APPENDIX J
SEDIMENT LOADING AND ALLOCATION ANALYSIS

This appendix summarizes the methods used to determine the sediment load estimates from hillslope and stream bank erosion and the allocation of those loads to land uses in the Middle Blackfoot-Nevada Creek planning area. Hillslope erosion loading was estimated using the Soil Water Assessment Tool (SWAT) model to obtain an initial estimate of loading by listed segment. A description of the SWAT model, its setup, calibration, and validation for use in the planning area is contained in **Appendix I**.

Stream bank erosion was estimated for sediment impaired stream segments using field data collected from selected assessment sites within each segment. The field assessment method was a modification of the Bank Erosion Hazard Index (BEHI) method of Rosgen (2000). The details of the methodology and procedures for extrapolation from surveyed sites to non-surveyed stream reaches are described in a separate document by DTM and AGI (2005).

Hillslope Erosion Loading Estimates and Adjustments

Sediment loading from hillslope erosion was estimated through use of the SWAT model. Model output included the number of tons of hillslope sediment delivered annually from each of 65 planning area subbasins. Due to large differences between subbasin land surface slope and stream channel slope, the channel transport capacity algorithms of the model allowed only a fraction of delivered hillslope sediment to be transported by channel processes. This sediment "bottle-necking" effect is due to the large slope variability within each subbasin and the model's assignment of a single subbasin slope value that, in most cases, is an order of magnitude greater than the channel slope. Steep, uniform slopes exaggerate sediment routing to the channel. Because of the coarse SWAT characterization of slope, sediment delivery could not be calibrated with channel sediment transport. At this point, SWAT model output for mean annual sediment loading from each hydrologic response unit or HRU (an HRU is a landcover-soil unit combination) becomes more narrowly a tool for estimating loads rather than simulating a sediment budget for the watershed. Because high average subbasin slopes exaggerate sediment yields, adjustments were needed to better quantify loading from sheet erosion directly entering the channel. Therefore, the SWAT estimates were adjusted downward to reflect the fractional area of sediment contributing HRUs that is likely to deliver sediment to the channel network of listed streams and their tributaries.

The surface erosion component of SWAT uses MUSLE to quantify sediment transported by overland flow as sheet erosion. Overland flow is water moving down slope as an irregular sheet prior to concentration in defined channels. Though estimates vary, the slope length over which overland flow occurs is usually less than 400 feet (McCuen 1998). A distance criterion of 350 feet and a slope criterion of greater than 3% were used in this analysis to obtain the fraction of each subbasin area likely to contribute sediment through sheet erosion to channels. GIS tools were used to define a 350-foot buffer and classify slopes greater than 3% on sediment impaired streams and their tributaries. The fraction, calculated by dividing the area of sediment contributing HRUs within the buffer by the total area of those HRUs in the subbasin, was used to adjust the SWAT subbasin sediment yields. These values are labeled as adjusted sheetflow area yields and given by listed stream segment in **Table J-1**. These adjusted yields were next apportioned into naturally occurring and controllable components.

The naturally occurring load was assumed to be that delivered with adequate vegetative filter conditions in place on contributing land cover types (HRUs). The SWAT buffering tool was used to apply this filtering condition to sediment contributing HRUs. The USDA filter strip practice standard for Powell County (USDA 2004) recommends a 35-foot filter width on moderate (4-7%) slopes to minimize sediment, particulate organics, and sediment-adsorbed contaminants. A filter width of 35 feet (11 m) was selected to represent adequate application of a sediment reducing management practice. Application of the filter through the SWAT model estimated a uniform loading reduction of 25%.

This 25% reduction is significantly lower than those reported in the literature. Sediment removal efficiency relationships developed by Castelle and Johnson (2000) estimated near 80% sediment removal and 65% particulate organic matter removal across a comparable buffer width. Research on buffers in southwest Montana by Hook (2003) reported greater than 90% removal of coarse textured sediment with a six meter buffer on bunchgrass uplands. A sediment reduction efficiency of 75% was assumed to represent naturally occurring loading conditions for this analysis. This value better reflects those reported in the literature and is closer to results reported for Montana settings while allowing for some hillslope loading from developed land. With 75% removal, 25% of the adjusted hillslope sediment yield is the assumed naturally occurring load representing the annual maximum loads from hillslope erosion in **Table J-1**. The remaining 75% of the adjusted hillslope load is assumed to be controllable by land management activities.

The initial SWAT hillslope sediment yields and the adjusted sheetflow area loads for each stream segment in **Table J-1** are displayed discretely. The discrete listing illustrates the degree of yield adjustment according to the fraction of total sediment contributing HRU area in the subbasin that is within the sheetflow area. After the sheetflow area adjustment, values for sheetflow area yield, naturally occurring loads and controllable loads are added cumulatively in **Table J-1** from the headwaters to the downstream outlets of listed segments. The cumulative naturally occurring load is the portion of the cumulative sheetflow area yield that is delivered to the stream channel from background hillslope erosion processes and from erosion processes on developed land with assumed application of all reasonable land, soil, and water conservation practices.

Using the lower Washington Creek values as an example, the SWAT model estimated loads of 407 tons/yr in upper Washington Creek and 22 tons/yr in lower Washington Creek are reduced by their respective sheetflow area fractions of 0.150 and 0.247. The respective loads from the sheetflow areas of the two segments are then 61 tons and five tons per year. The value of 67 tons per year for cumulative sheetflow area load in lower Washington Creek in **Table J-1** is the sum of 61 tons from upper Washington Creek and five tons from lower Washington Creek, rounded upward to the nearest whole number. The cumulative naturally occurring load of 17 tons per year in lower Washington Creek is the sum of 15.25 naturally occurring tons (61 tons times 0.25) contributed from upper Washington Creek, plus 1.25 tons (5 tons times 0.25) contributed from the lower Washington Creek segment, rounded to the nearest whole number. The cumulative controllable load of 50 tons/yr in lower Washington Creek is the sum of the upper Washington sheetflow area load of 61 tons multiplied by 0.75 (46 tons) and the lower Washington sheetflow area load of five tons multiplied by 0.75 (4 tons). The 0.75 multiplier is the value used to define the fraction of loading that can be removed by an effective vegetative buffer.

Table J-1. Hillslope Sediment Yield Adjustment and Partitioning into Naturally Occurring and Potential Human-Caused Components

Stream Name	Initial SWAT Sediment Load Estimate (tons/yr)	Sheetflow Source Area Fraction	Adjusted Sheetflow Area Load (tons/yr)	Cumulative Sheetflow Area Load (tons/yr)	Cumulative Naturally Occurring Load (tons/yr)	Cumulative Controllable Load (tons/yr)
Nevada Creek Planning Area						
Upper Washington Creek	407	0.150	61	61	15	46
Lower Washington Creek	22	0.247	5	67	17	50
Upper Jefferson Creek	482	0.654	315	315	79	236
Lower Jefferson Creek	2	0.000	0	315	79	236
Gallagher Creek	459	0.541	248	248	62	186
Buffalo Gulch	1,002	0.366	366	366	92	275
Upper Nevada Creek	2,125	0.859	1,826	2,822	705	2,116
Braziel Creek	182	0.392	71	71	18	53
Black Bear Creek	328	0.766	252	252	63	189
Murray Creek	6,486	0.770	4,997	4,997	1,249	3,748
Upper Douglas Creek	2,934	0.310	908	6,159	1,539	4,618
Cottonwood Creek	8,319	0.479	3988	3,988	977	2,991
Lower Douglas Creek	2,989	0.626	1,871	12,018	3,004	9,013
Nevada Spring Creek	0	0.000	0	0	0	0
McElwain Creek	507	0.459	233	233	58	175
Lower Nevada Creek	631	0.481	303	15,444	3,861	11,584
Middle Blackfoot Planning Area						
Yourname Creek	732	0.344	252	252	63	189
Wales Creek	174	0.172	30	30	8	22
Frazier Creek	103	0.193	20	20	5	15
Ward Creek	176	0.269	47	47	12	36
Kleinschmidt Creek	29	0.056	2	49	12	37
Rock Creek	20,397	0.113	2,307	2,356	589	1,767
North Fork Blackfoot River	53,040	0.226	11,992	14,348	3,587	10,761
Warren Creek	270	0.088	24	24	6	18
Monture Creek	1,928	0.248	478	478	120	359
Blackfoot River (Nevada Cr. to Monture Cr.)	33	0.576	19	30,617	7655	22,962
Chamberlain Creek	1,081	0.263	285	285	71	214

