

APPENDIX F TOTAL MAXIMUM DAILY LOADS

F.1 SEDIMENT

F.1.1 Overview

A percent reduction approach was used for the sediment TMDLs within this document because there is uncertainty associated with the loads derived from the source assessment, and using the estimated sediment loads creates a rigid perception that the loads are absolutely conclusive. However, because daily loads are a required product of TMDL development and percent reductions are most relevant at an annual scale, loads within this appendix are expressed as daily loads. Daily loads should not be considered absolutely conclusive and may be refined in the future as part of the adaptive management process. The TMDLs may not be feasible at all in locations within the watershed, but if the allocations are followed, sediment loads are expected to be reduced to a degree that the sediment targets are met and beneficial uses are no longer impaired.

F.1.2 Approach

The average annual sediment loads determined from source assessments (**Section 5.0**) were used, along with historical flow and suspended sediment data from the Big Hole River, to determine average daily sediment loads for water bodies in the Middle and Lower Big Hole TPA. A sediment rating curve was developed using daily flow and suspended solids load data collected from 1960 through 1964 at the USGS gage on the Big Hole River near Melrose, MT (Station 6025500) (**Figure F-1**). The gage near Melrose was selected based on its period of record (1923-current) and amount of suspended solids data.

The daily mean discharge based on 84 years of record (1923-2007) at the USGS gage was then plugged into the equation for the sediment rating curve to get a daily suspended sediment load. The suspended sediment load is only a fraction of the total load from the source assessment, but provides an approximation of the relationship between sediment and flow in the Big Hole River. Based on the sum of the calculated daily sediment loads, a daily percentage relative to the annual suspended sediment load was calculated for each day. The daily percentages were then applied to the total average annual loads associated with the TMDL percent reductions from **Section 5.0** to determine the average daily load. To conserve resources, this appendix contains daily loads for the Wise River as an example. As discussed in **Section 5.6.26**, the TMDL for the Wise River is a 34 percent reduction in the total average annual sediment load, which is roughly equivalent to 9,358 tons/year. The daily percentages discussed above were then multiplied by the annual load of 9,358 tons to get a daily expression of the Wise River TMDL (**Figure F-2, Table F-1**). Although the relationship between sediment and flow is likely different within the 303(d) Listed tributaries in the Middle and Lower Big Hole Watershed than in the Big Hole River, it was used to determine average daily loads because it is the best available data and TMDL implementation activities will not be driven by the daily loads. The daily loads are a composite of the allocations, but as allocations are not feasible on a daily basis, they are not contained within this appendix. If

desired, daily allocations may be obtained by applying allocations provided in **Section 5.6** to the daily load. Daily loads for all other TMDLs may be derived by using the daily percentages in **Table F-1** and the TMDLs expressed as an average annual load, which are discussed in **Section 5.6** and also provided in **Table F-2**.

