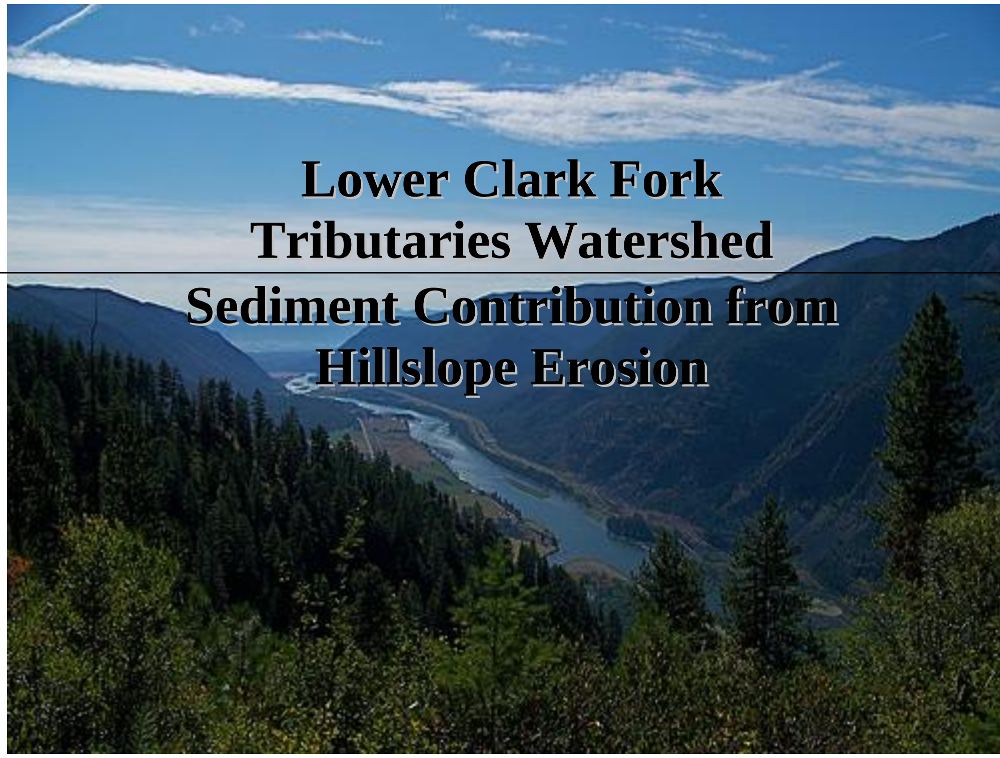
ATTACHMENT 2 - SEDIMENT CONTRIBUTION FROM HILLSLOPE EROSION



Lower Clark Fork Tributaries Watershed Sediment Contribution from Hillslope Erosion

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1.0 SEDIMENT CONTRIBUTION FROM HILLSLOPE EROSION

1.1 Introduction

Upland sediment loading due to hillslope erosion was modeled using the Universal Soil Loss Equation (USLE) and sediment delivery to the stream was predicted using a sediment delivery ratio. This model provided an assessment of existing sediment loading from upland sources, an assessment of potential sediment loading through the application of Best Management Practices (BMPs), and an assessment of the potential sediment loading before human alterations of the land cover. The BMP evaluated assumed modifications in upland management practices. When reviewing the results of the upland sediment load model, it is important to note that a significant portion of the sediment load is the "natural upland load" and not affected by the application of BMPs to the upland management practices.

The general form of the USLE has been widely used for erosion prediction in the U.S. and is presented in the National Engineering Handbook (1983) as:

(1) A = RK(LS)CP (in tons per acre per year)

where soil loss (A) is a function of the rainfall erosivity index (R), soil erodibility factor (K), overland flow slope and length (LS), crop management factor (C), and conservation practice factor (P) (Wischmeier and Smith 1978, Renard et al. 1997). USLE was selected for the Lower Clark Fork Tributaries watershed due to its relative simplicity and ease in parameterization and the fact that it has been integrated into a number of other erosion prediction models. These include: (1) the Agricultural Nonpoint Source Model (AGNPS), (2) Areal Nonpoint Source Watershed Environment Response Simulation Model (ANSWERS), (3) Erosion Productivity Impact Calculator (EPIC), (4) Generalized Watershed Loading Functions (GWLF), and (5) the Soil Water Assessment Tool (SWAT) (Doe, 1999). A detailed description of the general USLE model parameters is presented below.

The **R-factor** is an index that characterizes the effect of raindrop impact and rate of runoff associated with a rainstorm. It is a summation of the individual storm products of the kinetic energy in rainfall (hundreds of ft-tons per acre per year) and the maximum 30-minute rainfall intensity (inches per hour). The total kinetic energy of a storm is obtained by multiplying the kinetic energy per inch of rainfall by the depth of rainfall during each intensity period.

The **K-factor** or soil erodibility factor indicates the susceptibility of soil to resist 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. The K-factor is based on experimental data from the standard SCS erosion plot that is 72.6 ft long with uniform slope of 9%.

The **LS-factor** is a function of the slope and overland 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. The flow length refers to the distance between where overland flow originates and runoff reaches a defined channel or depositional zone. According to McCuen (1998), flow lengths are seldom greater than 400 ft or shorter than 20 ft.

The **C-factor** or crop management factor is the ratio of the soil eroded from a specific type of cover to that from a clean-tilled fallow under identical slope and rainfall. It integrates a number of factors that effect 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. It is now referred to as the vegetation management factor (VM) for non-agricultural settings (Brooks, 1997).

Three different kinds of effects are considered in determination of the VM-factor. These include: (1) canopy cover effects, (2) effects of low-growing vegetal cover, mulch, and litter, and (3) rooting structure. A set of metrics has been published by the Soil Conservation Service (SCS) for estimation of the VM-factors for grazed and undisturbed woodlands, permanent pasture, rangeland, and idle land. Although these are quite helpful for the Lower Clark Fork Tributaries setting, Brooks (1997) cautions that more work has been carried out in determining the agriculturally based C-factors than rangeland/forest VM-factors. Because of this, the results of the interpretation should be used with discretion.

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 (up-slope down-slope) farming practices with that of certain agriculturally based conservation practices.

1.2 Modeling Approach

Sediment delivery from hillslope erosion was estimated using a Universal Soil Loss Equation (USLE) based model to predict soil loss along with a distance and riparian health based sediment delivery ratio (SDR) to predict sediment delivered to the stream. This USLE based model is implemented as a watershed scale, grid format, GIS model using ArcView v 9.2 GIS software.

Desired results from the modeling effort include the following: (1) annual sediment load from each of the water quality limited segments on the state's 303(d) list, (2) the mean annual source distribution from each land category type, (3) annual potential sediment load from each of the water quality limited segments on the state's 303(d) list after the application of riparian buffer zone management BMP's, (4) annual potential sediment load from each of the water quality limited segments on the state's 303(d) list after the application of riparian buffer zone management BMP's and upland management BMPs, and (5) annual potential sediment load from each of the water quality limited segments on the state's 303(d) list before human affects. Based on these considerations, a GIS- modeling approach (USLE) was formulated to facilitate database development and manipulation, provide spatially explicit output, and supply output display for the modeling effort.

1.3 Modeling Scenarios

1.3.1 Management Scenarios

Four management scenarios were evaluated for the Lower Clark Fork Tributaries watershed. They include: (1) an existing conditions scenario that considers the current land cover, management practices, and riparian health in the watershed; (2) a riparian health BMP conditions scenario that considers improved riparian buffer zones; (3) a riparian health BMP and upland BMP conditions scenario that considers improved riparian buffer zones and grazing and cover management; and (4) a natural conditions scenario that assumes removal of any and all anthropogenic land uses.

Erosion was differentiated into two source categories for each scenario: (1) natural erosion that occurs on the time scale of geologic processes and (2) anthropogenic erosion that is accelerated by human-caused activity. A similar classification is presented as part of the National Engineering Handbook Chapter 3 – Sedimentation (USDA, 1983). Differentiation is necessary for TMDL planning. Land cover categories considered to be affected by human-caused activity and therefore affected by BMPs within the Lower Clark Fork Tributaries watershed were developed (open space), developed (low intensity), developed (medium intensity), pasture/hay, grasslands/herbaceous, cultivated crops, and transitional (logging). All other land cover categories were considered to have “natural erosion.”

Well vegetated riparian buffers have been shown to act as filters that help to remove sediment from overland flow. In general, the effectiveness of vegetated riparian buffers is proportional to their width and overall health. A riparian health assessment was completed by GEI Consultants (2005) for the Lower Clark Fork Tributaries Watershed, pursuant to fulfilling Avista Corporation’s license requirments for their operation of the Cabinet Gorge and Noxon Rapids dams. . The GEI riparian health assessment is used here to estimate further reduction in the quantity of eroded sediment that is ultimately delivered to the streams. These riparian areas are also considered to be affected by human-caused activity and are therefore subject to improved riparian health management.

1.3.2 Historic Scenario

Upon entering a stream, eroded sediment is transported downstream by fluvial processes until ultimately flushed from the stream to its receiving waterbody or removed from the system as a landforming deposit. As a stream make take many years to process its sediment load, sediment delivered to a stream in the past may be the source of current sediment related stream impairments. In the Lower Clark Fork Tributaries watershed, historic forest fire and timber harvest events may have resulted in a higher level of current impairment than can be attributed to current conditions and land management practices.

To assist assessment of the potential current effects of past fire and harvest events in the Lower Clark Fork Tributaries watershed, a historic conditions scenario was developed and evaluated. Polygon data representing the bounds of known timber harvests and forest fires from 1910 through 2004 were obtained from the Kootenai National Forest. These polygons were then grouped by decade (for example, 1910-1919), and an annualized model run was performed for each decade using the fire and harvest polygons as a landcover adjustment per the method outlined in section 1.5.7. All remaining parameters for the historic scenario replicate the existing conditions management scenario.

1.4 Data Sources

The USLE model was parameterized using a number of published data sources. These include information from: (1) U.S. Geological Survey (USGS), (2) Spatial Climate Analysis Service (SCAS), and (3) Soil Conservation Service (SCS). Additionally, local information regarding specific land cover was acquired from the U.S. Forest Service (USFS) and the Natural Resource Conservation Service (NRCS). Specific GIS coverages used in the modeling effort included the following:

Grid data of the **R-factor** was obtained from the NRCS, and is based on Parameter-elevation Regressions on Independent Slopes Model (PRISM) precipitation data. PRISM precipitation data is derived from weather station precipitation records, interpolated to a gridded landscape coverage by a method (developed by the Spatial Climate Analysis Service of Oregon State University) which accounts for the effects of elevation on precipitation patterns.

Polygon data of the **K-factor** were obtained from the NRCS General Soil Map (STATSGO) database. The USLE K factor is a standard component of the STATSGO soil survey. Soils polygon data were summarized and interpolated to grid format.

The **LS-factor** was derived from 30m USGS digital elevation model (DEM) grid data, interpolated to a 10m pixel. This factor is calculated within the model.

The **C-factor** was estimated using the National Land Cover (NLCD) dataset and using C-factor interpretations provided by the NRCS with input from MT DEQ and USFS. C-factors are intended to be conservatively representative of conditions in the Lower Clark Fork Tributaries watershed.

The **P-factor** was set to one, as per previous communication with the NRCS State Agronomist who suggested that this value is the most appropriate representation of current management practices in the Lower Clark Fork Tributaries watershed.

The **sediment delivery ratio** was derived by the model for each grid cell based on the observed relationship between the distance from the delivery point to the stream and the percent of eroded sediment delivered to the stream. This relationship was established by Megehan and Ketcheson (1996).

The **riparian health factor** was derived from a riparian health assessment completed by GEI Consultants (2005). Riparian health ratings of high, moderate, low, and no riparian vegetation were assigned according to the professional judgment of the assessment team. The percent of each subwatershed's area falling in each category was reported.

1.5 Modeling Methods

An appropriate grid for each data source was created, giving full and appropriate consideration to proper stream network delineation, grid cell resolution, etc. A computer model was built using ArcView Model Builder to derive the five factors from model inputs, multiply the five factors and arrive at a predicted sediment production for each grid cell. The model also derived a sediment delivery ratio for each cell, and reduced the predicted sediment production by that factor to estimate sediment delivered to the stream network.

Specific parameterization of the USLE factors was performed as follows:

1.5.1 Sub-basins

The Lower Clark Fork Tributaries watershed boundary and the sub-basin boundaries were defined using the USGS 6th code Hydrologic Unit Codes (HUC). Dry Creek is the only 303(d) listed stream that was not represented in the 6th code HUCs. The Dry Creek sub-basin was cut from the Upper Bull River West sub-basin using USGS topography as a guide to drainage divides. Additionally, a portion of the Elk Creek sub-basin extends across the state border into Idaho. As this area drains to Montana, it was included in this analysis. For reporting purposes, the sub-basin was divided along the state line to create the Elk Creek Idaho and Elk Creek sub-basins.

Figure 1-1. Sub-basin polygons for the Lower Clark Fork Tributaries Watershed.

1.5.2 Lower Clark Fork Tributaries Watershed DEM

The digital elevation model (DEM) for the Lower Clark Fork Tributaries watershed is the foundation for developing the LS factor, for defining the extent of the bounds of the analysis area (specifically Bull River, Dry Creek, Elk Creek, Marten Creek, Swamp Creek, and White Pine Creek sub-basins), and for delineating the area within the outer bounds of the analysis for which the USLE model is not valid (i.e. the concentrated flow channels of the stream network). The USGS 30m DEM (level 2) for the Lower Clark Fork Tributaries watershed was used for these analyses. The DEM was interpolated to a 10m analytic grid cell to render the delineated stream network more representative of the actual size of Lower Clark Fork Tributaries watershed streams and to minimize resolution dependent stream network anomalies. The resulting interpolated 10m DEM was then subjected to standard hydrologic preprocessing, including the filling of sinks to create a positive drainage condition for all areas of the watershed.

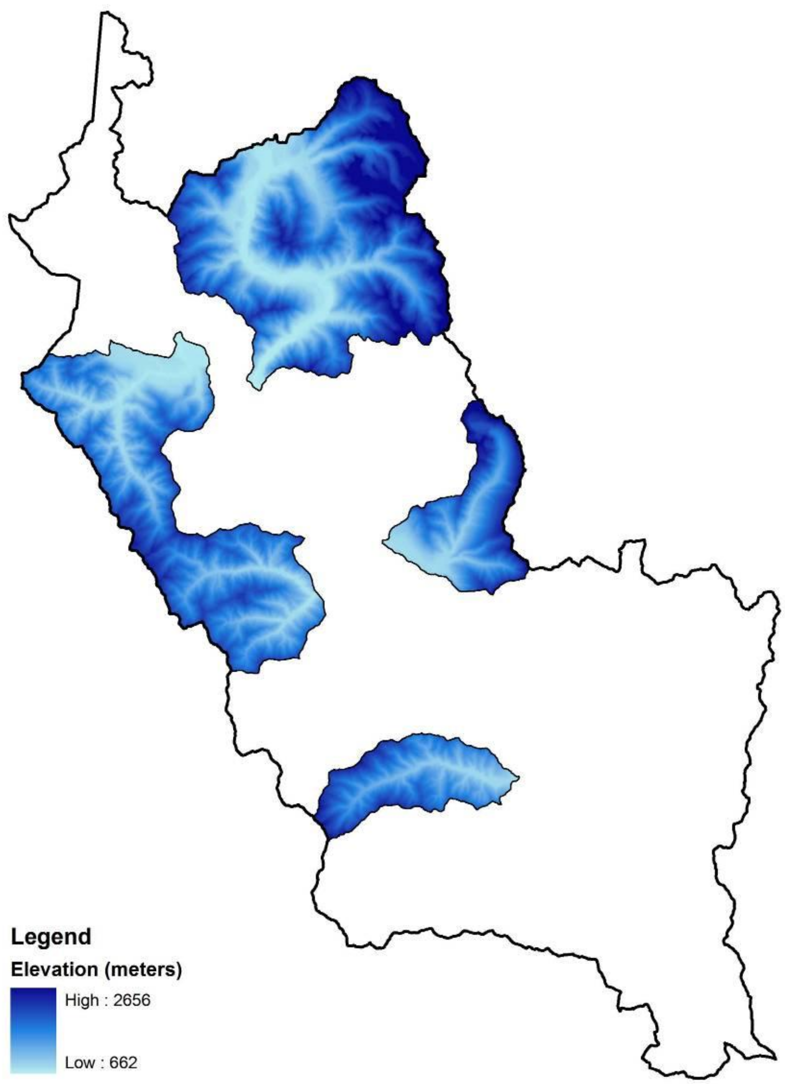

Figure 1-2. Digital Elevation Model (DEM) of the Lower Clark Fork Tributaries Watershed Prepared for Hydrologic Analysis.