Table J-1. Hillslope Sediment Yield Adjustment and Partitioning into Naturally Occurring and Potential Human-Caused Components

Stream Name	Initial SWAT Sediment Load Estimate (tons/yr)	Sheetflow Source Area Fraction	Adjusted Sheetflow Area Load (tons/yr)	Cumulative Sheetflow Area Load (tons/yr)	Cumulative Naturally Occurring Load (tons/yr)	Cumulative Controllable Load (tons/yr)
Cottonwood Creek	2,950	0.449	1,325	1,325	331	994
Richmond	91	0.020	2	2	0.5	1.4
West Fork Clearwater	1392	0.133	186	186	46	139
Deer Creek	2,770	0.418	1,157	1,157	289	868
Buck Creek	225	0.028	6	6	2	4
Blanchard Creek	410	0.130	53	53	13	40
Unimpaired Clearwater	25,198	0.215	5,405	5,405	1,351	4,054
Blackfoot River (Monture Cr. to Clearwater R.)	1,432	0.491	703	39,738	9,935	29,803

With the adjustments, the total SWAT subbasin yield of 26,875 tons/yr (**Table 5-51**) for the Nevada Creek planning area was reduced by 42% to 15,444 tons/yr; the corresponding reduction for the Middle Blackfoot planning area was 78% from 112,430 to 24,292 tons/yr. The low discrete values for adjusted sheetflow yield for Lower Jefferson Creek, Nevada Spring Creek, and Kleinschmidt Creek are due to low hillslope yields in these subbasins. A similar situation occurs for Richmond Creek and Buck Creek in the Clearwater drainage.

Hillslope loading from sediment impaired streams in the Clearwater River drainage is included in **Table J-1** as estimates for Richmond Creek, West Fork of the Clearwater, Deer Creek, Buck Creek, and Blanchard Creek. These estimates were obtained by adjusting SWAT output for Clearwater subbasins according to the proportion of total subbasin area occurring within these impaired watersheds.

The estimated hillslope loading from the North Fork Blackfoot River, at 53,040 tons/yr, is an order of magnitude higher than that for any other stream. The overriding effects of precipitation and slope steepness on SWAT output account for the loading from this steep, high elevation watershed. About 60% of the drainage is within the Scapegoat Wilderness. Despite this large area with minimal human influence on sediment loading, the same multipliers of 0.25 and 0.75 identifying naturally occurring and controllable loading were applied to this and other unimpaired streams to quantifying total loading from the planning area. However, the "controllable" loads from unimpaired streams are assumed to result in minimal loading due to currently sufficient sediment filtering capacity. This assumption does not preclude consideration of future water quality improvement projects on these streams where specific improvements in field conditions can potentially reduce existing sediment loads.

Existing ground cover conditions within the sheet erosion source areas were assumed to have some sediment filtering capacity. Ground cover condition categories of "sparse," "moderate," or "dense" were assigned as part of the 2004 base parameter assessment (DTM and AGI 2005). With these ground cover conditions as guidance, 2005 aerial photography and ground photos taken during stream bank assessment work in 2004 were interpreted to estimate an existing filtering efficiency value for each stream. These values range from 0.50 to 0.85 and represent coarse estimates of the effect of current vegetation on sediment removal. When multiplied by the values for controllable load from each listed segment, the product is the controllable load reductions needed to reflect naturally occurring conditions from developed land. Since the sediment removal efficiency figures describe sediment filtering conditions adjacent to each listed stream segment, the reductions are applied to segment-specific loads in **Table J-2**. Reductions are not estimated for streams determined to be fully supporting.

Table J-2. Controllable Loads, Sediment Removal Efficiency and Hillslope Load Reductions For Listed Stream Segments in the Nevada Creek and Middle Blackfoot-Planning Areas

Stream Name	Controllable Load (tons/yr)	Existing Sediment Removal Efficiency	Needed Reductions to Controllable Load (tons/yr)
Nevada Creek Planning Area			
Upper Washington Creek	46	0.50	23
Lower Washington Creek	4	0.50	2
Upper Jefferson Creek	236	0.50	118
Lower Jefferson Creek	0.0	0.60	0.0
Gallagher Creek	186	0.55	84
Buffalo Gulch	275	0.55	124
Upper Nevada Creek	1369	0.60	548
Braziel Creek	54	0.50	27
Black Bear Creek	189	0.65	66
Murray Creek	3,748	0.65	1,312
Upper Douglas Creek	792	0.65	239
Cottonwood Creek	2,991	0.65	1,047
Lower Douglas Creek	1,403	0.60	561
Nevada Spring Creek	0	0.65	0
McElwain Creek	210	0.55	79
Lower Nevada Creek	227	0.65	80
Middle Blackfoot River Planning Area			
Yourname Creek	189	0.65	66
Wales Creek	22	0.60	9
Frazier Creek	15	0.55	7
Ward Creek	36	0.65	12
Kleinschmidt Creek	1.2	0.80	0.2
Rock Creek	1,730	0.60	692
Warren Creek	18	0.75	4
Monture Creek	359	0.85	54
Blackfoot River (Nevada Cr. to Monture Cr.)	14	0.75	4
Cottonwood Creek	994	0.70	298
Richmond Creek	1.4	0.75	0.3
West Fork Clearwater	139	0.85	21
Deer Creek	868	0.80	174
Blanchard Creek	40	0.60	16
Blackfoot River (Monture Cr. To Clearwater R.)	527	0.60	211

Considered cumulatively from upstream to downstream, existing sediment removal capacity in the Nevada Creek planning area reduces the controllable load by 63% from 11,584 to 4,308 tons per year. The corresponding reduction for the combined Middle Blackfoot-Nevada Creek planning areas is 69% from 29,803 to 9,186 tons per year.

The SWAT modeling framework included subbasin loading from the Blackfoot River headwaters planning area that extends upstream of the mouth of Nevada Creek. The model estimated the hillslope erosion yield in the Blackfoot River headwaters to be 25,182 ton/yr.

Adjusting this value by the 24% figure used in the Middle Blackfoot to account for the proportion the sediment yielding cover types that occur within the near stream sheetwash area, gives an adjusted headwaters hillslope yield of 6,044 tons per year for the headwaters. The assumed naturally occurring portion (25%) of this load is 1,511 tons, giving a controllable load value of 4,533 tons. Adjusting this value further to account for the estimated sediment removal efficiency of 0.65 provided by headwaters vegetation conditions gives a needed reduction in headwaters hillslope loading of 1,587 tons per year.