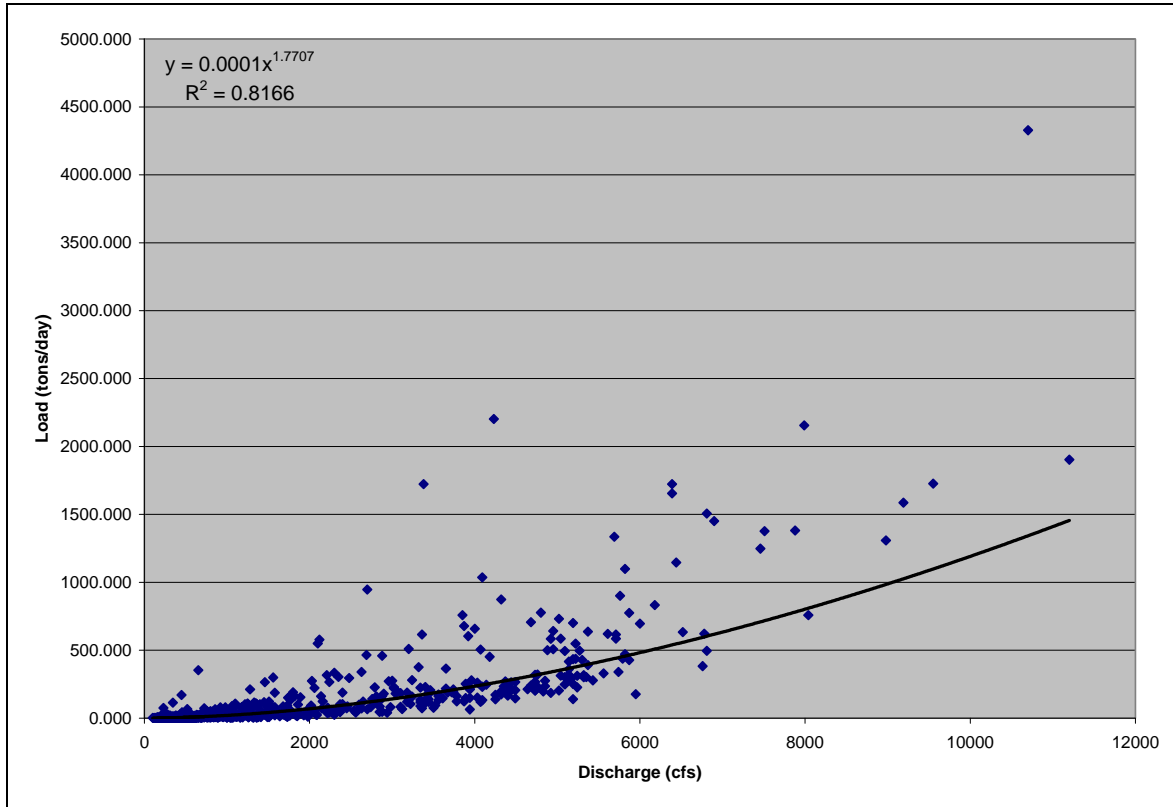


Figure F-1. Sediment Rating Curve for the Big Hole River

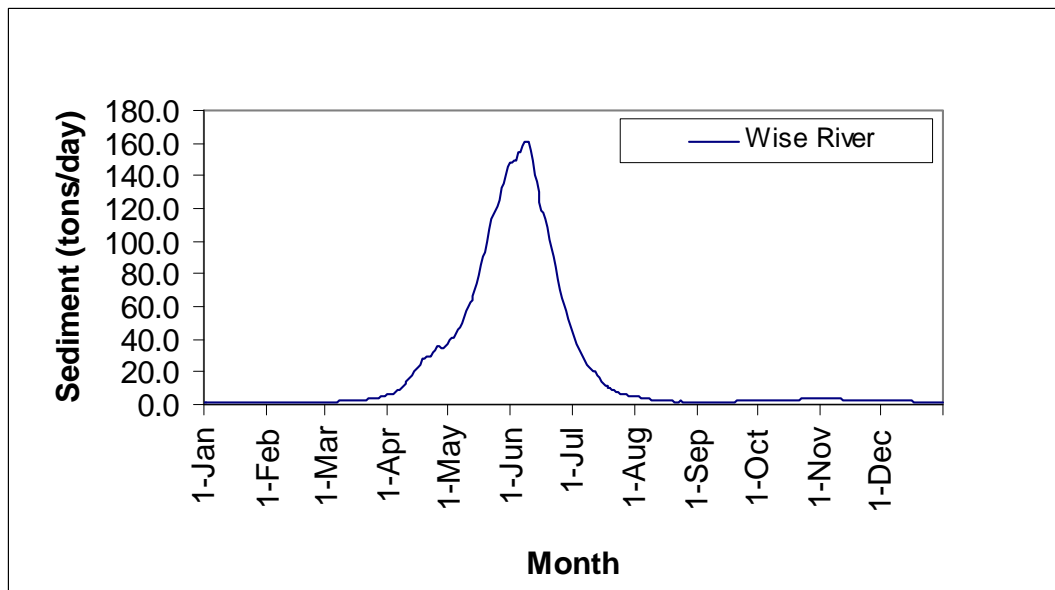


Figure F-2. Average Daily Sediment Load for the Wise River

Table F-1. Daily Sediment TMDL for the Wise River.