1.5.3 R-Factor

The rainfall and runoff factor grid was prepared by the Spatial Climate Analysis Service of Oregon State University, at 4 km grid cell resolution. For the purposes of this analysis, the SCAS R-factor grid was reprojected to Montana State Plane Coordinates (NAD83, meters), resampled to a 10m analytic cell size and clipped to the extent of the Lower Clark Fork Tributaries watershed, to match the project's standard grid definition.

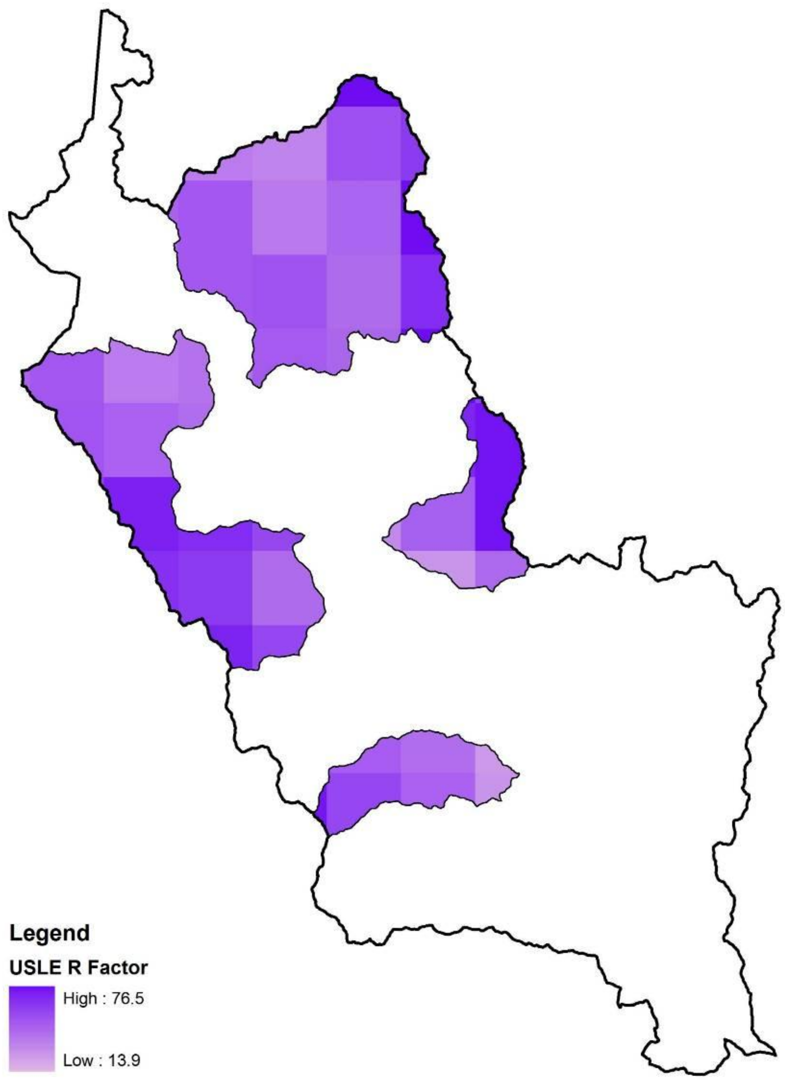

Figure 1-3. ULSE R-factor for the Lower Clark Fork Tributaries Watershed.

1.5.4 K-Factor

The soil erodibility factor grid was compiled from 1:250K STATSGO data, as published by the NRCS. STATSGO database tables were queried to calculate a component weighted K value for all surface layers, which was then summarized by individual map unit. The map unit K values were then joined to a GIS polygon coverage of the STATSGO map unit polygons, and the polygon coverage was converted to a 10m analytic grid for use in the model. SSURGO data were considered for use, due to the higher resolution and currency of the SSURGO datasets. However, SSURGO data for the Lower Clark Fork Tributaries watershed did not contain the required K-factor.

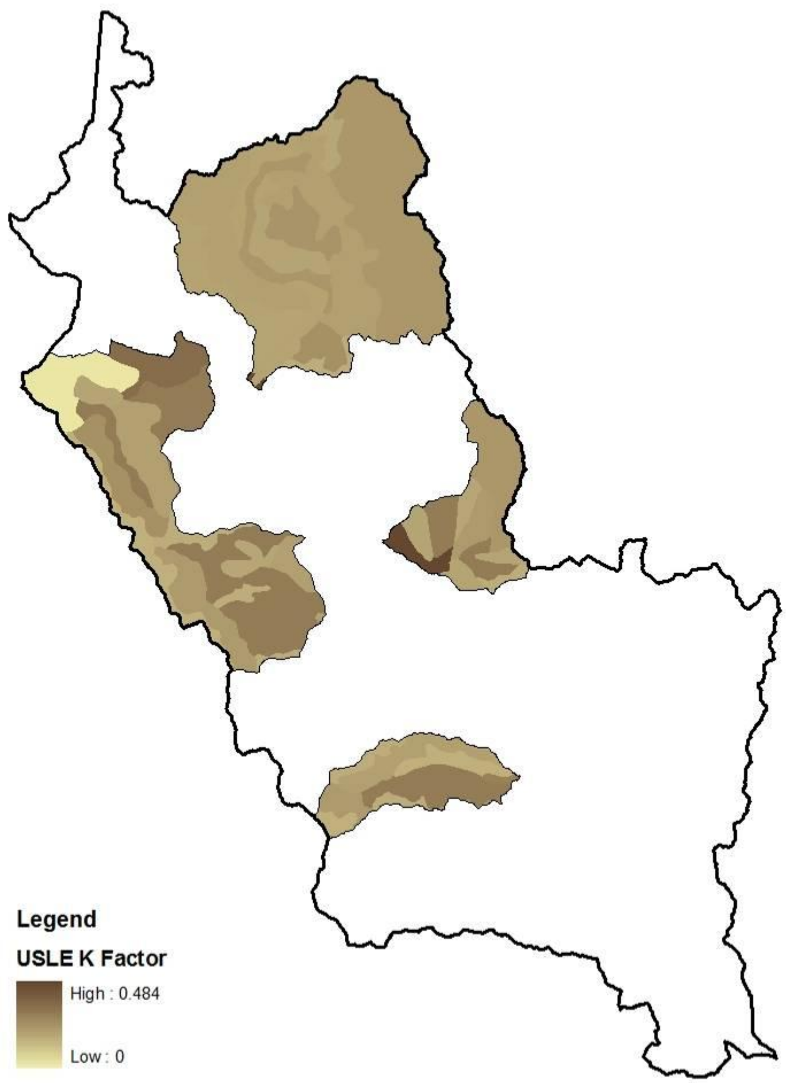

Figure 1-4. ULSE K-factor for the Lower Clark Fork Tributaries Watershed

1.5.5 LS-Factor

The equation used for calculating the slope length and slope factor was that given in the updated definition of RUSLE, as published in USDA handbook #703:

$LS = S_i (\lambda_i^{m+1} - \lambda_{i-1}^{m+1}) / (\lambda_I - \lambda_{i-1}) (72.6)^m$

Where:

λ_i = length in feet from top of slope to lower end of ith segment. This value was determined by applying GIS based surface analysis procedures to the Lower Clark Fork Tributaries watershed DEM, calculating total upslope length for each 10m grid cell, and converting the results to feet from meters. In accordance with research that indicates that, in practice, the slope length rarely exceeds 400 ft, λ was limited to that maximum value.

S_i = slope steepness factor for the ith segment.
$= 10.8 \sin \theta + 0.03$ for $\theta < 9\%$
$= 16.8 \sin \theta - 0.50$ for $\theta \geq 9\%$

m = a variable slope-length exponent.
$= \beta / (1 + \beta)$

and

B = ratio of rill to interrill erosion.
$= (\sin \theta / 0.0896) / [3.0 (\sin \theta)^{0.8} + 0.56]$

θ = slope angle as calculated by GIS based surface analysis procedures from the Lower Clark Fork Tributaries watershed DEM.

The LS factor grid was calculated from individual grids computed for each of these sub factors, using a simple ArcView Model Builder script.

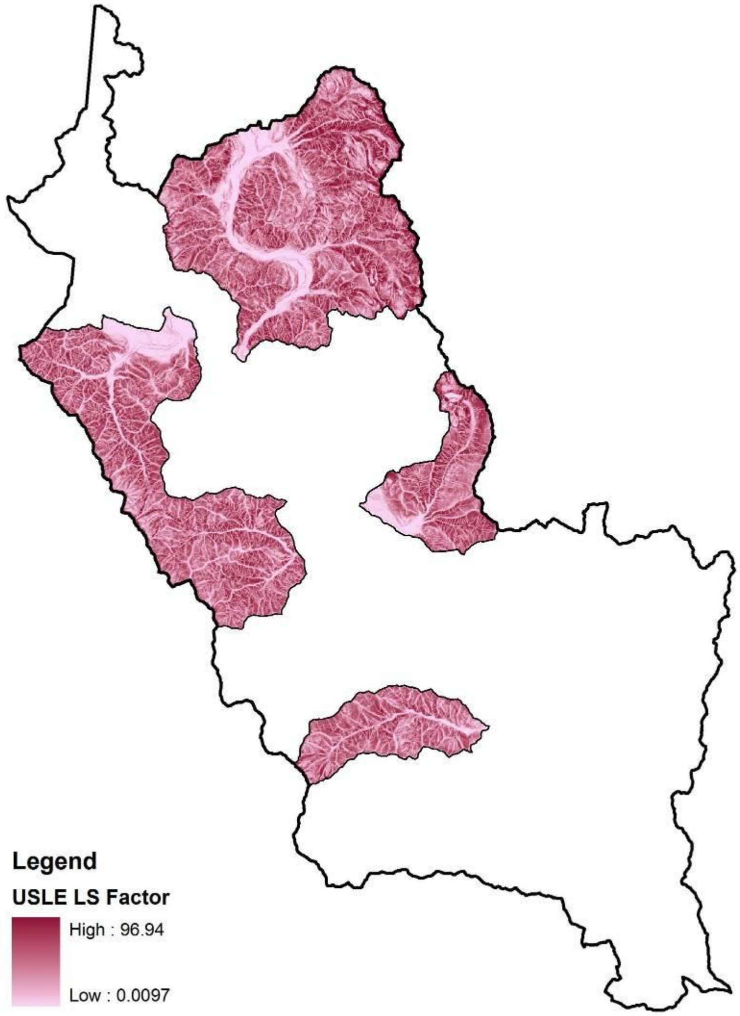

Figure 1-5. ULSE LS-factor for the Lower Clark Fork Tributaries Watershed

1.5.6 NLCD

The 2001 National Land Cover Dataset (NLCD) was obtained from USGS for use in establishing USLE C-factors for the Lower Clark Fork Tributaries watershed. The 2001 NLCD is the most current NLCD for the project are, and is a categorized 30 meter Landsat Thematic Mapper image shot in 2001. The NLCD image was reprojected to Montana State plane projection/coordinate system, and resampled to the project standard 10m grid. NLCD land cover classification codes for areas present in the Lower Clark Fork Tributaries watershed are described as follows:

11. Open Water - areas of open water, generally with less than 25 percent cover of vegetation or soil.

12. Perennial Ice/Snow - All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

21. Developed, Open Space - Includes areas with a mixture of constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

22. Developed, Low Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.

23. Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.

31. Barren Land (Rock/Sand/Clay) – Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.

41. Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.

52. Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation. This class includes tree shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

71. Grasslands/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

81. Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

82. Cultivated Crops - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

90. Woody Wetlands - Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

95. Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

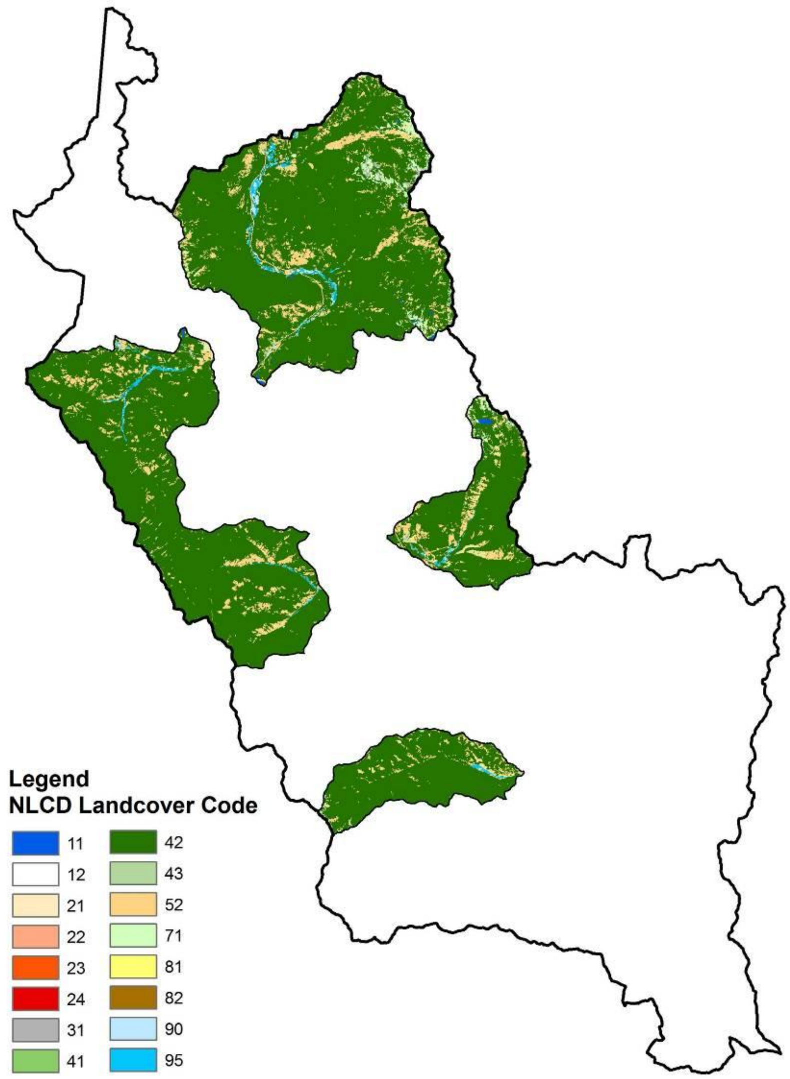

Figure 1-6. NLCD Landcover for the Lower Clark Fork Tributaries Watershed.

1.5.7 Logging and Fire Adjustment

In general, the land use classification of the NLCD was accepted as is, without ground truthing of original results or correction of changes that may have occurred since the NLCD image was shot. Given that we are looking for watershed and sub-watershed scale effects, the relative simplicity of the land use mix in the Lower Clark Fork Tributaries watershed, and the relative stability of that land use over the 7 years since the Landsat image that the NLCD is based on was taken, this was considered to be a reasonable assumption. One adjustment to the NLCD is necessary and appropriate, however. That is to quantify the amount of logging or fires that has occurred since 2001, and to also identify previously disturbed areas that are reforesting over that same period. As with other land uses in the valley, logging is a stable land use, but it is a land use that causes a land cover change that may effect sediment production.