The SWAT model estimated loading from unlisted portions of the Clearwater drainage to be 25,198 tons per year. Approximately 21% of the unimpaired subbasin area is within the near-stream sediment contributing area, giving an adjusted sheetflow area load of 5,405 tons per year. The naturally occurring portion (25%) of this load equals 1,351 tons per year, leaving a controllable load of 4,054 tons. An assumed sediment removal efficiency of 0.75 attributable to current vegetation conditions further reduces the controllable load to 1,013 tons per year. **Table J-3** summarizes the total controllable, naturally occurring and needed reductions to hillslope erosion loading in the Middle Blackfoot-Nevada Creek TPA.

Table J-3. Summary of Estimated Controllable, Naturally Occurring and Needed Reductions to Hillslope Erosion Loading in the Middle Blackfoot-Nevada Creek Planning Area

Watershed Source Area	Controllable Load (tons/yr)	Naturally Occurring Load (tons/yr)	Needed Reduction (tons/yr)	Percent Needed Reduction in Controllable Load
Blackfoot Headwaters	4,533	1,511	1,587	35
Nevada Creek	11,584	3,861	4,308	37
Middle Blackfoot,	18,219	6,074	4878	27
Total	38,846	11,446	10,773	28

Stream Bank Erosion Loading

The base parameter and stream bank erosion inventory project undertaken in 2004 (DTM and AGI, 2005) included direct measurement of sediment from eroding banks on representative reaches of 303(d) Listed streams. **Section 5** of this document and **Appendix C** describe the assessment methodology and results. The Bank Erosion Hazard Index method of Rosgen (2000) was used to obtain measured values for reach specific stream bank erosion rates. Measurements of total bank erosion were partitioned into controllable and background components by assuming a degree of improvement in selected stream bank dimensional and condition parameters that would occur in the absence human influence. The difference between the measured rate and the rate reflecting no human influence defined the controllable load.

Impaired streams in the Clearwater River watershed that were not included in the 2004 reach assessment effort include Richmond Creek, the West Fork of the Clearwater River and Deer Creek. Stream bank sediment contributions from these streams were estimated by the modeled relationship between measured values and upstream precipitation. The controllable fraction of 31%, derived from both the Nevada Creek and Middle Blackfoot stream bank assessment effort was applied to the Clearwater River tributaries to define their background and controllable loads.

Table J-4 contains an upstream to downstream accounting of the total stream bank loads, controllable loads, and background loading for assessed reaches and listed segments of Nevada Creek planning area streams. The total, controllable, and background contributions from listed stream segments are entered cumulatively in the last three columns of the table. Values for individual listed streams with upstream loading can be obtained by subtracting the given upstream loads. **Table J-5** contains the stream bank loading for the Middle Blackfoot planning area. The estimated stream bank sediment load of 12,453 tons/yr from controllable sources in the combined Nevada Creek and Middle Blackfoot planning areas is 33% of the total annual stream bank load of 37,911 tons/yr.

Table J-4. Nevada Creek Planning Area Stream Bank Erosion Inventory and Sediment Loads

Stream Name	Reach Code	Reach Load (Tons/Yr)	Controllable Fraction	Controllable Reach Load (Tons/Yr)	Background Reach Load (Tons/Yr)	Cumulative Total Segment Load (Tons/Yr)	Cumulative Controllable Segment Load (Tons/Yr)	Cumulative Background Segment Load (Tons/Yr)
Upper Washington Creek	Wash1	16	0.26	4.2	11.8	296	119	177
	Wash2	280	0.41	114.6	165.0			
Lower Washington Creek	Wash3	754	0.31	233.8	520.3	1,050	353	697
Upper Jefferson Creek	Jeff1	536	0.41	219.6	315.9	535	220	315
Lower Jefferson Creek	Jeff2	537	0.30	220	316.8	537	220	317
Gallagher Creek	Gall1	10	0.26	2.6	7.4	100	27	73
	Gall2	90	0.27	24.2	65.3			
Buffalo Gulch	Buff1	8.1	0.26	2.1	6.0	158	50	109
	Buff2	82.7	0.30	24.8	57.9			
	Buff3	67.6	0.34	22.6	45.0			
Nevada Creek (upper)	Nev1	17.4	0.30	5.2	12.2	3,480	1,178	2,302
	Nev2	27.8	0.27	7.5	20.3			
	Nev3	232.4	0.38	88.3	144.1			
	Nev4	212.5	0.34	72.3	140.3			
	Nev5	741.8	0.30	222.5	519.3			
	Nev6	402.6	0.33	132.9	269.7			
Braziel Creek	Braz1	1	0.30	0.3	0.7	262	70	192
	Braz2	233.4	0.26	60.7	172.7			
	Braz3	27.4	0.34	9.2	18.2			
Black Bear Creek	BlkBr1	0.6	0.30	0.2	0.4	113	30	83
	BlkBr2	1	0.30	0.3	0.7			
	BlkBr3	15.8	0.28	4.4	11.4			
	BlkBr4	94.8	0.26	24.6	70.2			
Murray Creek	Murr1	1.7	0.30	0.5	1.2	615	224	391
	Murr2	128.5	0.27	34.2	94.3			
	Murr3	484.6	0.39	189.0	295.6			
Upper Douglas Creek	Doug1	1.9	0.30	0.6	1.3	996	356	641
	Doug2	3.2	0.30	1.0	2.2			
	Doug3	43.8	0.35	15.3	28.5			
	Doug4	220	0.39	84.7	135.3			

Table J-4. Nevada Creek Planning Area Stream Bank Erosion Inventory and Sediment Loads

Stream Name	Reach Code	Reach Load (Tons/Yr)	Controllable Fraction	Controllable Reach Load (Tons/Yr)	Background Reach Load (Tons/Yr)	Cumulative Total Segment Load (Tons/Yr)	Cumulative Controllable Segment Load (Tons/Yr)	Cumulative Background Segment Load (Tons/Yr)
Cottonwood Creek	CttnNv1	59.9	0.34	20.4	39.5	309	95	214
	CttnNv2	128.7	0.30	38.7	90.0			
	CttnNv3	120.7	0.30	36.3	84.4			
Lower Douglas Creek	Doug5	805.8	0.42	338.4	467.4	4,224	1,448	2,777
	Doug6	944.1	0.35	325.7	618.4			
	Doug7	902.7	0.27	243.7	659.0			
	Doug8	102.3	0.30	30.8	71.5			
	Doug9	163.8	0.36	58.3	105.5			
Nevada Spring Creek						25	8	17
McElwain Creek	McEl1	333	0.36	119.9	213.1	333	119.9	213.1
Nevada Creek (lower)	Nev7	402.6	0.34	265.7	515.7	10,687	3,502	7,185
	Nev8	781.4	0.26	101.7	289.3			
	Nev9	391	0.26	7.9	22.4			
	Nev10	30.3	0.27	7.8	21.0			
	Nev11	28.8	0.26	23.4	66.6			
	Nev12	90	0.28	5.2	13.5			
	Nev13	18.7	0.33	4.9	9.8			
	Nev14	14.7	0.26	262.4	747.0			

Table J-5. Middle Blackfoot Planning Area Stream Bank Erosion Inventory and Sediment Loads