Month	Day	Daily % of annual load	Wise River TMDL (tons/day)	Month	Day	Daily % of annual load	Wise River TMDL (tons/day)
Jan	1	0.02%	2.0	Feb	17	0.02%	2.0
Jan	2	0.02%	2.0	Feb	18	0.02%	2.0
Jan	3	0.02%	2.0	Feb	19	0.02%	2.0
Jan	4	0.02%	1.9	Feb	20	0.02%	2.0
Jan	5	0.02%	1.9	Feb	21	0.02%	2.0
Jan	6	0.02%	1.9	Feb	22	0.02%	2.1
Jan	7	0.02%	1.9	Feb	23	0.02%	2.1
Jan	8	0.02%	1.9	Feb	24	0.02%	2.1
Jan	9	0.02%	1.9	Feb	25	0.02%	2.1
Jan	10	0.02%	1.9	Feb	26	0.02%	2.2
Jan	11	0.02%	1.9	Feb	27	0.02%	2.2
Jan	12	0.02%	1.9	Feb	28	0.02%	2.1
Jan	13	0.02%	1.9	Feb	29	0.02%	2.1
Jan	14	0.02%	1.9	Mar	1	0.02%	2.1
Jan	15	0.02%	1.9	Mar	2	0.02%	2.1
Jan	16	0.02%	1.9	Mar	3	0.02%	2.1
Jan	17	0.02%	1.9	Mar	4	0.02%	2.1
Jan	18	0.02%	1.8	Mar	5	0.02%	2.1
Jan	19	0.02%	1.8	Mar	6	0.02%	2.2
Jan	20	0.02%	1.8	Mar	7	0.02%	2.3
Jan	21	0.02%	1.8	Mar	8	0.02%	2.3
Jan	22	0.02%	1.8	Mar	9	0.03%	2.4
Jan	23	0.02%	1.8	Mar	10	0.03%	2.5
Jan	24	0.02%	1.8	Mar	11	0.03%	2.5
Jan	25	0.02%	1.8	Mar	12	0.03%	2.7
Jan	26	0.02%	1.8	Mar	13	0.03%	2.7
Jan	27	0.02%	1.8	Mar	14	0.03%	2.8
Jan	28	0.02%	1.8	Mar	15	0.03%	2.9
Jan	29	0.02%	1.8	Mar	16	0.03%	3.1
Jan	30	0.02%	1.8	Mar	17	0.04%	3.3
Jan	31	0.02%	1.9	Mar	18	0.04%	3.4
Feb	1	0.02%	1.9	Mar	19	0.04%	3.5
Feb	2	0.02%	2.0	Mar	20	0.04%	3.6
Feb	3	0.02%	1.9	Mar	21	0.04%	3.7
Feb	4	0.02%	1.9	Mar	22	0.04%	3.8
Feb	5	0.02%	1.9	Mar	23	0.04%	4.1
Feb	6	0.02%	2.0	Mar	24	0.04%	4.2
Feb	7	0.02%	2.0	Mar	25	0.05%	4.3
Feb	8	0.02%	2.0	Mar	26	0.05%	4.5
Feb	9	0.02%	2.1	Mar	27	0.05%	4.8
Feb	10	0.02%	2.0	Mar	28	0.06%	5.6
Feb	11	0.02%	2.0	Mar	29	0.07%	6.4
Feb	12	0.02%	2.0	Mar	30	0.07%	6.6
Feb	13	0.02%	1.9	Mar	31	0.07%	6.9
Feb	14	0.02%	1.9	Apr	1	0.08%	7.2
Feb	15	0.02%	1.9	Apr	2	0.08%	7.7
Feb	16	0.02%	1.9	Apr	3	0.08%	7.8

Table F-1. Daily Sediment TMDL for the Wise River.