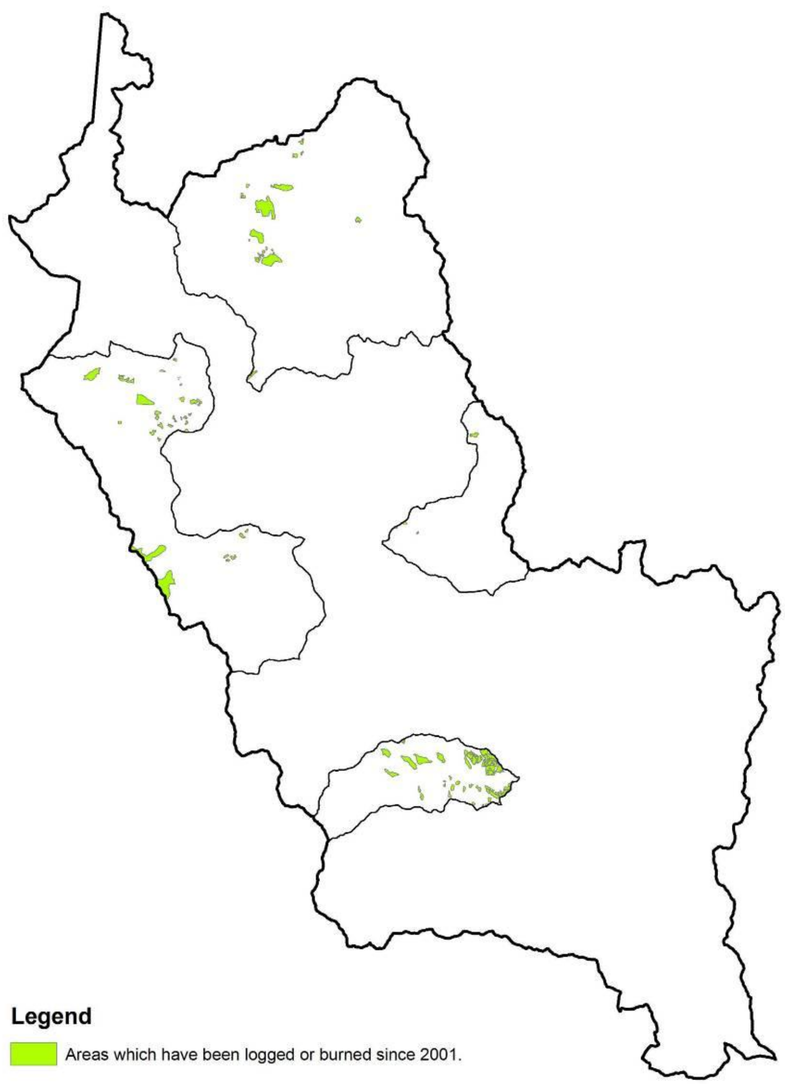

Figure 1-7. Logging and fire areas for the Lower Clark Fork Tributaries Watershed.

Adjustment for logging was accomplished by using fire and harvest record polygons provided by the U.S. Forest Service. Polygons with a fire or harvest date of 2001 or later were selected. Adjustment for logging on non-USFS property was accomplished by comparing the 2001 NLCD grid for the Lower Clark Fork Tributaries Watershed with the 2005 NAIP aerial photography. Areas which were coded as a forest type (41, 42 or 43) on the NLCD were digitized and coded as Type 1 (logged) if they appeared to be other than forested (typically bare ground, grassland, or shrubland) on the NAIP photos, if there were indications of logging activity (proximity to forest or logging roads, appearance of stands, etc), and if they were on non-USFS land. For the purposes of sediment generation estimation, Type 1 (logging) adjustment areas were treated as ‘transitional’ and classified with the corresponding C-factor.

Adjustment for reforestation was also accomplished by comparing the 2001 NLCD grid for the Lower Clark Fork Tributaries Watershed with the 2005 NAIP aerial photography. Areas which were coded as something other than forest on the NLCD, but which appeared to be forested on the NAIP photos were digitized and coded as Type 2 (reforesting). However, no areas of reforestation were noted for the Lower Clark Fork Tributaries watershed.

1.5.8 C-Factor Derivation

For purposes of the base (existing conditions) scenario, the following scheme of reclassification was used to derive annualized USLE C-factors from the NLCD land cover classes present in the Lower Clark Fork Tributaries watershed.

This reclassification is based on the NRCS table "C-Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland" and was developed with the assistance and input of local NRCS and USFS employees. A narrative description of the professional judgment involved in the selection of these factors and the NRCS table are provided in Attachment A.

To estimate the potential reduction in sediment production that might be accomplished under the desired conditions scenario(application of best management practices), the model was re-run using a different C-factor reclassification scheme. Relative to the existing conditions C-factor scheme, the BMP C-factor for the 'transitional' land classification was changed to reflect the forest cover that most such areas are transitioning to in the Lower Clark Fork Tributaries watershed. The 'grasslands/herbaceous', and 'pasture/hay' BMP C-factors were conservatively changed to reflect a 10 percent increase in ground cover over existing conditions. The 'cultivated crops' BMP C-factor was changed to reflect a 20 percent increase in ground cover over existing conditions.

To estimate the potential reduction in sediment production that might be accomplished under the natural conditions scenario, the model was re-run using a third C-factor reclassification scheme. For all anthropogenic land uses, 'developed, open space', 'developed, low intensity', 'developed, medium intensity', 'cultivated crops' and 'pasture/hay', the natural scenario assumed a conversion to forest or woody wetland land cover (both forest and woody wetland have the same c-factor). These are the assumed land covers of the areas in question before they were influenced by humans. No change was applied to the other land use types within the Lower Clark Fork Tributaries watershed from the desired conditions scenario.

The C-factors for the three scenarios are presented in **Table 1-1**.

Table 1-1 C-factors in the Lower Clark Fork Tributaries watershed.

NLCD Code	Description	C-Factor Existing Condition	C-Factor Desired Condition	C-Factor Natural Condition
21	Developed, Open Space	0.003	0.003	0.003
22	Developed, Low Intensity	0.001	0.001	0.003
23	Developed, Medium Intensity	0.001	0.001	0.003
31	Barren Land	0.001	0.001	0.001
41	Deciduous Forest	0.003	0.003	0.003
42	Evergreen Forest	0.003	0.003	0.003
43	Mixed Forest	0.003	0.003	0.003
52	Shrub/Scrub	0.008	0.008	0.008
71	Grasslands/Herbaceous	0.020	0.013	0.013
81	Pasture/Hay	0.020	0.013	0.003
82	Cultivated Crops	0.240	0.150	0.003
90	Woody Wetlands	0.003	0.003	0.003
95	Emergent Herbaceous Wetlands	0.003	0.003	0.003
N/A	Transitional	0.006	0.003	0.003

Table 1-2 Changes in percent ground cover for agricultural land cover types between existing and improved management conditions.

Land Cover	Existing % Ground Cover	Improved % Ground Cover
Grasslands/Herbaceous	75	85
Pasture/Hay	75	85
Cultivated Crops	20	40

1.5.9 Riparian Health Assessment

Well vegetated riparian buffers have been shown to act as filters that remove sediment from overland flow. Because of this ability, the influence of riparian corridors on water quality is proportionately much greater than the relatively small area in the landscape they occupy. In general, the effectiveness of vegetated riparian buffers is proportional to their width and overall health. Thus, information regarding riparian zone health can be used to refine estimates of sediment delivery to streams from upstream sources. This section describes a Riparian Health Assessment of the Lower Clark Fork Watershed, and adjustment of that assessment to correspond to the subwatershed used for this modeling effort.

1.5.9.1 GEI Riparian assessment

The riparian corridor quality assessment is taken from the report, "Lower Clark Fork River Drainage Habitat Problem Assessment" (GEI Consultants, 2005). The riparian corridor quality assessment is based on professional expertise of the Aquatic Implementation Team (AIT), field observations, and surveys. Riparian corridors are referred to as having low (marginal/limited), moderate (some good, some marginal), or high (majority adequate for aquatic resources) quality. The absence of riparian vegetation (referred to as none) is an additional category describing the condition of the riparian corridor. It is understood that within each subwatershed, riparian conditions are not homogeneous. For this reason, the AIT used best professional judgment to estimate the percentage of the riparian corridor within each sub watershed that was of high, moderate, low, or none quality.

The riparian corridor assessment included mainstem and main fork only. For channels classified as type A and B by the Rosgen classification system, the riparian area evaluated included 100 feet on either side of the channel (area affected by trees). For streams classified as Rosgen C or E channels, the area affecting the belt width (usually more than 100 feet on either side of the channel) was evaluated. Roads and extensive un-vegetated gravel/cobble were included in the "riparian vegetation not present" or "none" category.

1.5.9.2 Correcting for Differences in Subwatershed Delineation

The sub-basin division used for the GEI Consultants report varies slightly from the sub-basin division used for this TMDL assessment. Where the TMDL sub-basin encompassed more than one sub-basin in the GEI Consultants report, the TMDL riparian quality was taken to be the area weighted average of the contributing GEI sub-basins. Where the TMDL sub-basin was a subdivision of a larger sub-basin in the GEI Consultants report, the riparian quality for the larger sub-basin was used as is.

The results of the riparian quality assessment from the GEI Consultants report and the correlation of sub-basins are shown in **Table 1-3**.

Table 1-3 Riparian quality assessment and sub-basin correlation.

TMDL Sub-basin Name and Area	GEI Consultants Sub-basin Name	Existing Conditions Riparian Quality	Percent of GEI Sub-basin	GEI Sub-basin Area (acres)	Percent of TMDL Sub-basin Area	Weighted Riparian Quality Percent by Area	TMDL Sub-basin Riparian Quality	Percent of TMDL Sub-basin for Existing Conditions
Bull River Headwaters (24,192 acres)	North Fork Bull River	High	95	7,092	29.3%	27.9	High	93
		Moderate	5			1.5		
		Low	0			0		
		None	0			0	Moderate	7
	Middle Fork Bull River	High	90	7,858	32.5%	29.2		
		Moderate	10			3.3		
		Low	0			0	Low	0
		None	0			0		
	South Fork Bull River	High	95	9,242	38.2%	36.3		
		Moderate	5			1.9	None	0
		Low	0			0		
		None	0			0		
Dry Creek (5,429 acres)	Bull River	High	35	44,973	100%	35	High	35
		Moderate	30			30	Moderate	30
		Low	30			30	Low	30
		None	5			5	None	5
Upper Bull River West (28,364 acres)	Bull River	High	35	44,973	100%	35	High	35
		Moderate	30			30	Moderate	30
		Low	30			30	Low	30
		None	5			5	None	5
Upper Bull River East (16,951 acres)	East Fork Bull River	High	70	16,951	100%	70	High	70
		Moderate	25			25	Moderate	25
		Low	5			5	Low	5
		None	0			0	None	0

Table 1-3 Riparian quality assessment and sub-basin correlation (continued).

TMDL Sub-basin Name and Area	GEI Consultants Sub-basin Name	Existing Conditions Riparian Quality	Percent of GEI Sub-basin	GEI Sub-basin Area (acres)	Percent of TMDL Sub-basin Area	Weighted Riparian Quality Percent by Area	TMDL Sub-basin Riparian Quality	Percent of TMDL Sub-basin for Existing Conditions
Lower Bull River (16,330 acres)	Bull River	High	35	44,973	70.3%	24.6	High	38
		Moderate	30			21.1		
		Low	30			21.1	Moderate	33
		None	5			3.5		
	Copper Gulch	High	45	4,843	29.7%	13.4	Low	24
		Moderate	40			11.9		
		Low	10			3.0	None	5
		None	5			1.5		
Elk Creek Idaho (3,983 acres)	West Fork Elk Creek		Unknown	7,734	100%		same as Elk Creek	
East Fork Elk Creek (16,111 acres)	East Fork Elk Creek	High	30	16,111	100%	30	High	30
		Moderate	40			40	Moderate	40
		Low	25			25	Low	25
		None	5			5	None	5
Elk Creek (16,872 acres)	West Fork Elk Creek		Unknown	7,734	22.8%			
	Elk Creek	High	20	13,022	77.2%	20	High	20
		Moderate	30			30	Moderate	30
		Low	45			45	Low	45
		None	5			5	None	5
Swamp Creek (22,931 acres)	Swamp Creek	High	60	22,931	100%	60	High	60
		Moderate	20			20	Moderate	20
		Low	15			15	Low	15
		None	5			5	None	5

Table 1-3 Riparian quality assessment and sub-basin correlation (continued).

TMDL Sub-basin Name and Area	GEI Consultants Sub-basin Name	Existing Conditions Riparian Quality	Percent of GEI Sub-basin	GEI Sub-basin Area (acres)	Percent of TMDL Sub-basin Area	Weighted Riparian Quality Percent by Area	TMDL Sub-basin Riparian Quality	Percent of TMDL Sub-basin for Existing Conditions
Marten Creek (29,504 acres)	Marten Creek	High	20	17,717	60.0%	12.0	High	22
		Moderate	40			24.0		
		Low	30			18.0	Moderate	48
		None	10			6.0		
	South Fork Marten Creek	High	25	11,787	40.0%	10.0	Low	22
		Moderate	60			24.0		
		Low	10			4.0	None	8
		None	5			2.0		
White Pine Creek (19,966 acres)	White Pine Creek	High	40	19,966	100%	40	High	40
		Moderate	30			30	Moderate	30
		Low	20			20	Low	20
		None	10			10	None	10

1.5.10 Distance and Riparian Health Based Sediment Delivery Ratio

The USLE model upon which this model is founded is, as its name states, a soil loss (i.e. sediment production) model. Soil lost from one area due to erosive processes is typically redeposited a short distance downslope however, and most sediment produced from a hillslope erosion event does not travel so far as to be delivered to a stream channel. As TMDL questions deal specifically with sediment delivered to the stream, a method of accounting for redeposition and ultimate delivery to streams is required.

With USLE based models, this accounting of sediment redeposition is typically achieved through the application of a *sediment delivery ratio (SDR)*, a factor that estimates the percentage of sediment produced that is ultimately delivered to the stream. We apply a distance based sediment delivery ratio that reflects the relationship between downslope travel distance and ultimate sediment delivery.

Given that riparian zones can be effective sediment filters when wide and well vegetated, that riparian zone health is susceptible to anthropogenic impacts and thus to land management decisions, and that the effectiveness of riparian zones as sediment filters has been quantified in the literature, we incorporate riparian zone health and its effect on sediment delivery into our distance based sediment delivery ratio.

1.5.10.1 Distance based SDR

Megahan and Ketcheson (1996) found that the relationship between the percentage (by volume) of a sediment mass that travels a given percentage of the maximum sediment travel distance of that sediment mass is as shown in **Figure 1-8**.

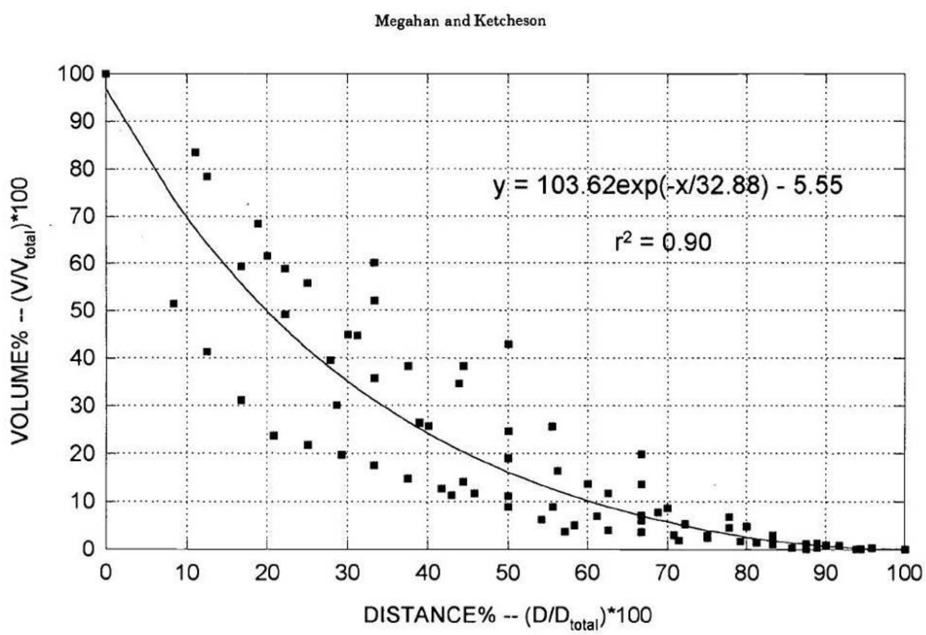

Figure 2. Dimensionless Plot of Sediment Volume Versus Travel Distance.