Stream Name	Reach Code	Reach Load (Tons/Yr)	Controllable Fraction	Controllable Reach Load (Tons/Yr)	Background Reach Load (Tons/Yr)	Cumulative Segment Load (Tons/Yr)	Cumulative Controllable Segment Load (Tons/Yr)	Cumulative Background Segment Load (Tons/Yr)
Yourname Creek	Your1	17.4	0.30	5.2	12.2	274	95	179
	Your2	11.3	0.30	3.4	7.9			
	Your3	20.2	0.27	5.5	14.7			
	Your4	225	0.36	81.0	144.0			
Wales Creek	Wale1	266.7	0.36	96.0	170.7	267	96.0	171
Frazier Creek	Fraz1	0.04	0.30	0.0	0.0	0.3	0.1	0.2
	Fraz2	0.1	0.30	0.0	0.1			
	Fraz3	0.1	0.30	0.0	0.1			
Ward Creek	Ward1	0	0.30	0.0	0.0	77	23	54
	Ward2	0	0.30	0.0	0.0			
	Ward3	65.6	0.30	19.7	45.9			
	Ward4	0.2	0.30	0.1	0.1			
	Ward5	0.3	0.30	0.1	0.2			
	Ward6	0.1	0.30	0.0	0.1			
	Ward7	0.1	0.30	0.0	0.1			
	Ward8	10.6	0.27	2.9	7.7			
Kleinschmidt Creek	Klein1	0.3	0.30	0.1	0.2	80	24	56
	Klein2	1.1	0.39	0.4	0.7			
	Klein3	1.3	0.39	0.5	0.8			
Rock Creek	Rock1	0	0.30	0.0	0.0	227	62	163
	Rock2	0.1	0.30	0.0	0.1			
	Rock3	0.9	0.30	0.3	0.6			
	Rock4	79.9	0.26	20.8	59.1			
	Rock5	57.4	0.26	14.9	42.5			
	Rock6	7.3	0.26	1.9	5.4			
	Rock7	1.3	0.30	0.4	0.9			
North Fork Blackfoot River		6334	0.31	1964	4370	6,561	2,026	4535

Table J-5. Middle Blackfoot Planning Area Stream Bank Erosion Inventory and Sediment Loads

Stream Name	Reach Code	Reach Load (Tons/Yr)	Controllable Fraction	Controllable Reach Load (Tons/Yr)	Background Reach Load (Tons/Yr)	Cumulative Segment Load (Tons/Yr)	Cumulative Controllable Segment Load (Tons/Yr)	Cumulative Background Segment Load (Tons/Yr)
Warren Creek	Warr1	0.2	0.30	0.1	0.1	85	26	59
	Warr2	1.1	0.28	0.3	0.8			
	Warr3	15.1	0.26	3.9	11.2			
	Warr4	5	0.27	1.4	3.7			
	Warr5	7.4	0.28	2.1	5.3			
	Warr6	6.3	0.28	1.8	4.5			
	Warr7	6.7	0.28	1.9	4.8			
	Warr8	7.7	0.28	2.2	5.5			
	Warr9	0.1	0.30	0.0	0.1			
	Warr10	6.6	0.36	2.4	4.2			
	Warr11	13.3	0.36	4.8	8.5			
	Warr12	15.1	0.36	5.4	9.7			
Monture Creek	Mont1	1.3	0.30	0.4	0.9	770	209	561
	Mont2	0.6	0.30	0.2	0.4			
	Mont3	7.4	0.30	2.2	5.2			
	Mont4	118.6	0.29	34.4	84.2			
	Mont5	90.4	0.27	24.4	66.0			
	Mont6	120.4	0.27	32.5	87.9			
	Mont7	95.5	0.26	24.8	70.7			
	Mont8	43.2	0.26	11.2	32.0			
	Mont9	68	0.26	17.7	50.3			
	Mont10	94	0.26	24.4	69.6			
	Mont11	47.4	0.26	12.3	35.1			
	Mont12	44.85	0.30	13.5	31.4			
	Mont13	37.95	0.30	11.4	26.6			
Blackfoot River (Nevada Creek to Monture Creek)	Blkft1	1429.6	0.34	491.8	937.8	29,940	9,840	20,100
	Blkft2	2501.8	0.34	860.6	1641.2			
	Blkft3	2654.2	0.34	913.0	1741.2			
	Blkft4	165.6	0.34	57.0	108.6			
	Blkft5	2244.7	0.0	0.0	2244.7			
	Blkft6	906.9	0.34	312.0	594.9			
	Blkft7	508.2	0.0	0.0	508.2			
	Blkft8	884.5	0.34	304.3	580.2			

Table J-5. Middle Blackfoot Planning Area Stream Bank Erosion Inventory and Sediment Loads

Stream Name	Reach Code	Reach Load (Tons/Yr)	Controllable Fraction	Controllable Reach Load (Tons/Yr)	Background Reach Load (Tons/Yr)	Cumulative Segment Load (Tons/Yr)	Cumulative Controllable Segment Load (Tons/Yr)	Cumulative Background Segment Load (Tons/Yr)
Chamberlain Creek		240	0.31	74	166	240	74	166
Cottonwood Creek	CttnBlk0	104.6	0.39	40.8	63.8	296	106	190
	CttnBlk1	51.4	0.39	20.0	31.4			
	CttnBlk2	35.9	0.39	14.0	21.9			
	CttnBlk3	41.2	0.34	14.0	27.2			
	CttnBlk4	14.8	0.28	4.1	10.7			
	CttnBlk5	35.8	0.28	10.0	25.8			
	CttnBlk6	12	0.28	3.4	8.6			
Richmond Creek		3	0.31	1	2	3	1	2
West Fork Clearwater River		371	0.31	115	256	371	115	256
Deer Creek		124	0.31	38	86	124	38	86
Buck Creek		5	0	0	5	5	1.5	3.3
Blanchard Creek	Blan1	39.7	0.26	10.3	29.4	59	15	44
	Blan2	19.2	0.26	5.0	14.2			
Lower Clearwater River		2,871	0.31	890	1981	3,433	1,061	2,372
Blackfoot River (Monture Creek to Clearwater River)	Blkft9	2237.3	0.34	769.6	1467.7	4,002	1,377	2,625
	Blkft10	1040.6	0.34	358.0	682.6			
	Blkft11	723.8	0.34	249.0	474.8			
Middle Blackfoot-Nevada Creek TPA Totals						**37,911**	**12,453**	**25,458**

The analysis of how the bank erosion hazard index parameters would change in the absence human influence divides the stream bank load into a human-caused loading component and a background component without human influence. An estimate of the achievable reduction in human-caused loading is needed to quantify naturally occurring loading that includes human caused loading with the application of all reasonable land, soil, and water conservation practices.

The achievable reduction was estimated by reviewing the reach assessment database entries for land use, vegetation conditions, and bank stability ratings. Field notes of bank conditions, reach photographs of ground conditions, and aerial photography were also considered in estimating an achievable reduction in human-caused loading. The reductions ranged from 20% to 80%, with the lower percentages applying to more remote headwaters reaches having fewer human impacts and inherently more stable channel types. Larger deductions are more common on lower reaches where human influence is more extensive.

Tables J-6 and J-7 specify the achievable reduction to the human caused component of stream bank erosion for each assessment reach in the Nevada Creek and Middle Blackfoot planning areas. The shaded rows in the tables contain total loading figures for the corresponding stream segment. Reductions in human caused loading are not specified for the unlisted tributaries of North Fork Blackfoot River, Chamberlain Creek, and the Clearwater River; their human caused loads are assumed to occur with the application of all reasonable land, soil, land water conservation practices.