Month	Day	Daily % of annual load	Wise River TMDL (tons/day)	Month	Day	Daily % of annual load	Wise River TMDL (tons/day)
Apr	4	0.09%	8.7	May	21	1.36%	127.1
Apr	5	0.10%	9.8	May	22	1.44%	134.4
Apr	6	0.12%	10.9	May	23	1.46%	136.9
Apr	7	0.13%	12.4	May	24	1.50%	140.0
Apr	8	0.15%	13.9	May	25	1.52%	142.6
Apr	9	0.17%	15.8	May	26	1.58%	148.3
Apr	10	0.18%	17.1	May	27	1.67%	156.1
Apr	11	0.20%	18.6	May	28	1.70%	159.5
Apr	12	0.22%	20.2	May	29	1.78%	166.2
Apr	13	0.23%	21.6	May	30	1.84%	172.3
Apr	14	0.25%	23.6	May	31	1.87%	175.1
Apr	15	0.28%	25.9	Jun	1	1.87%	175.1
Apr	16	0.30%	27.8	Jun	2	1.88%	175.8
Apr	17	0.31%	29.3	Jun	3	1.88%	175.8
Apr	18	0.35%	32.6	Jun	4	1.95%	182.8
Apr	19	0.35%	32.9	Jun	5	1.95%	182.8
Apr	20	0.36%	34.0	Jun	6	2.00%	187.1
Apr	21	0.38%	35.3	Jun	7	2.04%	190.6
Apr	22	0.38%	35.3	Jun	8	2.04%	190.6
Apr	23	0.40%	37.4	Jun	9	2.03%	189.9
Apr	24	0.43%	39.9	Jun	10	1.96%	183.5
Apr	25	0.45%	42.2	Jun	11	1.89%	176.5
Apr	26	0.45%	42.5	Jun	12	1.78%	166.2
Apr	27	0.44%	41.0	Jun	13	1.73%	161.5
Apr	28	0.43%	40.7	Jun	14	1.65%	154.2
Apr	29	0.45%	42.2	Jun	15	1.56%	145.7
Apr	30	0.47%	43.7	Jun	16	1.50%	140.7
May	1	0.50%	46.7	Jun	17	1.48%	138.2
May	2	0.51%	47.5	Jun	18	1.43%	133.8
May	3	0.52%	48.7	Jun	19	1.37%	128.3
May	4	0.55%	51.5	Jun	20	1.27%	118.8
May	5	0.58%	54.0	Jun	21	1.21%	113.5
May	6	0.60%	56.1	Jun	22	1.15%	107.3
May	7	0.62%	58.2	Jun	23	1.06%	99.0
May	8	0.67%	63.0	Jun	24	0.97%	90.5
May	9	0.73%	68.0	Jun	25	0.89%	82.9
May	10	0.76%	71.2	Jun	26	0.82%	76.5
May	11	0.79%	73.6	Jun	27	0.77%	71.7
May	12	0.80%	75.0	Jun	28	0.72%	67.5
May	13	0.83%	77.9	Jun	29	0.66%	61.7
May	14	0.89%	82.9	Jun	30	0.62%	57.8
May	15	0.93%	87.4	Jul	1	0.56%	52.3
May	16	1.01%	94.2	Jul	2	0.52%	48.3
May	17	1.08%	101.2	Jul	3	0.47%	44.0
May	18	1.15%	107.3	Jul	4	0.43%	40.7
May	19	1.18%	110.7	Jul	5	0.41%	38.1
May	20	1.26%	118.2	Jul	6	0.37%	34.3

Table F-1. Daily Sediment TMDL for the Wise River.

Month	Day	Daily % of annual load	Wise River TMDL (tons/day)	Month	Day	Daily % of annual load	Wise River TMDL (tons/day)
Jul	7	0.33%	31.0	Aug	22	0.02%	2.2
Jul	8	0.31%	29.0	Aug	23	0.02%	2.2
Jul	9	0.29%	27.5	Aug	24	0.02%	2.3
Jul	10	0.28%	25.9	Aug	25	0.02%	2.2
Jul	11	0.26%	24.4	Aug	26	0.02%	2.2
Jul	12	0.25%	23.6	Aug	27	0.02%	2.1
Jul	13	0.23%	21.3	Aug	28	0.02%	2.0
Jul	14	0.21%	19.4	Aug	29	0.02%	1.9
Jul	15	0.19%	17.3	Aug	30	0.02%	1.9
Jul	16	0.17%	15.6	Aug	31	0.02%	1.9
Jul	17	0.15%	14.2	Sep	1	0.02%	1.8
Jul	18	0.14%	13.2	Sep	2	0.02%	1.8
Jul	19	0.13%	12.4	Sep	3	0.02%	1.8
Jul	20	0.13%	12.0	Sep	4	0.02%	1.7
Jul	21	0.12%	11.2	Sep	5	0.02%	1.7
Jul	22	0.11%	10.6	Sep	6	0.02%	1.7
Jul	23	0.10%	9.8	Sep	7	0.02%	1.7
Jul	24	0.10%	8.9	Sep	8	0.02%	1.8
Jul	25	0.09%	8.2	Sep	9	0.02%	1.9
Jul	26	0.08%	7.7	Sep	10	0.02%	1.9
Jul	27	0.08%	7.4	Sep	11	0.02%	1.8
Jul	28	0.07%	6.9	Sep	12	0.02%	1.9
Jul	29	0.07%	6.6	Sep	13	0.02%	1.9
Jul	30	0.07%	6.3	Sep	14	0.02%	1.9
Jul	31	0.07%	6.3	Sep	15	0.02%	1.9
Aug	1	0.06%	6.1	Sep	16	0.02%	1.9
Aug	2	0.06%	5.7	Sep	17	0.02%	2.0
Aug	3	0.06%	5.4	Sep	18	0.02%	2.0
Aug	4	0.05%	5.1	Sep	19	0.02%	2.1
Aug	5	0.05%	4.8	Sep	20	0.02%	2.3
Aug	6	0.05%	4.5	Sep	21	0.03%	2.4
Aug	7	0.04%	4.1	Sep	22	0.03%	2.4
Aug	8	0.04%	3.8	Sep	23	0.03%	2.4
Aug	9	0.04%	3.5	Sep	24	0.03%	2.4
Aug	10	0.04%	3.3	Sep	25	0.03%	2.4
Aug	11	0.03%	3.2	Sep	26	0.03%	2.4
Aug	12	0.03%	3.1	Sep	27	0.03%	2.5
Aug	13	0.03%	2.9	Sep	28	0.03%	2.5
Aug	14	0.03%	2.8	Sep	29	0.03%	2.6
Aug	15	0.03%	2.7	Sep	30	0.03%	2.7
Aug	16	0.03%	2.6	Oct	1	0.03%	2.8
Aug	17	0.03%	2.5	Oct	2	0.03%	2.8
Aug	18	0.03%	2.4	Oct	3	0.03%	2.9
Aug	19	0.02%	2.3	Oct	4	0.03%	3.0
Aug	20	0.02%	2.2	Oct	5	0.03%	3.0
Aug	21	0.02%	2.2	Oct	6	0.03%	3.0