Figure 1-8. Figure 2 from Megahan and Ketcheson (1996), a dimensionless plot of sediment volume vs travel distance.

This relationship was derived from a dataset of approximately 100 observations of sediment transport downslope from a known source (forest roads) that was not intercepted by a stream. It thus represents the 'typical' transport distribution along the maximum transport distance under a variety of field conditions.

Megahan and Ketcheson's logarithmic regression of the data permits this relationship to be expressed by the equation presented in Figure 1-8, which may be restated as a function of three variables:

*Volume % = 103.62*EXP(-((D/Dtotal)/32.88))-5.55*

where:

Volume% = the percentage of sediment mobilized from a source that travels at least distance D from that source

D = distance from the sediment source, and

Dtotal = the maximum distance that sediment travels from the source

As this equation is dimensionless, to serve as an SDR it must first be scaled to the field conditions of the study area. This is accomplished by evaluating the equation with site specific values for D and Volume% at a single point, and solving for Dtotal. Having established a site specific Dtotal, the M&K equation reduces to two unknowns, the two variables that define a distance based SDR: distance and percent sediment delivered beyond that distance. This SDR may be used to estimate sediment delivery at all points on the sediment delivery path, from streambank to a distance Dtotal.

The derivation of site specific values of D and Volume % for use in scaling Megahan and Ketcheson's dimensionless equation is presented in section 1.5.10.2

1.5.10.2 Subwatershed specific Sediment Delivery Ratio scale factors.

Riparian zone sediment filtering capacity is typically expressed as a given percent reduction in delivery of sediment entering a riparian zone of a given width. This rating of a known percent delivery (Volume%) from a known distance from the stream (D) permits scaling of the Megahan and Ketcheson's dimensionless equation (section 1.5.10.1) for use in predicting percent delivery from other distances.

Literature review (Wegner 1999, Knutson and Naef 1997) indicates that a 100 foot wide, well vegetated riparian buffer zone can be expected to filter 75-90% of incoming sediment from reaching its stream channel. Accordingly, this analysis conservatively assumes that a sediment reduction efficiency of 75% represents the performance of a 100 foot wide, high quality (good) vegetated riparian buffer in the Lower Clark Fork Tributaries watersheds. Conversely, this analysis conservatively assumes that a 100 foot wide riparian zone without vegetation cover (corresponding to a riparian health assessment of 'none') would only filter 10% of incoming sediment from reaching its stream. An approximately equal apportionment of the remaining range in sediment reduction efficency between the ‘poor’ and ‘good’ riparian assessment categories results in the riparian health/sediment delivery relationship shown in Figure 1-9

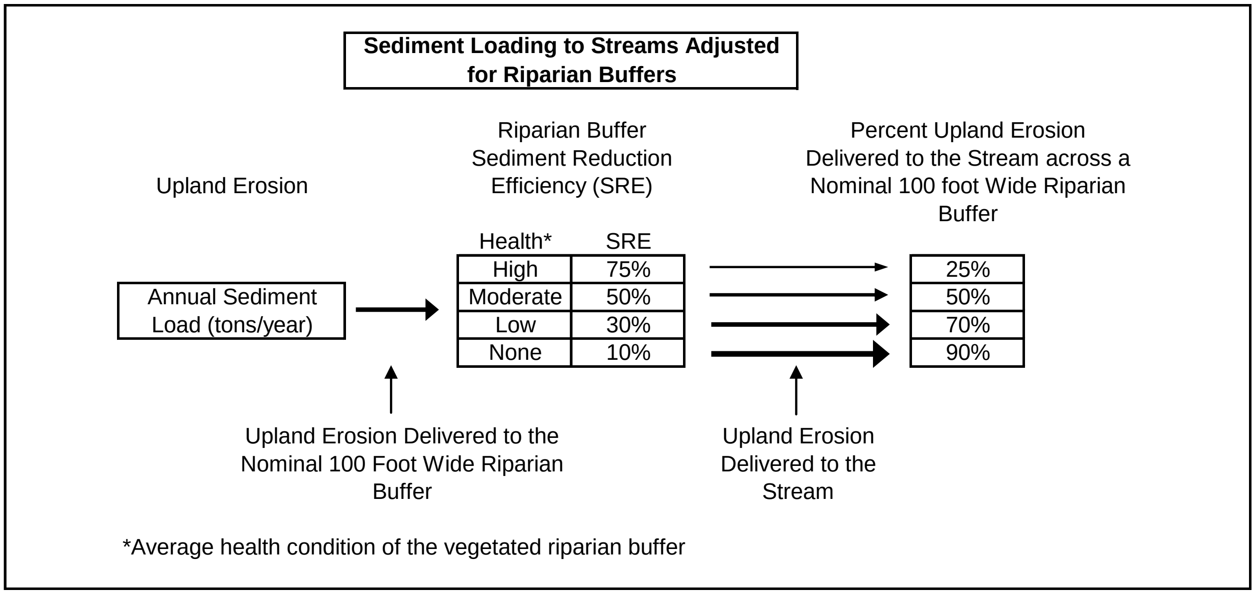

Figure 1-9. USLE Upland Sediment Load Delivery Adjusted for Riparian Buffer Capacity

Applying this relationship to the Lower Clark Fork Tributaries riparian assessment, we computed a riparian health score based sediment reduction percentage for each sub-basin of interest. This represents the percent reduction in delivery of sediment from a nominal 100 foot wide riparian zone. This was accomplished by taking the percentage of the sub-basin in each of the four riparian health classes, multiplying by the assumed sediment delivery efficiency reduction for each class (75% for high quality, 50% for a moderate quality, 30% for a low quality, and 10% for none) and summing for each stream. An example calculation is presented in **Table 1-4.**

Table 1-4 Example of Calculation of Riparian Health SDR Factor for Bull River Headwaters.

Existing Riparian Quality	Percent of GEI Sub-basin	Weighted Percent of TMDL Sub-basin by Area	Percent of GEI Sub-basin	Weighted Percent of TMDL Sub-basin by Area	Percent of GEI Sub-basin	Weighted Percent of TMDL Sub-basin by Area	Sub-Total Percent of TMDL Sub-basin	Weighted Sediment Reduction Percentage Existing Conditions
	North Fork Bull River		Middle Fork Bull River		South Fork Bull River			
High	95	95 * 0.293 = 27.9	90	90 * 0.325 = 29.2	95	95 * 0.382 = 36.3	27.9+29.2+ 36.2 = 93.4	0.934 * 0.75 = 0.70
Moderate	5	5 * 0.293 = 1.5	10	10 * 0.325 = 3.3	5	5 * 0.382 = 1.9	1.5+3.3+1. 9 = 6.6	0.066 * 0.50 = 0.03
Low	0	0 * 0.293 = 0	0	0 * 0.293 = 0	0	0 * 0.293 = 0	0+0+0 = 0	0 * 0.30 = 0
None	0	0 * 0.293 = 0	0	0 * 0.293 = 0	0	0 * 0.293 = 0	0+0+0 = 0	0 * 0.10 = 0
Total	100		100		100		100	0.70 + 0.03 + 0 + 0 = 0.73
Therefore the sediment delivered to the stream is 1 – 0.73 = 0.27 or 27% of the total calculated sediment load.								

The riparian health assessment based Sediment Reduction Percentage computed for each sub-basin of interest is presented in **Table 1-5.** Values are presented for both the existing conditions scenario and a BMP scenario. Under the BMP scenario, it is assumed that the implementation of BMPs on those activities that affect the overall health of the vegetated riparian buffer will increase an area with moderate quality riparian health to high quality and an area with low quality riparian health would improve to moderate quality.

A riparian health assessment was not completed for the Elk Creek Idaho sub-basin. The Elk Creek Idaho sub-basin was assumed to be similar to the Elk Creek sub-basin and assigned a sediment delivery reduction of 41%.

Table 1-5 Sediment reduction percentage based on riparian health assessment.

Sub-Basin	Riparian Quality	Percent of TMDL Sub-Basin for Existing Conditions	Weighted Sediment Reduction Percentage Existing Conditions	Percent of TMDL Sub-Basin for BMP Conditions	Weighted Sediment Reduction Percentage BMP Conditions	Change in Sediment Reduction Percentage
Bull River Headwaters	High	93	70	100	75	
	Moderate	7	3	0	0	
	Low	0	0	0	0	
	None	0	0	0	0	
	Total	100	**73**	100	**75**	**2**
Dry Creek	High	35	26	65	49	
	Moderate	30	15	30	15	
	Low	30	9	0	0	
	None	5	1	5	1	
	Total	100	**51**	100	**65**	**14**
Upper Bull River West	High	35	26	65	49	
	Moderate	30	15	30	15	
	Low	30	9	0	0	
	None	5	1	5	1	
	Total	100	**51**	100	**65**	**14**
Upper Bull River East	High	70	53	95	71	
	Moderate	25	13	5	3	
	Low	5	2	0	0	
	None	0	0	0	0	
	Total	100	**68**	100	**74**	**6**
Lower Bull River	High	38	28	65	53	
	Moderate	33	16	60	23	
	Low	24	7	0	0	
	None	5	1	5	1	
	Total	100	**52**	100	**77**	**25**
Elk Creek Idaho	High	20	15	50	38	
	Moderate	30	15	45	23	
	Low	45	14	0	0	
	None	5	1	5	1	
	Total	100	**45**	100	**62**	**17**

Table 1-5 Sediment reduction percentage based on riparian health assessment.

Sub-Basin	Riparian Quality	Percent of TMDL Sub-Basin for Existing Conditions	Weighted Sediment Reduction Percentage Existing Conditions	Percent of TMDL Sub-Basin for BMP Conditions	Weighted Sediment Reduction Percentage BMP Conditions	Change in Sediment Reduction Percentage
East Fork Elk Creek	High	30	23	70	53	
	Moderate	40	20	25	13	
	Low	25	8	0	0	
	None	5	1	5	1	
	Total	100	**52**	100	**67**	**15**
Elk Creek	High	20	15	50	38	
	Moderate	30	15	45	23	
	Low	45	14	0	0	
	None	5	1	5	1	
	Total	100	**45**	100	**62**	**17**
Swamp Creek	High	60	45	80	60	
	Moderate	20	10	15	8	
	Low	15	5	0	0	
	None	5	1	5	1	
	Total	100	**61**	100	**69**	**8**
Marten Creek	High	22	16	70	52	
	Moderate	48	24	22	11	
	Low	22	7	0	0	
	None	8	1	8	1	
	Total	100	**48**	100	**64**	**16**
White Pine Creek	High	40	30	70	53	
	Moderate	30	15	20	10	
	Low	20	6	0	0	
	None	10	1	10	1	
	Total	100	**52**	100	**64**	**12**

1.5.10.3 Sediment Delivery Ratio - Example Calculation

To create a final, subwatershed specific SDR, Megahan and Ketcheson's dimensionless equation relating percent sediment volume to percent travel distance (**Figure 1-8**) was scaled to each subwatershed by using its riparian health assessment based 100 ft Sediment Reduction Percentage to derive a site specific maximum sediment travel distance. For each subwatershed, the following method was applied:

1 From the subwatershed's Riparian Health Assessment, determine the expected % sediment delivery across a nominal 100 foot wide riparian zone.

Example:
Per Table 1-5, the Bull River Headwaters subwatershed's expected sediment delivery across a **100** foot wide riparian zone is (100%-73% reduction) = **27%** delivered.

2 Substitute the expected % sediment delivery across a 100 foot wide riparian zone into Megahan and Ketcheson's dimensionless sediment volume vs travel distance equation.

Example:
Volume% = 103.62exp(-((D/Dtotal)*100)/32.88) -5.55 =

27% = 103.62exp(-((**100**/Dtotal)*100)/32.88) -5.55

3 Solve the M&K equation for Dtotal to arrive at a representative maximum sediment travel distance for that subwatershed.

Example:
27% = 103.62exp(-((**100**/Dtotal)*100)/32.88) -5.55

Dtotal = **100**/(-0.3288*ln((**27**+5.55)/103.62))

Dtotal = **263** feet

4 Restate the M&K equation using the subwatershed's calculated maximum sediment travel distance (Dtotal) to arrive at an integrated Distance and Riparian Health based Sediment Deliver Ratio (SDR) for that subwatershed.

Example:
Within the Bull River Headwaters subwatershed, the SDR for an analytical pixel with a drainage path to the nearest stream of length **D** would be given by:

Volume% = 103.62exp(-((D/263)*100)/32.88) -5.55

By this method, the Sediment Delivery Ratio for each analytical pixel in a Lower Clark Fork Tributaries subwatershed is obtained by evaluating this equation:

***SDR** = 103.62*EXP(-((**D/Dtotal**)/32.88))-5.55*

Where:

SDR = the percentage of sediment generated from the pixel that is delivered to a stream,
D = the downslope distance from the pixel to the nearest stream channel, and
Dtotal = the subwatershed specific Riparian Health derived maximum sediment travel distance.

1.5.11 Model Assumptions

The following assumptions are made, concerning the applicability and accuracy of the model with respect to the intended use of the results:

1. That the USLE model is sufficiently accurate for TMDL purposes. Discussion: The USLE model has been in widespread use for more than thirty years, and has been found to be sufficient for natural resources management decision making at the field scale.

2. That it is appropriate to extend the field scale USLE model to watershed scale. Discussion: Many watershed scale implementations of the USLE model have been developed and presented in the peer reviewed literature. This model is a similar gridded USLE implementation, and it faithfully executes the methodology specified in USDA Agriculture Handbook No. 703. It operates in field scale on a 10 meter analytic pixel, and achieves watershed scale implementation through aggregation of field scale results.
3. That the data sources used are appropriate for USLE parameterization. Discussion: Data sources for USLE R and K factors were purpose built for that use. The USLE C factor is derived from Landsat thematic mapper imagery, classified by a rigorous process of peer reviewed methods into the NLCD landcover dataset. Specific assignment of C factors to landcover classes was performed under the guidance of natural resource professional well versed in the application of USLE and USLE based sediment production models at the field scale. The USLE P factor was not used, as the best professional judgement of these same land managers is that the agricultural practices intended to be reflected by the USLE P factor are not in significant use in the Lower Clark Fork watershed. The USLE L&S factors are mathematical constructs representing landform, and are derived here from Digital Terrain data. This analysis assumes that a 10 meter analytic pixel adequately describes the micro terrain slope and slope length at field scale. To the extent that this assumption is not met, results may deviate.
4. That the Riparian Health Assessment is of sufficient accuracy, resolution and coverage to serve as the basis for a sediment delivery ratio. Discussion: The Riparian Health Assessment only surveyed mainstem reaches. The condition of mainstem reaches is considered here to be broadly representative of overall watershed condition. To the extent that this assumption is not met, results may deviate proportionately.
5. That it is appropriate to use Megehan and Ketcheson’s (1996) dimensionless equation relating sediment travel distance and delivered volume as the basis for a sediment delivery ratio. Discussion: Megehan and Ketcheson (1996) establishes that the purpose of the work is to provide an empirical alternative to process based modeling approaches for sediment delivery to streams. A decade later, Megehan and Ketcheson went on to produce the Washington Road Surface Erosion Model (WARSEM, 2004) which uses the Megehan and Ketcheson (1996) dimensionless equation as an SDR to account for delivery across fillslopes to streams. Here, we replicate Megehan and Ketcheson’s use of the three variable dimensionless equation for the WARSEM SDR, evaluating that equation for a representative maximum sediment travel distance, and arriving at a scaled distance/sediment delivery relationship.

   A specific concern is that the Megehan and Ketcheson method, because it does not explicitly account for changes in vegetation as might be expected transitioning an upland/riparian zone boundary, may not adequately represent sediment delivery across a riparian zone. We note that whereas Megehan and Ketcheson used a single scaling of the dimensionless equation for all locations in an attempt to render the WARSEM model broadly applicable with minimum data collection needs, we take advantage of the available Lower Clark Fork Riparian Health Assessment data to derive site-specific scalings of the dimensionless equation for Lower Clark Fork subwatersheds, based on riparian condition.