Table J-6. Nevada Creek Stream Bank Erosion Load Apportionment into Human Caused Loading, Background Loading and Achievable Reductions to Human Caused Loading

Listed Reach Name	Assessment Reach Name	Reach Load (tons/yr)	Load Reduction Percentage	Human Caused Load (tons/yr)	Background Load (tons/yr)	Achievable Reduction in Human Caused Load (Percent)	Achievable Reduction in Human Caused Load (tons/yr)
Upper Washington Creek	Wash1	16	26%	4	12	25%	1
Upper Washington Creek	Wash2	280	41%	114.6	165.0	50%	57
Upper Washington Creek Total		296	40%	119	177	33%	58
Lower Washington Creek	Wash3	754	31%	234	520	75%	175
Upper Jefferson Creek	Jeff1	536	41%	220	316	75%	165
Lower Jefferson Creek	Jeff2	1.3	30%	0.4	1	80%	0.3
Lower Jefferson Creek Total		537	41%	220	317	52%	165
Gallagher Creek	Gall1	10	26%	3	7	25%	0.1
Gallagher Creek	Gall2	90	27%	24	65	75%	18
Gallagher Creek Total		100	27%	27	73	70%	19
Buffalo Gulch	Buff1	8	26%	2	6	30%	0.1
Buffalo Gulch	Buff2	83	30%	25	58	70%	17
Buffalo Gulch	Buff3	68	34%	23	45	60%	14
Buffalo Gulch Total		159	31%	50	109	64%	32
Upper Nevada Creek	Nev1	17	30%	5	12	25%	1
Upper Nevada Creek	Nev2	28	27%	8	20	25%	2
Upper Nevada Creek	Nev3	232	38%	88	144	35%	31
Upper Nevada Creek	Nev4	213	34%	72	140	60%	43
Upper Nevada Creek	Nev5	742	30%	223	519	75%	167
Upper Nevada Creek	Nev6	403	33%	133	270	75%	100
Upper Nevada Creek Total		1635	32%	529	1106	65%	344
Braziel Creek	Braz1	1	30%	0.3	1	25%	0.1
Braziel Creek	Braz2	233	26%	61	173	60%	36
Braziel Creek	Braz3	27	34%	9	18	80%	7
Braziel Creek Total		262	27%	70	192	62%	44
Black Bear Creek	BlkBr1	1	30%	0.2	0.4	20%	0.0
Black Bear Creek	BlkBr2	1	30%	0.3	0.7	25%	0.1
Black Bear Creek	BlkBr3	16	28%	4	11	70%	3
Black Bear Creek	BlkBr4	95	26%	25	70	80%	20
Black Bear Creek Total		112	26%	30	83	78%	24
Murray Creek	Murr1	2	30%	1	1	20%	0.2
Murray Creek	Murr2	129	27%	34	94	60%	21

Table J-6. Nevada Creek Stream Bank Erosion Load Apportionment into Human Caused Loading, Background Loading and Achievable Reductions to Human Caused Loading

Listed Reach Name	Assessment Reach Name	Reach Load (tons/yr)	Load Reduction Percentage	Human Caused Load (tons/yr)	Background Load (tons/yr)	Achievable Reduction in Human Caused Load (Percent)	Achievable Reduction in Human Caused Load (tons/yr)
Murray Creek	Murr3	485	39%	189	296	75%	142
Murray Creek Total		615	36%	224	391	73%	162
Upper Douglas Creek	Doug1	2	30%	1	1	30%	0.2
Upper Douglas Creek	Doug2	3	30%	1	2	40%	0.4
Upper Douglas Creek	Doug3	44	35%	15	29	80%	12
Upper Douglas Creek	Doug4	220	39%	85	135	75%	64
Upper Douglas Creek Total		269	38%	102	167	75%	77
Cottonwood Creek	CttnNev1	60	34%	20	40	80%	16
Cottonwood Creek	CttnNev2	129	30%	39	90	80%	31
Cottonwood Creek	CttnNev3	121	30%	36	84	80%	29
Cottonwood Creek Total		310	31%	95	214	80%	76
Lower Douglas Creek	Doug5	806	42%	338	467	75%	72
Lower Douglas Creek	Doug6	944	35%	326	618	50%	163
Lower Douglas Creek	Doug7	903	27%	244	659	70%	171
Lower Douglas Creek	Doug8	102	30%	31	72	80%	25
Lower Douglas Creek	Doug9	164	36%	58	106	80%	47
Lower Douglas Creek Total		2919	34%	997	1922	48%	478
Nevada Spring Creek	NA	25	31%	8	17	75%	6
McElwain Creek	McEl1	333	36%	120	213	75%	90
Lower Nevada Creek	Nev7	781	34%	266	516	80%	213
Lower Nevada Creek	Nev8	391	26%	102	289	75%	76
Lower Nevada Creek	Nev9	30	26%	8	22	50%	4
Lower Nevada Creek	Nev10	29	27%	8	21	60%	5
Lower Nevada Creek	Nev11	90	26%	23	67	80%	19
Lower Nevada Creek	Nev12	19	28%	5	14	70%	4
Lower Nevada Creek	Nev13	15	33%	5	10	40%	2
Lower Nevada Creek	Nev14	1009	26%	262	747	75%	197
Lower Nevada Creek Total		2364.3	29%	679	1685		519

Table J-7. Middle Blackfoot Stream Bank Erosion Load Apportionment into Anthropogenic Loading, Background Loading and Achievable Anthropogenic Load Reductions

Listed Segment Name	Assessment Reach Name	Reach Load (tons/yr)	Load Reduction Percentage	Human Caused Load (tons/yr)	Background Load (tons/yr)	Achievable Reduction in Human Caused Load (Percent)	Achievable Reduction in Human Caused Load (tons/yr)
Yourname Creek	Your1	17	30%	5	12	25%	1
Yourname Creek	Your2	11	30%	3	8	30%	1
Yourname Creek	Your3	20	27%	5	15	75%	4
Yourname Creek	Your4	225	36%	81	144	75%	61
Yourname Creek Total		274	35%	95	179	71%	67
Wales Creek	Wale1	267	36%	96.0	171	75%	72
Frazier Creek	Fraz1	0.0	30%	0.0	0.0	25%	0.0
Frazier Creek	Fraz2	0.1	30%	0.0	0.1	25%	0.0
Frazier Creek	Fraz3	0.1	30%	0.0	0.1	25%	0.0
Frazier Creek Total		0.2	42%	0.1	0.2	25%	0.0
Ward Creek	Ward1	0	30%	0.0	0.0	25%	0.0
Ward Creek	Ward2	0	30%	0.0	0.0	25%	0.0
Ward Creek	Ward3	66	30%	20	46	80%	16
Ward Creek	Ward4	0.2	30%	0.1	0.1	80%	0.0
Ward Creek	Ward5	0.3	30%	0.1	0.2	75%	0.1
Ward Creek	Ward6	0.1	30%	0.0	0.1	25%	0.0
Ward Creek	Ward7	0.1	30%	0.0	0.1	40%	0.0
Ward Creek	Ward8	11	27%	3	8	75%	2
Ward Creek Total		779	30%	23	54	79%	18
Kleinschmidt Creek	Klein1	0	30%	0	0	80%	0
Kleinschmidt Creek	Klein2	1	39%	0	1	60%	0
Kleinschmidt Creek	Klein3	1	39%	1	1	70%	0
Kleinschmidt Creek Total		3	37%	1	2	70%	1
Rock Creek	Rock1	0	30%	0	0	20%	0
Rock Creek	Rock2	0	30%	0	0	60%	0
Rock Creek	Rock3	1	30%	0	1	75%	0
Rock Creek	Rock4	80	26%	21	59	75%	16
Rock Creek	Rock5	57	26%	15	42	80%	12
Rock Creek	Rock6	7	26%	2	5	80%	2
Rock Creek	Rock7	1	30%	0	1	75%	0
Rock Creek Total		147	26%	38	109	77%	30

