsloped Unrutted	Native	Low	50	2.0	51	13	0	0	12	48	0.00	0.5	12	12	0	0	27	3	0.83	0.83
CHIP-X1_CRL2	10/18/10			18.50			Outsloped Unrutted	Native	Low	50	0.5	33	12	0	0	27	3	2.29									2.29
CHIP-X2	10/18/10	47.13059	-109.20651	18.50	Sand L	30	Outsloped Unrutted	Gravel	Low	50	5.0	426	21	0	0	27	40	27.18									27.18
CHIP-X3	10/18/10	47.12965	-109.19432	18.50	Sand L	5	Outsloped Unrutted	Native	Low	50	0.5	14	12	0	0	173	1	1.30	0.5	7	12	0	0	84	1	0.65	1.95
																model default of 100											
																fill and buffer lower defaults: 0.3% and 1 ft											

Location ID	Segment 1 Installed BMPs		Segment 1 Potential BMPs		Road Crossing and BMP Notes/Comments
	L	R	L	R	
CHIP-X1_CRL1	natural vegetative buffer	none	not required	slash filter	granitic road material
CHIP-X1_CRL2	none		slash filter		granitic road material
CHIP-X2	none		slash filter, fabric wraps		hard gravel road
CHIP-X3	none	none	slash filter, vegetative buffer	slash filter, vegetative buffer	

ATTACHMENT CB - SEDIMENT AND HABITAT DATABASE

Site	Date	Cell	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Bankfull Channel Width (Feet)	Cross-Sectional Area (Feet²)	Bankfull Mean Depth (Feet)	Width / Depth Ratio	Maximum Depth (Feet)	Floodprone Width (Feet)	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Number of Pools per 1000 Feet	Mean Residual Pool Depth	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Buffer Width	Left Bank Mean Riparian Buffer Width
CHIP-01	10/18/10	1	B4c	E4	1.03	1.0	6.5	4.2	0.65	10.0	1.0	14.0	2.2	8	22	40	37	8	0.4	2	0	4	0	65	0	0	0	0
CHIP-01	10/18/10	2	B4c	E4	1.03	1.0	5.0	3.5	0.70	7.1	1.2	8.0	1.6										35	25	0	0	5	2
CHIP-01	10/18/10	3			1.03	1.0																	0	55	0	0	2	2
CHIP-01	10/18/10	4	B4c	E4	1.03	1.0	4.5	3.8	0.84	5.4	1.1	8.5	1.9	25	21	25	13						75	35	0	0	3	5
CHIP-01	10/18/10	5	B4c	E4	1.03	1.0	6.8	4.3	0.63	10.8	1.3	10.8	1.6	8	28	41	25						0	30	0	0	0	0
CHIP-02	10/18/10	1	B4c	E4	1.36	1.0	4.9	2.6	0.52	9.4	0.8	8.9	1.8	18	26	26	24	14	0.4	0	0	14	65	0	0	0	3	5
CHIP-02	10/18/10	2	B4c	E4	1.36	1.0	5.3	3.8	0.72	7.3	1.0	9.3	1.8										65	25	0	0	5	5
CHIP-02	10/18/10	3			1.36	1.0																	25	0	0	0	5	5
CHIP-02	10/18/10	4	E4	E4	1.36	1.0	4.9	2.9	0.59	8.4	0.8	15.8	3.2	23	18	22	20						55	0	0	0	20	4
CHIP-02	10/18/10	5	E4	E4	1.36	1.0	6.2	3.7	0.60	10.4	0.9	21.2	3.4	7	39	44	44						20	0	0	0	0	5

ATTACHMENT CC - MILL TAILINGS PHOTOS