In this implementation, it is assumed that a significant difference in vegetation density between riparian and upland is unlikely to favor the upland, i.e. if there is a great difference, it is going to be a well vegetated near-stream zone paired with a sparsely vegetated upland. The most extreme instance of that would be reflected in this modeling approach as a 'good' riparian health category. For that category, we evaluate the dimensionless equation using the literature values of 90% sediment reduction at 100 feet, deriving a Dtotal value that may be used to estimate the % sediment reduction at all distances. If failing to explicitly account for a significant change in vegetation produces a 'bust' in this procedure, it will be that it somewhat underestimates the sediment delivered from the upland portion of the delivery path. Given that:

- the maximum % delivery for that portion of the path is 10%, declining to 0% at the outer bound, and
- that vegetation is only one component of the obstruction value, and
- that the obstruction value is only one of the factors predictive for sediment delivery,

we may conclude that the maximum effect of such a vegetation difference induced 'bust' is, in the most extreme case, some small fraction of 10%. Working down from that rare, most extreme case - if riparian condition and immediately adjacent upland condition are more similar, the potential magnitude of a 'bust' rooted in their difference becomes smaller as well. This places potential error in sediment due to the riparian transition well within the bounds of this effort.

6. That the uncalibrated watershed scale USLE model and sediment delivery ratio are sufficiently accurate for Lower Clark Fork TMDL purposes. Discussion: The USLE is an empirical model developed initially for eastern US crop lands, but has been extended via revised C factors and other means to be more broadly applicable. The C factors used for this effort were chosen to be as representative of Lower Clark Fork conditions as professional judgement allows. The Megehan and Ketcheson dimensionless equation was similarly developed as an empirical method for sediment delivery accounting in watersheds similar to the Lower Clark Fork. The implementation of that SDR method used here is further fit to the Lower Clark Fork project area with the use of site specific scaling factors. Both components of the model remain uncalibrated to local conditions however, in the sense that these attempts to better represent the Lower Clark Fork watershed have not been tested empirically. Use of the results for relative comparison (as between subwatersheds or alternative management scenarios) is well supported. Use of the results as predictors of absolute sediment load should be undertaken with care. Though both the USLE and the Megehan and Ketcheson SDR are currently in widespread use for absolute

prediction of sediment load, local verification of predictive power is (as here) rarely undertaken.

1.6 Results

1.6.1 Management Scenarios

Figures 1-10 through 1-13 present the USLE based hillslope model's prediction of existing and potential conditions graphically. **Tables 1-6 through 1-10** present the prediction of existing and potential conditions numerically, broken out by 6th code HUC (as modified to represent the 303d listed streams) and existing land cover type. **Tables 1-6 through 1-10** also present the delivered sediment load cumulative totals within the watershed. The cumulative totals for a sub-basin are a sum of the results for that sub-basin plus the sub-basins upstream of it. For example, Lower Bull River is a sum of the results for that sub-basin plus the results for Upper Bull River East, Upper Bull River West, Dry Creek, and Bull River Headwaters.

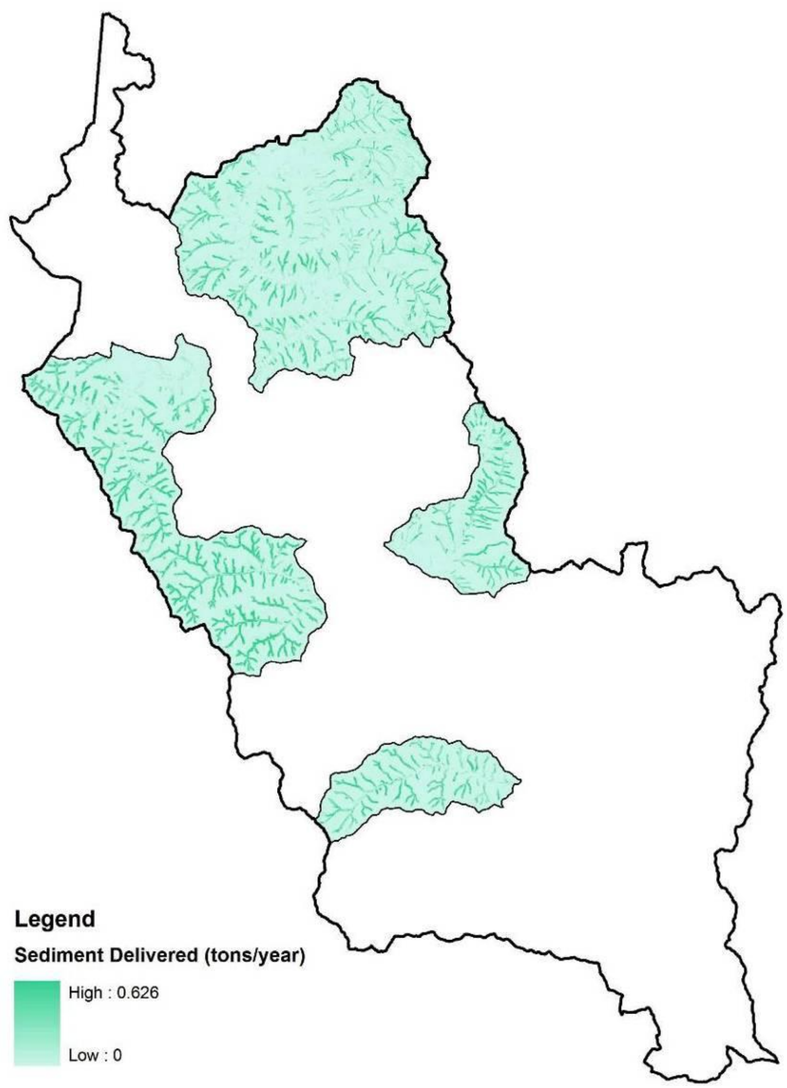

Figure 1-10. Upland Erosion Sediment Load for Existing Conditions Scenario 1.

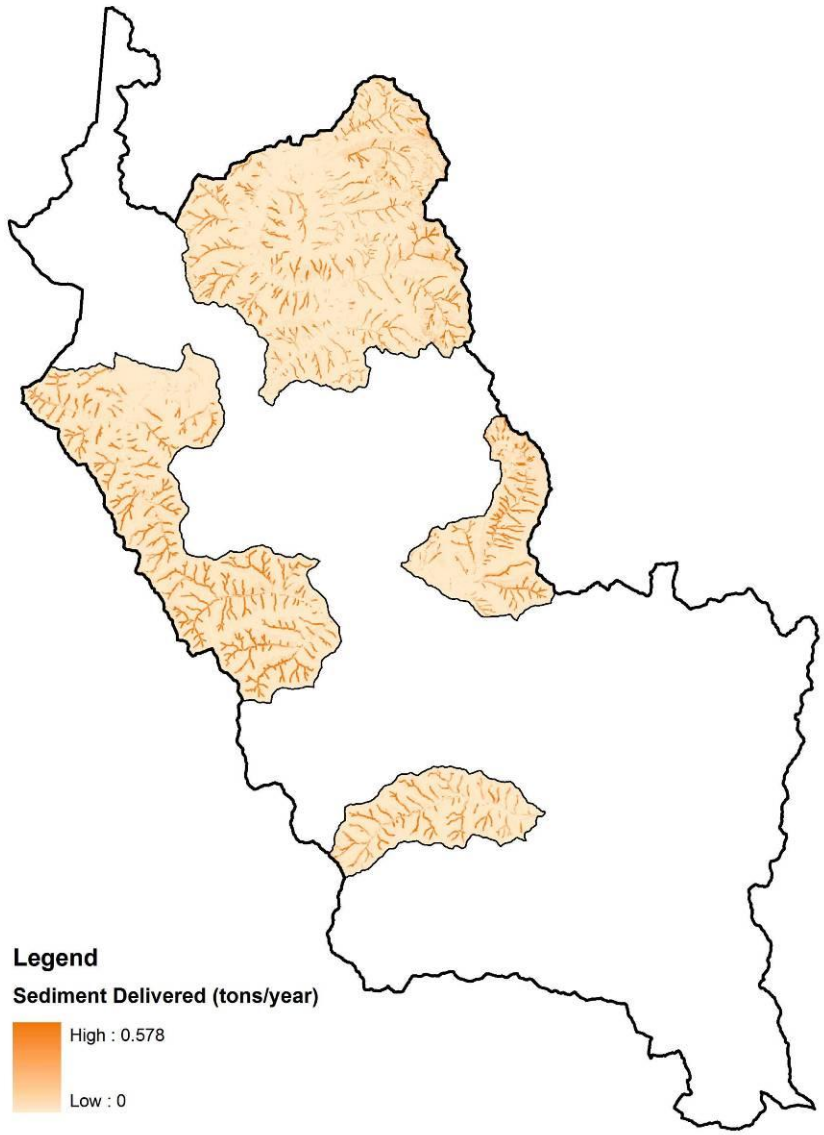

Figure 1-11. Upland Erosion Sediment Load for Existing Upland Conditions and BMP Riparian Health Conditions Scenario 2.

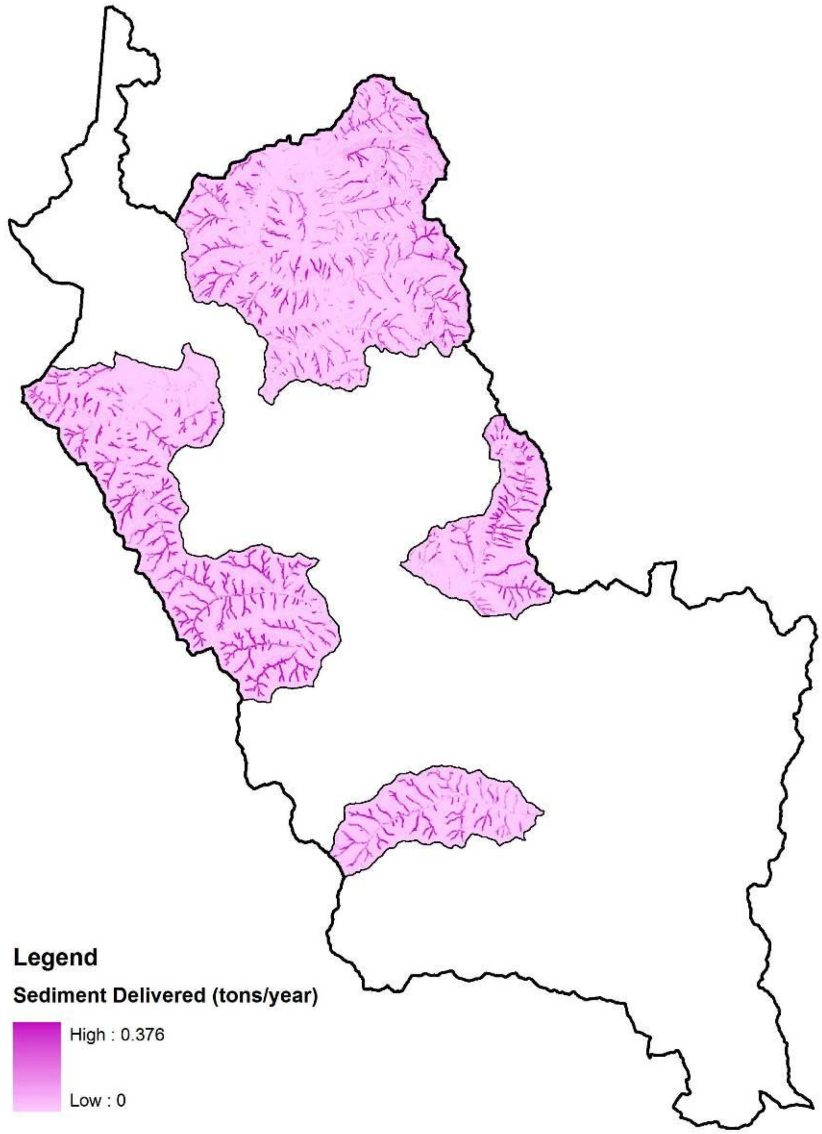

Figure 1-12. Upland Erosion Sediment Load for BMP Upland and Riparian Health Conditions Scenario 3.

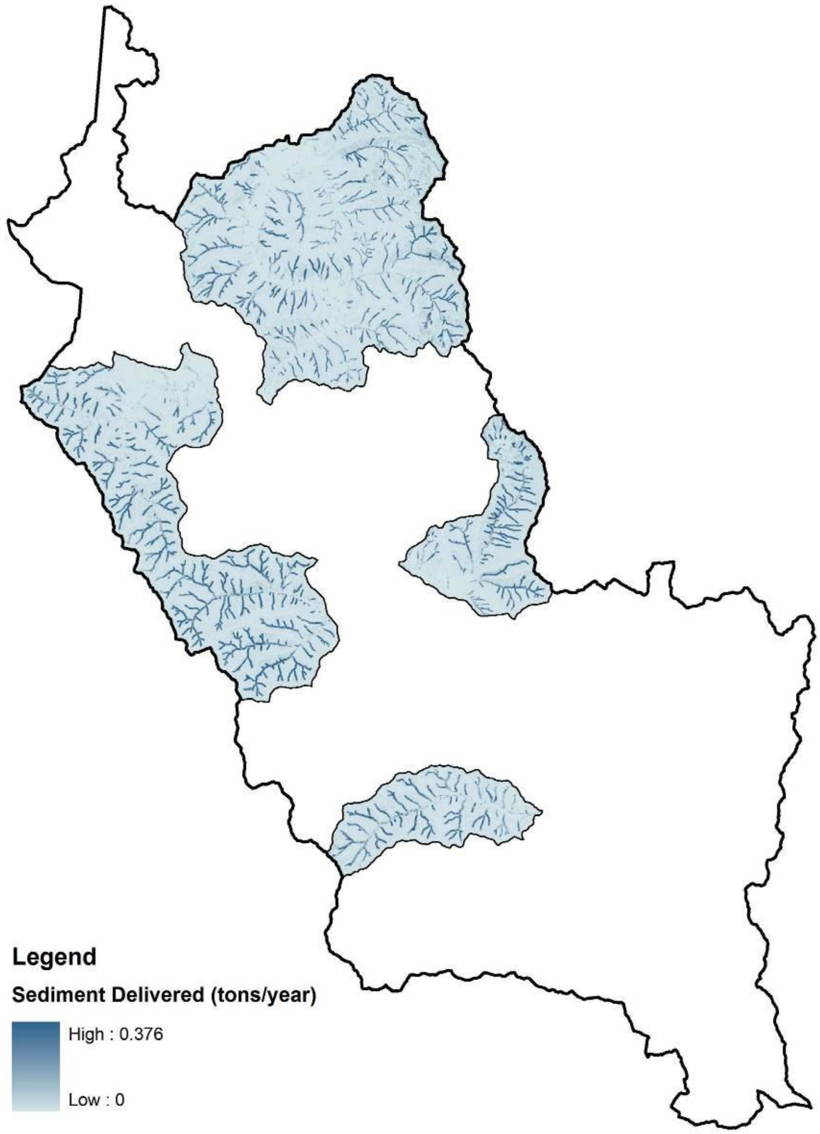

Figure 1-13. Upland Erosion Sediment Load for Natural Conditions Scenario 4.

Table 1-6 Delivered Sediment Load by Land Cover Type for the Bull River Watershed

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Bull River Headwaters	Evergreen Forest	19,670	1,086.4	1,027.6	5%	1,027.6	5%	1,027.6	5%
	Shrub/Scrub	2,201	251.2	240.2	4%	240.2	4%	240.2	4%
	Transitional	28	0.6	0.6	0%	0.3	50%	0.3	50%
	Grassland/Herbaceous	1,737	416.2	399.1	4%	259.4	38%	259.4	38%
	Emergent Herbaceous Wetland	1	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Woody Wetlands	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Barren Land	363	4.9	4.7	4%	4.7	4%	4.7	4%
	Developed, Open Space	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Deciduous Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Low Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Pasture/Hay	2	0.8	0.8	3%	0.5	37%	0.1	86%
	Mixed Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**24,002**	**1,760.0**	**1,673.0**	**5%**	**1,532.7**	**13%**	**1,532.3**	**13%**
Dry Creek	Evergreen Forest	5,157	453.8	313.9	31%	313.9	31%	313.9	31%
	Shrub/Scrub	238	23.7	14.7	38%	14.7	38%	14.7	38%
	Transitional	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Grassland/Herbaceous	29	5.2	2.9	45%	1.9	64%	1.9	64%
	Emergent Herbaceous Wetland	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Woody Wetlands	1	0.1	0.1	19%	0.1	19%	0.1	19%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Deciduous Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Low Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Pasture/Hay	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Mixed Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**5,426**	**482.7**	**331.5**	**31%**	**330.5**	**32%**	**330.5**	**32%**

*Value is below reporting limit.