Table J-7. Middle Blackfoot Stream Bank Erosion Load Apportionment into Anthropogenic Loading, Background Loading and Achievable Anthropogenic Load Reductions

Listed Segment Name	Assessment Reach Name	Reach Load (tons/yr)	Load Reduction Percentage	Human Caused Load (tons/yr)	Background Load (tons/yr)	Achievable Reduction in Human Caused Load (Percent)	Achievable Reduction in Human Caused Load (tons/yr)
North Fork Blackfoot River		6334	31%	1964	4370	0.0	0.0
Warren Creek	Warr1	0	30%	0	0	75%	0
Warren Creek	Warr10	7	30%	2	5	75%	1
Warren Creek	Warr11	13	36%	5	9	40%	2
Warren Creek	Warr12	15	36%	5	10	40%	2
Warren Creek	Warr2	1	28%	0	1	25%	0
Warren Creek	Warr3	15	26%	4	11	50%	2
Warren Creek	Warr4	5	27%	1	4	60%	1
Warren Creek	Warr5	7	28%	2	5	75%	2
Warren Creek	Warr6	6	28%	2	5	75%	1
Warren Creek	Warr7	7	28%	2	5	75%	1
Warren Creek	Warr8	8	28%	2	6	75%	2
Warren Creek	Warr9	0	30%	0	0	20%	0
Warren Creek Total		85	30%	26	59	56%	14
Monture Creek	Mont1	1	30%	0	1	20%	0
Monture Creek	Mont10	94	26%	24	70	65%	16
Monture Creek	Mont11	47	26%	12	35	75%	9
Monture Creek	Mont12	45	30%	13	31	60%	8
Monture Creek	Mont13	38	30%	11	27	70%	8
Monture Creek	Mont2	1	30%	0	0	20%	0
Monture Creek	Mont3	7	30%	2	5	20%	0
Monture Creek	Mont4	119	28%	33	85	60%	20
Monture Creek	Mont5	90	27%	24	66	60%	15
Monture Creek	Mont6	120	27%	33	88	60%	20
Monture Creek	Mont7	96	26%	25	71	60%	15
Monture Creek	Mont8	43	26%	11	32	60%	7
Monture Creek	Mont9	68	26%	18	50	60%	11
Monture Creek Total		770		208	561	61%	128
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft1	1430	34%	492	938	65%	320
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft2	2502	34%	861	1641	65%	559

Table J-7. Middle Blackfoot Stream Bank Erosion Load Apportionment into Anthropogenic Loading, Background Loading and Achievable Anthropogenic Load Reductions

Listed Segment Name	Assessment Reach Name	Reach Load (tons/yr)	Load Reduction Percentage	Human Caused Load (tons/yr)	Background Load (tons/yr)	Achievable Reduction in Human Caused Load (Percent)	Achievable Reduction in Human Caused Load (tons/yr)
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft3	2654	34%	913	1741	65%	593
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft4	166	34%	57	109	65%	37
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft5	2245	34%	772	1473	60%	463
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft6	907	34%	312	595	65%	203
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft7	508	34%	175	333	65%	114
Blackfoot River (Nevada Cr. To Monture Cr.)	Blkft8	885	34%	304	580	70%	213
Blackfoot River (Nevada Cr. To Monture Cr.) Total		11295	34%	3886	7410	64%	2502
Chamberlain Creek		240	31%	74	166	0.0	0.0
Cottonwood Creek	CttnBlk0	105	39%	41	64	75%	31
Cottonwood Creek	CttnBlk1	51	39%	20	31	75%	15
Cottonwood Creek	CttnBlk2	36	39%	14	22	50%	7
Cottonwood Creek	CttnBlk3	41	34%	14	27	75%	11
Cottonwood Creek	CttnBlk4	15	28%	4	11	40%	2
Cottonwood Creek	CttnBlk5	36	28%	10	26	50%	5
Cottonwood Creek	CttnBlk6	12	28%	3	9	65%	2
Cottonwood Creek Total		296		106	189	68%	72
Richmond Creek		3	31%	1	2.	70%	1
West Fork Clearwater River		371	31%	115	256	60%	69
Deer Creek		124	31%	38	86	60%	23
Buck Creek		5	0%	1	4	60%	1
Blanchard Creek	Blan1	40	26%	10	29	75%	8
Blanchard Creek	Blan2	19	26%	5	14	75%	4
Blanchard Creek Total		59	26%	15	44	75%	11
Clearwater River		2871	31%	890	1981	0.0	0.0

Table J-7. Middle Blackfoot Stream Bank Erosion Load Apportionment into Anthropogenic Loading, Background Loading and Achievable Anthropogenic Load Reductions

Listed Segment Name	Assessment Reach Name	Reach Load (tons/yr)	Load Reduction Percentage	Human Caused Load (tons/yr)	Background Load (tons/yr)	Achievable Reduction in Human Caused Load (Percent)	Achievable Reduction in Human Caused Load (tons/yr)
Blackfoot River (Monture Cr. To Clearwater R.)	Blkft9	2237	34%	770	1468	45%	346
Blackfoot River (Monture Cr. To Clearwater R.)	Blkft10	1041	34%	358	683	60%	215
Blackfoot River (Monture Cr. To Clearwater R.)	Blkft11	724	34%	249	475	30%	75
Blackfoot River (Monture Cr. To Clearwater R.) Total		4002	34%	1377	2625	46%	636

Sediment Loading From Culvert Failure

Sediment contributions from road fill failure at crossings can occur from fill saturation by ponded water at the upstream inlet of undersized culverts or from overflow of ponded water onto the road with subsequent erosion of the fill. The estimation of sediment from roadways conducted in 2005 included an analysis of sediment from culvert failure. Seventy-three culverts were surveyed in the Middle Blackfoot-Nevada Creek planning area during the 2005 road sediment source assessment. The analysis associated risk of failure with the ratio of culvert width to bankfull channel width (constriction ratio) of less that one.

A total of 1,060 tons of fill from 17 sites in the Nevada Creek planning area and 4,393 tons of sediment from 38 surveyed sites in the middle Blackfoot River planning area were considered at risk from culvert failure. Per crossing means were 62.4 tons in Nevada Creek and 115.6 tons in the middle Blackfoot. These means were multiplied by number of crossings per listed segment to estimate per segment loading. Most of the Nevada Creek tonnage was surveyed at culverts that were 70% or less of the channel bankfull width; tonnage in the middle Blackfoot was mostly from culverts that were 40% or less of the channel bankfull width; (RDG 2006). Annual loads from culvert failure were based on an assumed one percent failure rate. Thus annual loading was 450 tons in the Nevada Creek planning area and 2,100 tons per year in the middle Blackfoot planning area. The annual load is partitioned into controllable versus naturally occurring components by applying a percent reduction derived from an alternative, discharge based culvert failure analysis used in other forested watersheds in Montana.