Table 1-6 Delivered Sediment Load by Land Cover Type for the Bull River Watershed (continued)

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Upper Bull River West	Evergreen Forest	22,760	1,979.8	1,365.7	31%	1,365.7	31%	1,365.7	31%
	Shrub/Scrub	2,748	390.7	272.4	30%	272.4	30%	272.4	30%
	Transitional	1,121	134.8	92.6	31%	46.3	66%	46.3	66%
	Grassland/Herbaceous	218	36.8	25.3	31%	16.4	55%	16.4	55%
	Emergent Herbaceous Wetland	707	4.6	2.9	36%	2.9	36%	2.9	36%
	Woody Wetlands	486	2.2	1.4	34%	1.4	34%	1.4	34%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	187	8.1	4.9	39%	4.9	39%	4.9	39%
	Deciduous Forest	31	9.7	7.7	20%	7.7	20%	7.7	20%
	Developed, Low Intensity	68	0.7	0.5	34%	0.5	34%	1.4	-98%
	Pasture/Hay	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Mixed Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Cultivated Crops	4	1.3	1.0	19%	0.6	49%	0.0*	99%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**28,330**	**2,568.6**	**1,774.4**	**31%**	**1,718.9**	**33%**	**1,719.2**	**33%**
Upper Bull River East	Evergreen Forest	14,454	1,095.9	878.0	20%	878.0	20%	878.0	20%
	Shrub/Scrub	1,750	558.3	455.2	18%	455.2	18%	455.2	18%
	Transitional	3	0.1	0.1	0%	0.0	50%	0.0	50%
	Grassland/Herbaceous	570	179.4	154.9	14%	100.7	44%	100.7	44%
	Emergent Herbaceous Wetland	9	0.2	0.2	23%	0.2	23%	0.2	23%
	Woody Wetlands	5	0.1	0.1	23%	0.1	23%	0.1	23%
	Barren Land	17	0.1	0.1	0%	0.1	0%	0.1	0%
	Developed, Open Space	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Deciduous Forest	30	14.1	11.7	17%	11.7	17%	11.7	17%
	Developed, Low Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Pasture/Hay	4	1.7	1.4	17%	0.9	46%	0.2	88%
	Mixed Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**16,841**	**1,849.8**	**1,501.5**	**19%**	**1,446.8**	**22%**	**1,446.1**	**22%**

*Value is below reporting limit.

Table 1-6 Delivered Sediment Load by Land Cover Type for the Bull River Watershed (continued)

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Lower Bull River	Evergreen Forest	14,376	1,212.9	644.0	47%	644.0	47%	644.0	47%
	Shrub/Scrub	1,221	188.4	100.3	47%	100.3	47%	100.3	47%
	Transitional	44	0.7	0.7	0%	0.3	50%	0.3	50%
	Grassland/Herbaceous	35	30.6	15.0	51%	9.7	68%	9.7	68%
	Emergent Herbaceous Wetland	156	1.2	0.6	48%	0.6	48%	0.6	48%
	Woody Wetlands	171	3.7	1.9	49%	1.9	49%	1.9	49%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	143	3.4	1.6	52%	1.6	52%	1.6	52%
	Deciduous Forest	90	16.1	8.6	47%	8.6	47%	8.6	47%
	Developed, Low Intensity	29	0.2	0.1	59%	0.1	59%	0.3	-22%
	Pasture/Hay	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Mixed Forest	6	0.4	0.2	53%	0.2	53%	0.2	53%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**16,269**	**1,457.6**	**772.9**	**47%**	**767.3**	**47%**	**767.5**	**47%**
Bull River Total	Evergreen Forest	76,417	5,828.7	4,229.1	27%	4,229.1	27%	4,229.1	27%
	Shrub/Scrub	8,158	1,412.2	1,082.8	23%	1,082.8	23%	1,082.8	23%
	Transitional	1,196	136.1	93.9	31%	46.9	66%	46.9	66%
	Grassland/Herbaceous	2,589	668.1	597.1	11%	388.1	42%	388.1	42%
	Emergent Herbaceous Wetland	873	6.0	3.7	38%	3.7	38%	3.7	38%
	Woody Wetlands	663	6.1	3.5	43%	3.5	43%	3.5	43%
	Barren Land	380	5.0	4.8	4%	4.8	4%	4.8	4%
	Developed, Open Space	330	11.6	6.6	0%	6.6	0%	6.6	0%
	Deciduous Forest	151	39.9	28.0	30%	28.0	30%	28.0	30%
	Developed, Low Intensity	97	0.9	0.6	0%	0.6	0%	1.7	0%
	Pasture/Hay	6	2.5	2.2	12%	1.4	43%	0.3	87%
	Mixed Forest	6	0.4	0.2	0%	0.2	0%	0.2	0%
	Cultivated Crops	4	1.3	1.0	0%	0.6	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**90,869**	**8,118.8**	**6,053.4**	**25%**	**5,796.3**	**29%**	**5,795.7**	**29%**

*Value is below reporting limit. Note: Results for the Bull River Total sub-basin is a sum of the results for the Bull River Headwaters, Dry Creek, Upper Bull River West, Upper Bull River East, and Lower Bull River sub-basins.

Table 1-7 Delivered Sediment Load by Land Cover Type for the Elk Creek Watershed

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Elk Creek Idaho	Evergreen Forest	3,632	468.7	285.8	39%	285.8	39%	285.8	39%
	Shrub/Scrub	350	92.6	49.1	47%	49.1	47%	49.1	47%
	Transitional	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Grassland/Herbaceous	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Emergent Herbaceous Wetland	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Woody Wetlands	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Deciduous Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Low Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Pasture/Hay	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Mixed Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**3,982**	**561.3**	**334.9**	**40%**	**334.9**	**40%**	**334.9**	**40%**
East Fork Elk Creek	Evergreen Forest	14,782	2,041.5	1,305.2	36%	1,305.2	36%	1,305.2	36%
	Shrub/Scrub	860	240.6	136.2	43%	136.2	43%	136.2	43%
	Transitional	290	16.6	11.4	31%	5.7	66%	5.7	66%
	Grassland/Herbaceous	14	12.8	5.0	61%	3.3	75%	3.3	75%
	Emergent Herbaceous Wetland	102	2.0	1.3	36%	1.3	36%	1.3	36%
	Woody Wetlands	2	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Deciduous Forest	27	6.1	3.4	44%	3.4	44%	3.4	44%
	Developed, Low Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Pasture/Hay	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Mixed Forest	5	0.6	0.3	53%	0.3	53%	0.3	53%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**16,082**	**2,320.3**	**1,462.8**	**37%**	**1,455.3**	**37%**	**1,455.3**	**37%**

*Value is below reporting limit.

Table 1-7 Delivered Sediment Load by Land Cover Type for the Elk Creek Watershed (continued)

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Elk Creek	Evergreen Forest	13,633	1,056.6	648.9	39%	648.9	39%	648.9	39%
	Shrub/Scrub	1,897	216.3	120.2	44%	120.2	44%	120.2	44%
	Transitional	598	80.5	47.4	41%	23.7	71%	23.7	71%
	Grassland/Herbaceous	134	1.3	0.4	65%	0.3	77%	0.3	77%
	Emergent Herbaceous Wetland	374	8.3	5.0	40%	5.0	40%	5.0	40%
	Woody Wetlands	96	1.0	0.5	47%	0.5	47%	0.5	47%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	1	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Deciduous Forest	71	11.3	6.1	46%	6.1	46%	6.1	46%
	Developed, Low Intensity	9	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Pasture/Hay	3	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Mixed Forest	13	0.4	0.2	44%	0.2	44%	0.2	44%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**16,828**	**1,375.8**	**828.9**	**40%**	**805.1**	**41%**	**805.1**	**41%**
Elk Creek Total	Evergreen Forest	32,047	3,566.9	2,239.9	37%	2,239.9	37%	2,239.9	37%
	Shrub/Scrub	3,106	549.5	305.5	44%	305.5	44%	305.5	44%
	Transitional	888	97.1	58.8	39%	29.4	70%	29.4	70%
	Grassland/Herbaceous	148	14.1	5.4	61%	3.5	75%	3.5	75%
	Emergent Herbaceous Wetland	476	10.3	6.2	39%	6.2	39%	6.2	39%
	Woody Wetlands	97	1.0	0.6	46%	0.6	46%	0.6	46%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	1	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Deciduous Forest	98	17.4	9.5	45%	9.5	45%	9.5	45%
	Developed, Low Intensity	9	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Pasture/Hay	3	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Mixed Forest	18	1.0	0.5	50%	0.5	50%	0.5	50%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**36,892**	**4,257.4**	**2,626.5**	**38%**	**2,595.2**	**39%**	**2,595.3**	**39%**

*Value is below reporting limit. Note: Results for the Elk Creek Total sub-basin is a sum of the results for the Elk Creek Idaho, East Fork Elk Creek, and Elk Creek sub-basins.

Table 1-8 Delivered Sediment Load by Land Cover Type for the Swamp Creek Watershed

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Swamp Creek	Evergreen Forest	18,620	1,779.0	1,428.5	20%	1,428.5	20%	1,428.5	20%
	Shrub/Scrub	2,780	534.4	420.5	21%	420.5	21%	420.5	21%
	Transitional	65	10.8	8.2	24%	4.1	62%	4.1	62%
	Grassland/Herbaceous	961	282.4	228.2	19%	148.4	47%	148.4	47%
	Emergent Herbaceous Wetland	153	1.7	1.4	17%	1.4	17%	1.4	17%
	Woody Wetlands	94	1.0	0.8	19%	0.8	19%	0.8	19%
	Barren Land	11	0.1	0.1	0%	0.1	0%	0.1	0%
	Developed, Open Space	38	0.7	0.5	26%	0.5	26%	0.5	26%
	Deciduous Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Low Intensity	12	0.0*	0.0*	0%	0.0*	0%	0.1	-113%
	Pasture/Hay	55	6.8	5.5	18%	3.6	47%	0.8	88%
	Mixed Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Cultivated Crops	6	2.0	1.5	24%	0.9	53%	0.0*	99%
	Developed, Medium Intensity	1	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Total	**22,796**	**2,618.9**	**2,095.4**	**20%**	**2,008.9**	**23%**	**2,005.3**	**23%**

*Value is below reporting limit.

Table 1-9 Delivered Sediment Load by Land Cover Type for the Marten Creek Watershed									
			Scenario 1	**Scenario 2**		**Scenario 3**		**Scenario 4**	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
Marten Creek	Evergreen Forest	26,174	4,226.5	2,627.7	38%	2,627.7	38%	2,627.7	38%
	Shrub/Scrub	2,312	890.0	534.1	40%	534.1	40%	534.1	40%
	Transitional	763	114.4	70.9	38%	35.4	69%	35.4	69%
	Grassland/Herbaceous	85	42.5	18.7	56%	12.1	71%	12.1	71%
	Emergent Herbaceous Wetland	167	5.5	3.4	38%	3.4	38%	3.4	38%
	Woody Wetlands	20	0.9	0.6	36%	0.6	36%	0.6	36%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	5	1.2	0.6	51%	0.6	51%	0.6	51%
	Deciduous Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Low Intensity	3	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Pasture/Hay	2	0.0*	0.0*	0%	0.0*	0%	0.0*	0%
	Mixed Forest	5	1.0	0.4	64%	0.4	64%	0.4	64%
	Cultivated Crops	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**29,536**	**5,282.0**	**3,256.2**	**38%**	**3,214.2**	**39%**	**3,214.3**	**39%**

*Value is below reporting limit.

Table 1-10 Delivered Sediment Load by Land Cover Type for the White Pine Creek Watershed

			Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Sub-basin	**Land Cover Classification**	**Area (acres)**	Upland Erosion Sediment Load for **Existing** Conditions and **Existing** Riparian Health **(tons/year)**	Upland Erosion Sediment Load for **Existing** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **BMP** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**	Upland Erosion Sediment Load for **Natural** Conditions and **BMP** Riparian Health **(tons/year)**	**Percent Change from Existing**
White Pine Creek	Evergreen Forest	16,706	1,628.7	1,167.0	28%	1,167.0	28%	1,167.0	28%
	Shrub/Scrub	1,139	160.4	107.0	33%	107.0	33%	107.0	33%
	Transitional	1,650	124.5	85.9	31%	42.9	66%	42.9	66%
	Grassland/Herbaceous	285	60.9	42.4	30%	27.6	55%	27.6	55%
	Emergent Herbaceous Wetland	149	1.2	0.8	29%	0.8	29%	0.8	29%
	Woody Wetlands	5	0.2	0.1	29%	0.1	29%	0.1	29%
	Barren Land	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Open Space	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Deciduous Forest	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Developed, Low Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Pasture/Hay	22	0.3	0.3	18%	0.2	46%	0.0*	88%
	Mixed Forest	3	0.1	0.1	0%	0.1	0%	0.1	0%
	Cultivated Crops	2	1.5	1.1	27%	0.7	54%	0.0*	99%
	Developed, Medium Intensity	0	0.0	0.0	0%	0.0	0%	0.0	0%
	Total	**19,961**	**1,977.7**	**1,404.6**	**29%**	**1,346.4**	**32%**	**1,345.6**	**32%**

*Value is below reporting limit.

1.6.2 Historic Scenario

Figure 1-14 presents the historic timber harvest and forest fire event polygons, color coded according to decadal groupings.

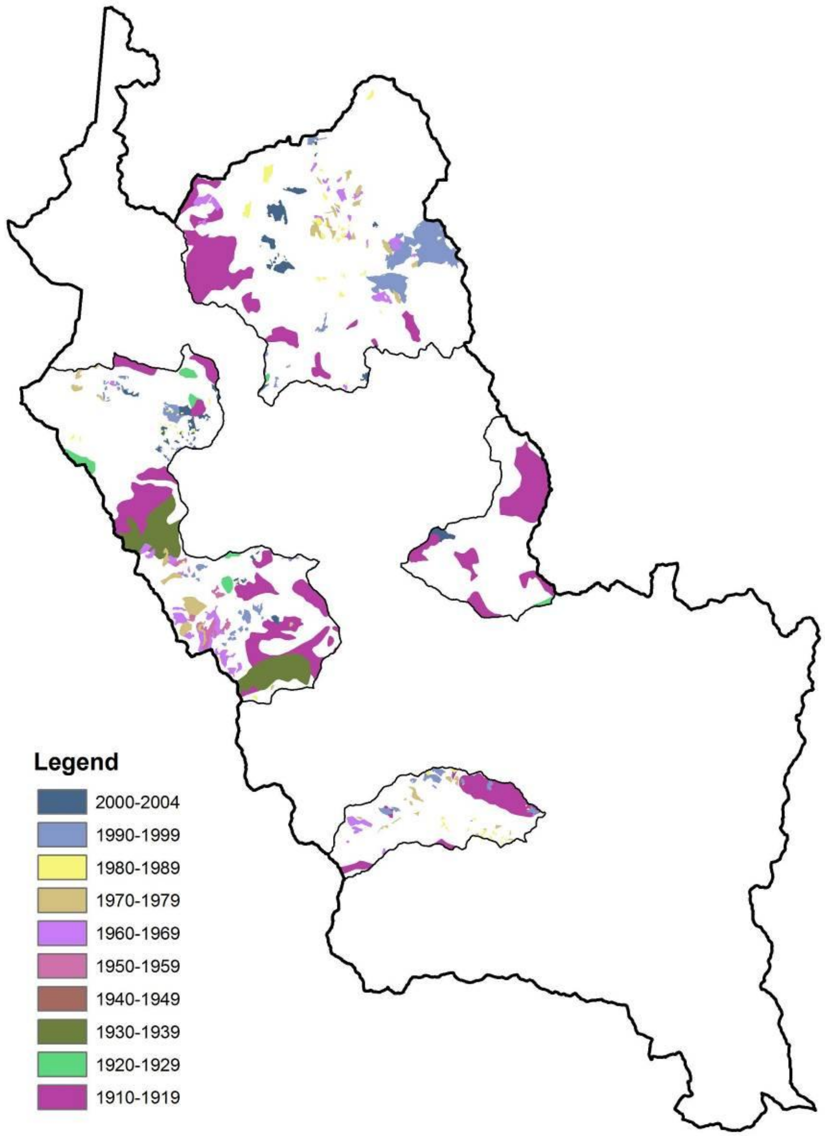

Figure 1-14. Areas that have been logged or burned for a given decade within the Lower Clark Fork Tributaries watershed.

Figure 1-15 presents the estimated annualized sediment delivery to streams from the 'transitional' landcover category for each decadal grouping, broken out by sub watershed. It thus presents the influence of timber harvest and fire events on those subwatersheds for the time periods of interest. **Figure 1-16** presents the total estimated annualized sediment delivery to streams for each decadal grouping, broken out by sub watershed. This permits evaluation of the effects of historic fire and logging on individual subwatersheds, as well as comparison to existing conditions estimates.

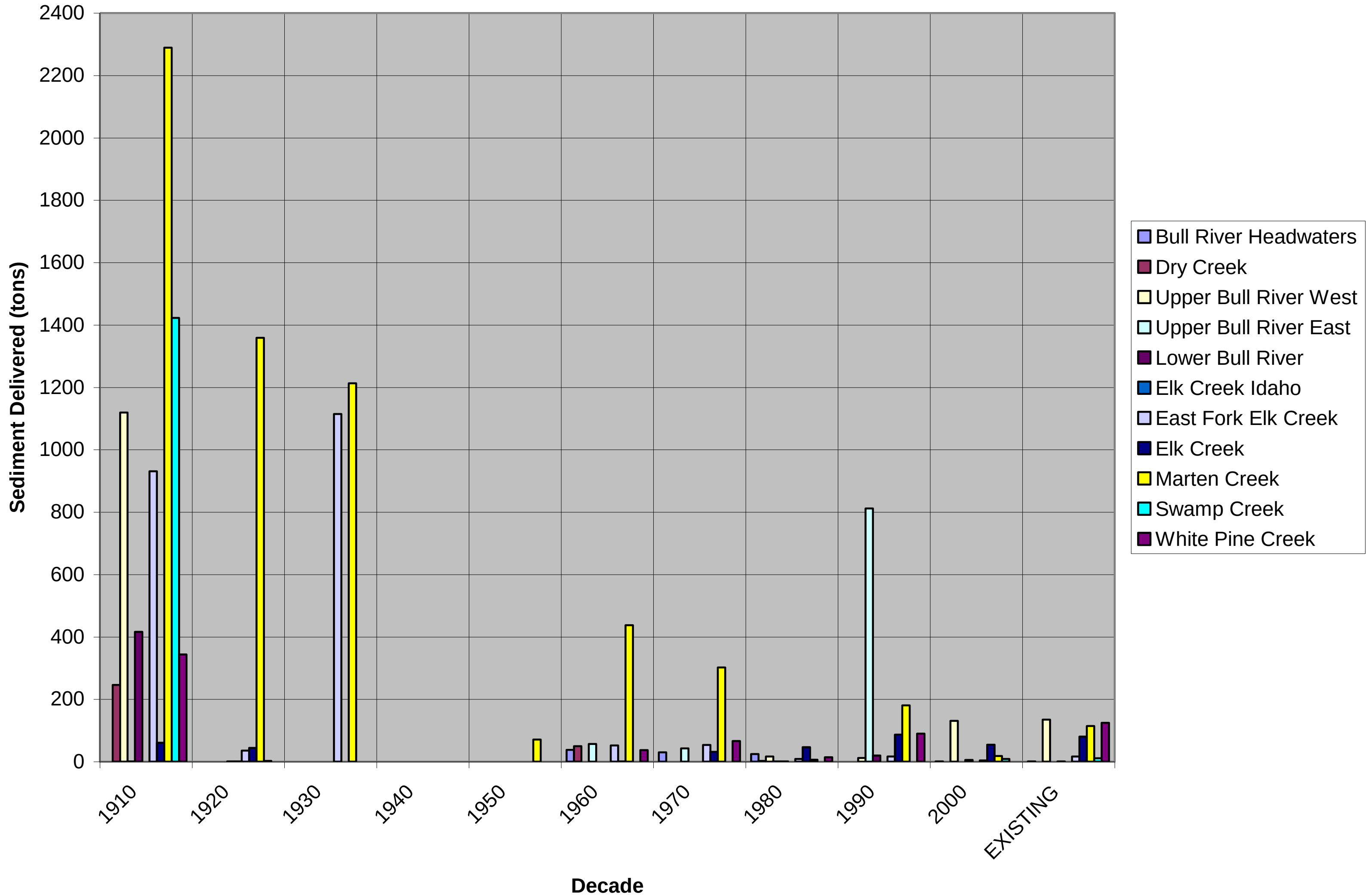

Figure 1-15. Estimated quantity of sediment delivered to the streams from the transitional land use areas within each sub-basin for each decade evaluated.

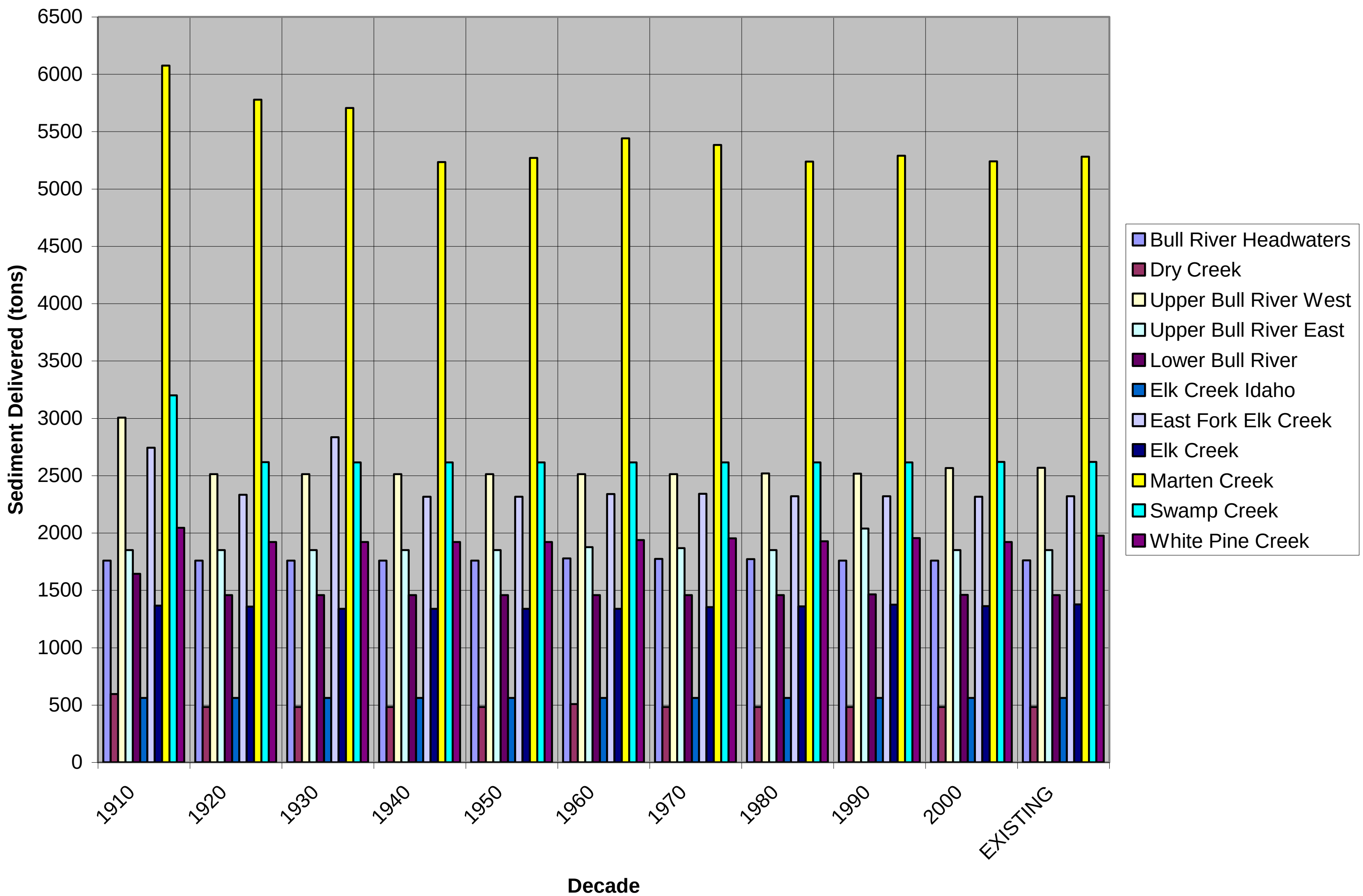

Figure 1-16. Total estimated quantity of sediment delivered to the streams from all land use areas within each sub-basin for each decade evaluated.

Table 1-11 through **Table 1-15** present the estimated sediment delivered from annual timber harvest and/or fire events for each decadal grouping, for each sub watershed. Results are broken out by landcover categories 'transitional' (includes the fire and harvest areas) and 'other' (all other lancovers/land uses). The results from each decade with the most significant effect from annual events are presented in bold.

The following are some general observations of the Historic Scenario results:

- The 1910 fire affected the most sub-basins and covered the largest area.
- For the Lower Clark Fork Tributaries TMDL sub-basins, there were no reported logging or fires in the decade 1940-1949.
- From 1910-1939, the predominant transitional polygon type was fire.
- After 1960, the predominant transitional polygon type was timber harvest.
- The Marten Creek sub-basin has experienced a large fire or harvest impact in almost every decade reviewed, except 1940-1949 and 1980-1989.
- Most events in most sub watersheds have marginal estimated effect on total sediment delivered for the watershed as a whole. Severe events such as the 1910 fires are estimated here to have resulted in a 20-30% increase in annual sediment delivery.

Table 1-11 Estimated sediment delivered from annual events within each decade for the Marten Creek Watershed.

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Marten Creek	**1910-1919**	**Other**	**3,785.7**	**22,537**	**76%**
		Transitional	**2,288.9**	**6,993**	**24%**
	1920-1929	Other	4,419.0	26,501	90%
		Transitional	1,358.7	3,028	10%
	1930-1939	Other	4,492.1	26,836	91%
		Transitional	1,213.0	2,694	9%
	1940-1949	Other	5,234.7	29,530	100%
		Transitional	0.0	0	0%
	1950-1959	Other	5,199.0	28,890	98%
		Transitional	70.6	640	2%
	1960-1969	Other	5,004.7	28,338	96%
		Transitional	437.4	1,192	4%
	1970-1979	Other	5,081.6	28,605	97%
		Transitional	302.3	925	3%
	1980-1989	Other	5,231.6	29,481	100%
		Transitional	6.1	49	0%
	1990-1999	Other	5,108.3	28,973	98%
		Transitional	180.8	557	2%
	2000-2004	Other	5,222.1	29,379	99%
		Transitional	18.1	151	1%
	Existing	Other	5,167.7	28,773	97%
		Transitional	114.4	763	3%

Table 1-12 Estimated sediment delivered from annual events within each decade for the Bull River Watershed.

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Bull River Headwaters	1910-1919	Other	1,759.7	24,001	100%
		Transitional	0.0	0	0%
	1920-1929	Other	1,759.7	24,001	100%
		Transitional	0.0	0	0%
	1930-1939	Other	1,759.7	24,001	100%
		Transitional	0.0	0	0%
	1940-1949	Other	1,759.7	24,001	100%
		Transitional	0.0	0	0%
	1950-1959	Other	1,759.7	24,001	100%
		Transitional	0.0	0	0%
	1960-1969	**Other**	**1,740.7**	**23,611**	**98%**
		Transitional	**38.0**	**391**	**2%**
	1970-1979	Other	1,744.4	23,426	98%
		Transitional	29.8	575	2%
	1980-1989	Other	1,746.6	23,712	99%
		Transitional	24.5	289	1%
	1990-1999	Other	1,759.7	24,001	100%
		Transitional	0.0	0	0%
	2000-2004	Other	1,759.4	23,973	100%
		Transitional	0.6	28	0%
	Existing	Other	1,759.5	23,974	100%
		Transitional	0.6	28	0%
Dry Creek	**1910-1919**	**Other**	**349.0**	**3,956**	**73%**
		Transitional	**246.0**	**1,470**	**27%**
	1920-1929	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	1930-1939	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	1940-1949	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	1950-1959	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	1960-1969	Other	457.9	5,069	93%
		Transitional	49.3	357	7%
	1970-1979	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	1980-1989	Other	481.2	5,359	99%
		Transitional	2.3	68	1%
	1990-1999	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	2000-2004	Other	482.7	5,426	100%
		Transitional	0.0	0	0%
	Existing	Other	482.7	5,426	100%
		Transitional	0.0	0	0%

Table 1-12 Estimated sediment delivered from annual events within each decade for the Bull River Watershed (continued).

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Upper Bull River West	**1910-1919**	**Other**	**1,885.7**	**23,657**	**83%**
		Transitional	**1,119.3**	**4,675**	**17%**
	1920-1929	Other	2,511.6	28,329	100%
		Transitional	0.0	0	0%
	1930-1939	Other	2,511.6	28,329	100%
		Transitional	0.0	0	0%
	1940-1949	Other	2,511.6	28,329	100%
		Transitional	0.0	0	0%
	1950-1959	Other	2,511.6	28,329	100%
		Transitional	0.0	0	0%
	1960-1969	Other	2,511.5	28,290	100%
		Transitional	0.1	38	0%
	1970-1979	Other	2,511.6	28,329	100%
		Transitional	0.0	0	0%
	1980-1989	Other	2,502.7	28,029	99%
		Transitional	16.3	299	1%
	1990-1999	Other	2,505.7	28,214	100%
		Transitional	11.8	114	0%
	2000-2004	Other	2,435.6	27,266	96%
		Transitional	131.1	1,063	4%
	Existing	Other	2,433.8	27,209	96%
		Transitional	134.8	1,121	4%
Upper Bull River East	1910-1919	Other	1,849.3	16,811	100%
		Transitional	0.8	29	0%
	1920-1929	Other	1,849.7	16,840	100%
		Transitional	0.0	0	0%
	1930-1939	Other	1,849.7	16,840	100%
		Transitional	0.0	0	0%
	1940-1949	Other	1,849.7	16,840	100%
		Transitional	0.0	0	0%
	1950-1959	Other	1,849.7	16,840	100%
		Transitional	0.0	0	0%
	1960-1969	Other	1,819.9	16,361	97%
		Transitional	56.9	479	3%
	1970-1979	Other	1,825.3	16,517	98%
		Transitional	42.7	322	2%
	1980-1989	Other	1,849.2	16,817	100%
		Transitional	1.1	23	0%
	1990-1999	**Other**	**1,226.1**	**12,909**	**77%**
		Transitional	**811.9**	**3,931**	**23%**
	2000-2004	Other	1,849.7	16,837	100%
		Transitional	0.1	3	0%
	Existing	Other	1,849.7	16,838	100%
		Transitional	0.1	3	0%

Table 1-12 Estimated sediment delivered from annual events within each decade for the Bull River Watershed (continued).