In these analyses, regression equations developed by the USGS (Omang 1992) were used to estimate peak discharge (Q) for the 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals at surveyed stream crossings based on drainage area (square miles) and mean annual precipitation (inches). Survey data was used to calculate a ratio of ponded headwater depth to culvert inlet depth (Hw:D) at each culvert. Culverts exceeding a Hw:D ratio of 1.4 were considered at risk for failure. The annual probability of modeled discharge, Hw:D ratio and road fill volume subject to erosion at failure were used to quantify annual loading from failure. The existing loading condition assumed that failed culverts were replaced with culverts of the same size. An appropriate reduction from the current loading condition was based on a scenario where failed culverts were upgraded to those passing the Q100 discharge. This scenario follows the guidance from the USFS INFISH recommendations which call for all culverts on USFS land to be able to pass the Q100 flow event. The sediment yields and reductions from the surveyed locations were extrapolated to unsurveyed culverts at the watershed scale. The Q100 replacement scenario resulted in annual loading reductions ranging from 70 to 80 percent. The Q100 replacement BMP and assumed loading reduction were applied to the annual loading estimates to define the controllable and naturally occurring loads. The culvert upgrade scenario was assumed to represent application of all reasonable land, soil, and water conservation practices addressing culvert failure. **Table J-8** below gives the details of loading from culvert failure by listed stream segment.

Table J-8. Annual Loading from Culvert Failure by Listed Segment

Stream Name	Crossings	At Risk Mass (tons)	Annual Loading (tons/yr)	Controllable Load (tons/year)	Load Per Q100 Replacement (tons/yr)
Nevada Creek Planning Area					
Upper Washington Creek	9	562	6	4	1
Lower Washington Creek	8	499	5	4	1
Upper Jefferson Creek	21	1,310	13	10	3
Lower Jefferson Creek	4	250	2	2	1
Gallagher Creek	7	437	4	3	1
Buffalo	39	2,434	24	19	6
Upper Nevada Creek	18	1,123	11	9	3
Braziel Creek	13	811	8	6	2
Black Bear Creek	12	749	7	6	2
Murray Creek	50	3,120	31	24	7
Upper Douglas Creek	111	6,926	69	53	16
Cottonwood Creek	69	4,306	43	33	10
Lower Douglas Creek	88	5,491	55	42	13
Nevada Spring Creek	5	312	3	2	1
McElwain Creek	24	1,498	15	12	3
Nevada Creek TPA Non-303(d) Listed Streams	201	12,542	125	97	29
Lower Nevada Creek	39	2,434	24	19	6
Sub Planning Area Totals	**718**	**44,803**	**448**	**345**	**103**
Middle Blackfoot Planning Area					
Yourname Creek	33	3,815	38	29	9
Wales Creek	4	462	5	4	1
Frazier Creek	8	925	9	7	2
Ward Creek	16	1,850	18	14	4
Kleinschmidt Creek	8	925	9	7	2
Rock Creek	29	3,352	34	26	8
North Fork Blackfoot River	79	9,132	91	70	21
Warren Creek	43	4,971	50	38	11
Monture Creek	121	13,988	140	108	32
Blackfoot River (Nevada Creek to Monture Creek)	39	4,508	45	35	10
Chamberlain Creek	109	12,600	126	97	29
Cottonwood Creek	177	20,461	205	158	47
Richmond Creek	11	1,272	13	10	3
West Fork Clearwater River	81	9,364	94	72	22
Deer Creek	68	7,861	79	61	18
Buck Creek	12	1,387	14	11	3
Blanchard Creek	97	11,213	112	86	26
Middle Blackfoot TPA, Non-303(d) Listed Streams	800	92,480	925	712	213

Table J-8. Annual Loading from Culvert Failure by Listed Segment

Stream Name	Crossings	At Risk Mass (tons)	Annual Loading (tons/yr)	Controllable Load (tons/year)	Load Per Q100 Replacement (tons/yr)
Blackfoot River (Monture Creek to Clearwater River)	83	9,595	96	74	22
Sub Planning Area Totals	**1,818**	**210,161**	**2,102**	**1,618**	**483**
Middle Blackfoot-Nevada Creek Totals	**2,536**	**254,964**	**2,550**	**1,963**	**586**

Allocations for Sediment Loading

The estimated annual load reductions are allocated to land uses within the watersheds of impaired streams. The allocation for each land use is expressed as a percentage of the needed annual reduction for the listed water body and converted to annual reductions in tons per year. The annual reduction allocations given in **Table 9.7** are a composite of those determined separately for hillslope, stream bank and road erosion.

Annual hillslope allocations are based partially upon the proportional loading from cover type categories that are linked to specific land uses. The size of the allocation to silviculture activities, for example, reflects the magnitude of modeled annual loading from forest landcover types. Allocations to livestock grazing are proportional to modeled loading from rangeland types. SWAT loading estimates by cover type are at the subbasin scale, allowing for broad land use allocations. The allocations were refined by considering the extent of cover types, and corresponding land uses, occurring within the sheetflow area defined by the 350-foot buffer extending from each stream bank.

Clipping the USGS 2001 landcover layer to the stream buffer layer allowed the calculation of landcover proportions within the sheetflow area. Examining the aerial imagery at the larger scale required to discern buffer zone land uses identified land use sources such as placer mining that are not accounted for in SWAT. Interpretation of the aerial imagery of the buffer zone and its landcover polygons also exposed noted differences between USGS landcover categories and actual ground conditions. Nearly the entire Rock Creek buffer area on Kleinschmidt Flats is classified as annually harvested cropland on the USGS landcover map. The aerial imagery indicates that seasonal grazing is the principal land use. In many cases, the 2005 aerial imagery and ground photos taken during the 2004 field assessment were used to adjust the allocations derived by strict adherence to USGS landcover category. **Table J-9** below lists the landcover types identified by SWAT as the hillslope loading sources and gives in parentheses the proportion of total loading attributable to each.

Table J-9 also contains values for land use extent expressed as a percentage of the sheetflow area adjacent to sediment impaired channels. These values frequently sum to greater than 100 percent due to the overlapping uses such as grazing within forest as well as rangeland types. Seasonal grazing on irrigated hay acreage is also a common practice within both planning areas.

Table J-9. SWAT Sediment Yield Percentages by Cover Type, Sheetflow Area Land Use Extent (%) and Hillslope Land Use Allocations (%) for Sediment Impaired Waters in the Nevada Creek and Middle Blackfoot Planning Areas

Impaired Segment Name	SWAT Landcover Types (Yield Percentage)	Sheetflow Area Land Use Percentage				Hillslope Land Use Allocation Percentage			
		Forestry	Placer Mining	Grazing	Irrigated Hay	Forestry	Placer Mining	Grazing	Irrigated Hay
Nevada Creek TPA									
Upper Washington	Grasslands (62) Shrublands (38)		50	50			40	50	10
Lower Washington	Grasslands (82) Shrublands (18)		30	70				100	
Upper Jefferson	Grasslands (62) Shrublands (38)	50	30	70	0	20	40	40	
Lower Jefferson	No Hillslope Yield		10	100	10				
Gallagher	Grasslands (84) Shrublands (16)			100	30	5		75	20
Buffalo Gulch	Forest Roads (70) Shrublands (10) Grasslands (20)	40		60	0.1	70		30	
Upper Nevada	Grasslands (73) Shrublands (16) Pasture (1)	20	10	70	40			55	45
Braziel	Grasslands (67) Shrublands (30) Forest (3)	10		80	10			100	
Black Bear	Grasslands (86) Shrublands (12) Pasture (2)	60		80				100	
Murray	Forest Roads (69) Shrublands (9) Grasslands (22)	40		80	25	70		30	
Upper Douglas	Grasslands (79) Shrublands (19) Pasture (2)	50		50	10			56	44
Cottonwood	Grasslands (38) Pasture (36) Shrublands (14) Rural Residential (12)			60	40			50	50