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Lower Bull River	**1910-1919**	**Other**	**1,227.3**	**14,716**	**90%**
		Transitional	**416.2**	**1,549**	**10%**
	1920-1929	Other	1,456.8	16,210	100%
		Transitional	1.1	54	0%
	1930-1939	Other	1,457.3	16,264	100%
		Transitional	0.0	0	0%
	1940-1949	Other	1,457.3	16,264	100%
		Transitional	0.0	0	0%
	1950-1959	Other	1,457.3	16,264	100%
		Transitional	0.0	0	0%
	1960-1969	Other	1,457.1	16,241	100%
		Transitional	0.4	24	0%
	1970-1979	Other	1,457.3	16,264	100%
		Transitional	0.0	0	0%
	1980-1989	Other	1,456.9	16,222	100%
		Transitional	0.8	42	0%
	1990-1999	Other	1,444.9	16,083	99%
		Transitional	19.4	181	1%
	2000-2004	Other	1,454.0	16,155	99%
		Transitional	5.4	109	1%
	Existing	Other	1,457.0	16,226	100%
		Transitional	0.7	44	0%
Bull River Total	**1910-1919**	**Other**	**7,071.1**	**83,141**	**92%**
		Transitional	**1,782.3**	**7,723**	**8%**
	1920-1929	Other	8,060.6	90,806	100%
		Transitional	1.1	54	0%
	1930-1939	Other	8,061.2	90,860	100%
		Transitional	0.0	0	0%
	1940-1949	Other	8,061.2	90,860	100%
		Transitional	0.0	0	0%
	1950-1959	Other	8,061.2	90,860	100%
		Transitional	0.0	0	0%
	1960-1969	Other	7,987.2	89,572	99%
		Transitional	144.7	1,288	1%
	1970-1979	Other	8,021.4	89,962	99%
		Transitional	72.5	898	1%
	1980-1989	Other	8,036.6	90,139	99%
		Transitional	45.0	721	1%
	1990-1999	Other	7,419.2	86,633	95%
		Transitional	843.1	4,226	5%
	2000-2004	Other	7,981.5	89,657	99%
		Transitional	137.1	1,203	1%
	Existing	Other	7,982.7	89,673	99%
		Transitional	136.1	1,196	1%

Table 1-13 Estimated sediment delivered from annual events within each decade for the Elk Creek Watershed.

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Elk Creek Idaho	1910-1919	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	1920-1929	**Other**	**561.1**	**3,945**	**99%**
		Transitional	**0.5**	**36**	**1%**
	1930-1939	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	1940-1949	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	1950-1959	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	1960-1969	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	1970-1979	Other	561.2	3,967	100%
		Transitional	0.2	14	0%
	1980-1989	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	1990-1999	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	2000-2004	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
	Existing	Other	561.3	3,981	100%
		Transitional	0.0	0	0%
East Fork Elk Creek	1910-1919	Other	1,811.3	13,026	81%
		Transitional	931.1	3,054	19%
	1920-1929	Other	2,298.0	15,898	99%
		Transitional	35.2	181	1%
	1930-1939	**Other**	**1,721.4**	**12,772**	**79%**
		Transitional	**1,114.2**	**3,308**	**21%**
	1940-1949	Other	2,315.6	16,079	100%
		Transitional	0.0	0	0%
	1950-1959	Other	2,315.6	16,078	100%
		Transitional	0.0	1	0%
	1960-1969	Other	2,287.3	15,804	98%
		Transitional	51.8	275	2%
	1970-1979	Other	2,288.8	15,966	99%
		Transitional	53.5	113	1%
	1980-1989	Other	2,311.4	16,051	100%
		Transitional	8.4	28	0%
	1990-1999	Other	2,303.9	16,015	100%
		Transitional	16.4	65	0%
	2000-2004	Other	2,312.9	15,962	99%
		Transitional	4.2	117	1%
	Existing	Other	2,303.7	15,792	98%
		Transitional	16.6	290	2%

Table 1-13 Estimated sediment delivered from annual events within each decade for the Elk Creek Watershed (continued).

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Elk Creek	1910-1919	Other	1,306.2	15,405	92%
		Transitional	60.6	1,422	8%
	1920-1929	Other	1,313.2	16,232	96%
		Transitional	44.2	594	4%
	1930-1939	Other	1,337.6	16,826	100%
		Transitional	0.0	0	0%
	1940-1949	Other	1,337.6	16,826	100%
		Transitional	0.0	0	0%
	1950-1959	Other	1,337.6	16,826	100%
		Transitional	0.0	0	0%
	1960-1969	Other	1,337.0	16,789	100%
		Transitional	0.9	37	0%
	1970-1979	Other	1,321.8	16,625	99%
		Transitional	31.5	201	1%
	1980-1989	Other	1,312.5	16,689	99%
		Transitional	46.7	137	1%
	1990-1999	**Other**	**1,288.0**	**16,303**	**97%**
		Transitional	**87.1**	**523**	**3%**
	2000-2004	Other	1,308.6	16,327	97%
		Transitional	54.3	499	3%
	Existing	Other	1,295.3	16,230	96%
		Transitional	80.5	598	4%
Elk Creek Total	**1910-1919**	**Other**	**3,678.9**	**32,412**	**88%**
		Transitional	**991.7**	**4,475**	**12%**
	1920-1929	Other	4,172.3	36,075	98%
		Transitional	79.8	811	2%
	1930-1939	Other	3,620.3	33,579	91%
		Transitional	1,114.2	3,308	9%
	1940-1949	Other	4,214.6	36,886	100%
		Transitional	0.0	0	0%
	1950-1959	Other	4,214.6	36,885	100%
		Transitional	0.0	1	0%
	1960-1969	Other	4,185.6	36,574	99%
		Transitional	52.7	312	1%
	1970-1979	Other	4,171.8	36,558	99%
		Transitional	85.2	328	1%
	1980-1989	Other	4,185.2	36,721	100%
		Transitional	55.1	165	0%
	1990-1999	Other	4,153.3	36,299	98%
		Transitional	103.5	588	2%
	2000-2004	Other	4,182.8	36,270	98%
		Transitional	58.4	616	2%
	Existing	Other	4,160.3	36,003	98%
		Transitional	97.1	888	2%

Table 1-14 Estimated sediment delivered from annual events within each decade for the Swamp Creek Watershed.

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
Swamp Creek	**1910-1919**	**Other**	**1,777.4**	**16,775**	**74%**
		Transitional	**1,422.7**	**6,015**	**26%**
	1920-1929	Other	2,614.0	22,654	99%
		Transitional	2.7	136	1%
	1930-1939	Other	2,615.3	22,776	100%
		Transitional	0.3	15	0%
	1940-1949	Other	2,615.4	22,791	100%
		Transitional	0.0	0	0%
	1950-1959	Other	2,615.4	22,791	100%
		Transitional	0.0	0	0%
	1960-1969	Other	2,615.4	22,791	100%
		Transitional	0.0	0	0%
	1970-1979	Other	2,615.4	22,791	100%
		Transitional	0.0	0	0%
	1980-1989	Other	2,615.4	22,791	100%
		Transitional	0.0	0	0%
	1990-1999	Other	2,615.4	22,791	100%
		Transitional	0.0	0	0%
	2000-2004	Other	2,609.4	22,523	99%
		Transitional	8.9	267	1%
	Existing	Other	2,608.1	22,731	100%
		Transitional	10.8	65	0%

Table 1-15 Estimated sediment delivered from annual events within each decade for the White Pine Creek Watershed.

Sub-Basin	Time Period	Land Use	Sediment Delivered (tons)	Area (acres)	% Area
White Pine Creek	**1910-1919**	**Other**	**1,701.5**	**16,711**	**84%**
		Transitional	**344.0**	**3,244**	**16%**
	1920-1929	Other	1,920.9	19,955	100%
		Transitional	0.0	0	0%
	1930-1939	Other	1,920.9	19,955	100%
		Transitional	0.0	0	0%
	1940-1949	Other	1,920.9	19,955	100%
		Transitional	0.0	0	0%
	1950-1959	Other	1,920.9	19,955	100%
		Transitional	0.0	0	0%
	1960-1969	Other	1,901.6	19,628	98%
		Transitional	37.1	327	2%
	1970-1979	Other	1,887.7	19,605	98%
		Transitional	66.1	350	2%
	1980-1989	Other	1,913.0	19,746	99%
		Transitional	14.5	209	1%
	1990-1999	Other	1,864.2	19,353	97%
		Transitional	90.1	602	3%
	2000-2004	Other	1,920.9	19,955	100%
		Transitional	0.0	0	0%
	Existing	Other	1,853.3	18,311	92%
		Transitional	124.5	1,650	8%

1.7 References

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Attachment A – Assignment of USLE C-factors to NLCD Landcover Values

The NRCS table "C-Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland" (Figure A-1) was used to develop C-factors for the various land use types as defined by the NLCD database within the Lower Clark Fork Tributaries watershed. This table uses four sub-factors: the vegetative canopy type and height, the vegetative canopy percent cover, the type of cover that contacts the soil surface, and the percent ground cover to derive a C-factor. The resulting C-factor is very sensitive to the type and percent of ground cover and less sensitive to the type and percent of canopy cover.

The type and percent of canopy cover were determined based on the NLCD land use definition. In some cases the minimum percent canopy cover specified in the land use definition was used and resulted in a conservative C-factor. The type of ground cover was considered to be G (cover is grass, grasslike plants, decaying compacted duff, or litter at least 2 inches deep) for all of the land uses in the Lower Clark Fork Tributaries watershed. The percent ground cover not only includes the basal plant material, but also gravel and plant litter. The percent ground cover for each of the land uses within the Lower Clark Fork Tributaries watershed was estimated by Confluence.

Table A-1 provides the C-factors for all land use types within the sub-basins of interest in the Lower Clark Fork Tributaries watershed for the existing conditions. The C-factors for the 'barren land', 'developed, low intensity', and 'developed, medium intensity' land uses are the same C-factors previously recommended by Richard Fasching, the NRCS Montana State Agronomist, for other hillslope USLE modeling efforts.

Table A-2 provides the C-factors for all land use types within the sub-basins of interest in the Lower Clark Fork Tributaries watershed for the desired well managed scenario. The percent ground cover was increased by 10% over the existing percentage for the 'grassland/herbaceous' and 'pasture/hay' land uses to reflect a decrease in grazing. For the 'cultivated crops' land use, the percent ground cover was increased by 20% over the existing percentage to reflect improved agricultural practices. For the 'transitional' land use, the desired scenario assumed a return to a forest land use. The C-factors for the other land use types were not changed. This is similar to the methods used by the DEQ for the Shields River watershed TMDL and by Confluence for other hillslope USLE modeling efforts.

Table A-3 provides the C-factors for all land use types within the sub-basins of interest in the Lower Clark Fork Tributaries watershed for the natural scenario. For all anthropogenic land uses, 'developed, open space', 'developed, low intensity', 'developed, medium intensity', 'cultivated crops' and 'pasture/hay', the natural scenario assumed a conversion to forest or woody wetland land use (both forest and woody wetland have the same c-factor). These are the assumed land uses of these areas before they were influenced by humans.

These tables were reviewed and approved by NRCS (Neal Svendsen) and USFS (Craig Neesvig) employees familiar with the Lower Clark Fork Tributaries watershed.

Exhibit MT510.03

"C" Factors for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland 1/

Vegetal Canopy			Cover that Contacts the Surface (Vegetation, living and dead)					
Type and Height of Raised Canopy 2/	Canopy Cover 3/ %	Type 4/	Percent Ground Cover					
			0	20	40	60	80	95-100
No appreciable canopy		G	.45	.20	.10	.042	.013	.003
		W	.45	.24	.15	.090	.043	.011
Canopy of tall grass, weeds or brushes with average drop fall height of less than 3 feet 5/	25	G	.36	.17	.09	.038	.012	.003
		W	.36	.20	.13	.082	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.075	.039	.011
	75	G	.17	.10	.06	.031	.011	.003
		W	.17	.12	.09	.067	.038	.011
Appreciable brush or bushes (2 m fall ht.)	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.085	.042	.011
	50	G	.34	.16	.085	.038	.012	.003
		W	.34	.19	.13	.081	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.077	.040	.011
Trees but no appreciable low brush (4 m fall ht.)	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.087	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.085	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.083	.041	.011

1/ All values shown assume: 1) random distribution of mulch or vegetation, and 2) mulch of appreciable depth where it exists. Idle land refers to land with undisturbed profiles for at least a period of three consecutive years. Also to be used for burned forest land and forest land that has been harvested less than three years ago.

For grazed woodland with high buildup of organic matter in the topsoil under permanent forest conditions, multiply the table values by 0.7.

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4/ G: Cover at surface is grass, grasslike plants, decaying compacted duff.
W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface), and/or undecayed residue.

5/ The portion of a grass or weed cover that contacts the soil surface during a rainstorm and interferes with water flow over the soil surface is included in "cover at the surface." The remainder is included in canopy cover.

Figure A-1. NRCS C-factor table

Table A-1 C-factors for land cover types in the Lower Clark Fork Tributaries watershed for existing conditions.

NLCD #	Name	Type and Height of Raised Canopy	Percent Canopy Cover[1]	Type	Percent Ground Cover	C-factor	Percent of Watershed
42	Evergreen forest	trees	75	G	95-100	0.003	84.7%
52	Shrub/scrub	appreciable brush	25	G	85	0.008	8.7%
N/A	Transitional	no appreciable canopy	-	G	90	0.006	2.6%
71	Grassland/herbaceous	no appreciable canopy	-	G	75	0.020	2.0%
95	Emergent Herbaceous Wetlands	tall grass	75	G	95-100	0.003	0.9%
90	Woody Wetlands	trees	25	G	95-100	0.003	0.4%
31	Barren land	-	-	-	-	0.001	0.19%
21	Developed, open space	no appreciable canopy	-	G	95-100	0.003	0.18%
41	Deciduous forest	trees	75	G	95-100	0.003	0.12%
22	Developed, low intensity	-	-	-	-	0.001	0.06%
81	Pasture/Hay	no appreciable canopy	-	G	75	0.020	0.04%
43	Mixed forest	trees	75	G	95-100	0.003	0.02%
82	Cultivated Crops	no appreciable canopy	-	G	20	0.240	0.01%
23	Developed, medium intensity	-	-	-	-	0.001	0.001%

Notes:
1) Canopy cover percents were selected based on the land cover class definition.

Table A-2 C-factors for land cover types in the Lower Clark Fork Tributaries watershed for desired conditions.

NLCD #	Name	Type and Height of Raised Canopy	Percent Canopy Cover[1]	Type	Percent Ground Cover	C-factor	Percent of Watershed
42	Evergreen forest	trees	75	G	95-100	0.003	84.7%
52	Shrub/scrub	appreciable brush	25	G	85	0.008	8.7%
N/A	Transitional	trees	75	G	95-100	0.003	2.6%
71	Grassland/herbaceous	no appreciable canopy	-	G	85	0.013	2.0%
95	Emergent Herbaceous Wetlands	tall grass	75	G	95-100	0.003	0.9%
90	Woody Wetlands	trees	25	G	95-100	0.003	0.4%
31	Barren land	-	-	-	-	0.001	0.19%
21	Developed, open space	no appreciable canopy	-	G	95-100	0.003	0.18%
41	Deciduous forest	trees	75	G	95-100	0.003	0.12%
22	Developed, low intensity	-	-	-	-	0.001	0.06%
81	Pasture/Hay	no appreciable canopy	-	G	85	0.013	0.04%
43	Mixed forest	trees	75	G	95-100	0.003	0.02%
82	Cultivated Crops	no appreciable canopy	-	G	40	0.150	0.01%
23	Developed, medium intensity	-	-	-	-	0.001	0.001%

Notes:

1) Canopy cover percents were selected based on the land cover class definition.

Table A-3 C-factors for land cover types in the Lower Clark Fork Tributaries watershed for natural conditions.

NLCD #	Name	Type and Height of Raised Canopy	Percent Canopy Cover[1]	Type	Percent Ground Cover	C-factor	Percent of Watershed
42	Evergreen forest	trees	75	G	95-100	0.003	84.7%
52	Shrub/scrub	appreciable brush	25	G	85	0.008	8.7%
N/A	Transitional	trees	75	G	95-100	0.003	2.6%
71	Grassland/herbaceous	no appreciable canopy	-	G	85	0.013	2.0%
95	Emergent Herbaceous Wetlands	tall grass	75	G	95-100	0.003	0.9%
90	Woody Wetlands	trees	25	G	95-100	0.003	0.4%
31	Barren land	-	-	-	-	0.001	0.19%
21	Developed, open space	trees	75	G	95-100	0.003	0.18%
41	Deciduous forest	trees	75	G	95-100	0.003	0.12%
22	Developed, low intensity	trees	75	G	95-100	0.003	0.06%
81	Pasture/Hay	trees	25	G	95-100	0.003	0.04%
43	Mixed forest	trees	75	G	95-100	0.003	0.02%
82	Cultivated Crops	trees	25	G	95-100	0.003	0.01%
23	Developed, medium intensity	trees	75	G	95-100	0.003	0.001%

Notes:
1) Canopy cover percents were selected based on the land cover class definition.