Table J-9. SWAT Sediment Yield Percentages by Cover Type, Sheetflow Area Land Use Extent (%) and Hillslope Land Use Allocations (%) for Sediment Impaired Waters in the Nevada Creek and Middle Blackfoot Planning Areas

Impaired Segment Name	SWAT Landcover Types (Yield Percentage)	Sheetflow Area Land Use Percentage				Hillslope Land Use Allocation Percentage			
		Forestry	Placer Mining	Grazing	Irrigated Hay	Forestry	Placer Mining	Grazing	Irrigated Hay
Lower Douglas	Grasslands (75) Shrublands (25)			90	10			100	
Nevada Spring	No Hillslope Yield			100	15				
McElwain	Grasslands (66) Shrublands (31) Pasture (3)			100	40			60	40
Lower Nevada	Grasslands (94) Shrublands (1) Pasture (5)			100	40			95	5
Middle Blackfoot TPA									
Yourname	Grasslands (72) Shrublands (27) Forest (1)			100				100	
Wales	Grasslands (67) Shrublands (32) Forest (1)			100				100	
Frazier	Grasslands (77) Shrublands (23)			100	10			100	
Ward	Grasslands (74) Shrublands (23) Forest (3)			100				100	
Kleinschmidt	Pasture (92) Grasslands (8)			40	50				
Rock	Pasture (96) Rural Residential (4)	10		90	10	30		70	
Warren	Forest Roads (81) Grasslands (16) Shrublands (3)	20		80	20	100			
Monture	Forest (80) Grasslands (17) Shrublands (3)	85		15		80		20	

Table J-9. SWAT Sediment Yield Percentages by Cover Type, Sheetflow Area Land Use Extent (%) and Hillslope Land Use Allocations (%) for Sediment Impaired Waters in the Nevada Creek and Middle Blackfoot Planning Areas

Impaired Segment Name	SWAT Landcover Types (Yield Percentage)	Sheetflow Area Land Use Percentage				Hillslope Land Use Allocation Percentage			
		Forestry	Placer Mining	Grazing	Irrigated Hay	Forestry	Placer Mining	Grazing	Irrigated Hay
Blackfoot River (Nevada Cr. to Monture Cr.)	Grasslands (85) Shrublands (15)			100				100	
Cottonwood	Grasslands (87) Shrublands (12) Forest (1)	10		90		10		90	
Richmond	Forest (100)	100				100			
West Fork Clearwater	Forest (99) Grasslands (1)	100				100			
Deer	Forest (84) Shrublands (14) Grasslands (2)	90		10		100			
Blanchard	Grasslands (87) Shrublands (12) Forest (1)			100				100	
Blackfoot River (Monture Cr. To Clearwater R.)	Forest Roads (84) Grasslands (13) Shrublands (3)	10		90		85		15	

Both SWAT landcover sediment yields and land use extent within the sheetflow area influenced the final land use allocation percentages for hillslope erosion. Hillslope allocations were weighted toward forestry land uses in SWAT subbasins such as Buffalo Gulch, Murray Creek, Warren Creek and the Blackfoot River below Monture Creek that have large yields from “forest roads”. Among subbasins without the forest roads HRU, forestry land use allocations are significant only where the majority of the watershed is consists of forest cover. Examples include Richmond Creek, West Fork Clearwater and Deer Creek.

In the majority of the SWAT subbasins most the hillslope loading comes from rangeland cover types. This reflects the strong influences of canopy cover and surface litter accumulation on simulated hillslope erosion. Both the larger canopy density and thicker surface litter accumulation of forests suppress sediment mobility compared to the more open canopy and larger bare soil area characteristic of arid grasslands and shrub dominated rangelands.

As with the hillslope allocations, those for stream bank erosion reflect land use extent as recorded by the assessment field crews during the stream bank erosion inventory in 2004. Land uses were recorded and vegetation conditions evaluated and photographed within assessed reaches. Recorded reach attribute information included woody vegetation density and visible sources of sediment to channels (DTM and AGI 2004). These field observations and the interpretation of ground and aerial imagery identified the principal land uses affecting stream bank conditions and evaluated the degree of sediment loading from each. **Table J-10** gives the percent reduction allocations for land uses affecting stream bank erosion loading.

Table J-10. Land Use Allocations for Streambank Erosion Loading

Stream Name	Livestock Grazing	Irrigated Hay	Silviculture	Placer Mining	Rural Residential
Nevada Creek TPA					
Upper Washington Creek	50			50	
Lower Washington Creek	40	60			
Upper Jefferson Creek	50		20	30	
Lower Jefferson Creek	50	0	20	30	
Gallagher Creek	50	48	2	0	
Buffalo Gulch	40	26	23	11	
Upper Nevada Creek	33	63	2	2	
Braziel Creek	42		58		
Black Bear Creek	96		4		
Murray Creek	47	44	10		
Upper Douglas Creek	50	50			
Cottonwood Creek	58	42			
Lower Douglas Creek	91	9			
Nevada Spring Creek	90	10			
McElwain Creek	50	50			
Lower Nevada Creek	92	8			

Table J-10. Land Use Allocations for Streambank Erosion Loading

Stream Name	Livestock Grazing	Irrigated Hay	Silviculture	Placer Mining	Rural Residential
Middle Blackfoot TPA					
Yourname Creek	96	2	1	1	
Wales Creek	60	40			
Frazier Creek	29	13	58		
Ward Creek	56	0	44		
Kleinschmidt Creek	79	21			
Rock Creek	62	0	38		
Warren Creek	90	10	1		
Monture Creek	20		80		
Blackfoot River (Nevada Cr. To Monture Cr.)	43	34	23		
Cottonwood Creek	25	10	65		
Richmond Creek			100		
West Fork Clearwater River			100		
Deer Creek			100		
Blanchard Creek			100		
Blackfoot River (Monture Cr. To Clearwater R.)	73	5			22

There is fair agreement between the land use allocations for hillslope and stream bank erosion. Livestock grazing effects on woody vegetation condition and bank stability were common in both planning areas. Stream bank allocations to irrigated hay production are generally larger than those for hillslope erosion. This reflects the generally low hillslope loading from this cover type due mostly to the relatively level slopes of hay fields compared to rangeland slopes.

The reductions in road surface erosion and culvert failure are those possible with BMP implementation. A 30 percent reduction is allocated to sediment loading from road crossings. This is the reduction expected with full implementation of road construction and maintenance BMP. The reduction in loading from culvert failure is that achieved by implementing a culvert replacement BMP that calls for the replacement of failed culverts those sized to pass the 100 year storm event as described above under culvert failure loading. An evaluation of the Q100 replacement scenario found that annual reductions ranged from 70 to 80 percent.

The total sediment load reduction allocations by contributing land use category for the Nevada Creek and Middle Blackfoot planning areas are summarized in the **Figure 9-4**.