Table F-1. Daily Sediment TMDL for the Wise River.

Month	Day	Daily % of annual load	Wise River TMDL (tons/day)	Month	Day	Daily % of annual load	Wise River TMDL (tons/day)
Oct	7	0.03%	3.1	Nov	22	0.03%	3.0
Oct	8	0.03%	3.1	Nov	23	0.03%	2.9
Oct	9	0.03%	3.1	Nov	24	0.03%	2.9
Oct	10	0.03%	3.2	Nov	25	0.03%	3.1
Oct	11	0.03%	3.2	Nov	26	0.03%	3.1
Oct	12	0.04%	3.3	Nov	27	0.03%	2.9
Oct	13	0.04%	3.4	Nov	28	0.03%	2.8
Oct	14	0.04%	3.4	Nov	29	0.03%	2.8
Oct	15	0.04%	3.5	Nov	30	0.03%	2.7
Oct	16	0.04%	3.6	Dec	1	0.03%	2.8
Oct	17	0.04%	3.6	Dec	2	0.03%	2.9
Oct	18	0.04%	3.6	Dec	3	0.03%	2.9
Oct	19	0.04%	3.6	Dec	4	0.03%	2.8
Oct	20	0.04%	3.6	Dec	5	0.03%	2.6
Oct	21	0.04%	3.7	Dec	6	0.03%	2.5
Oct	22	0.04%	3.8	Dec	7	0.03%	2.4
Oct	23	0.04%	3.9	Dec	8	0.02%	2.3
Oct	24	0.04%	3.9	Dec	9	0.03%	2.4
Oct	25	0.04%	3.9	Dec	10	0.03%	2.4
Oct	26	0.04%	4.0	Dec	11	0.03%	2.5
Oct	27	0.04%	4.0	Dec	12	0.03%	2.4
Oct	28	0.04%	4.0	Dec	13	0.03%	2.4
Oct	29	0.04%	3.9	Dec	14	0.03%	2.3
Oct	30	0.04%	3.9	Dec	15	0.03%	2.3
Oct	31	0.04%	3.9	Dec	16	0.02%	2.3
Nov	1	0.04%	3.9	Dec	17	0.02%	2.2
Nov	2	0.04%	3.8	Dec	18	0.02%	2.1
Nov	3	0.04%	3.9	Dec	19	0.02%	2.1
Nov	4	0.04%	4.0	Dec	20	0.02%	2.1
Nov	5	0.04%	3.9	Dec	21	0.02%	2.1
Nov	6	0.04%	4.0	Dec	22	0.02%	2.1
Nov	7	0.04%	4.0	Dec	23	0.02%	2.2
Nov	8	0.04%	4.0	Dec	24	0.02%	2.2
Nov	9	0.04%	4.0	Dec	25	0.02%	2.1
Nov	10	0.04%	3.9	Dec	26	0.02%	2.1
Nov	11	0.04%	3.8	Dec	27	0.02%	2.2
Nov	12	0.04%	3.7	Dec	28	0.02%	2.1
Nov	13	0.04%	3.7	Dec	29	0.02%	2.0
Nov	14	0.04%	3.6	Dec	30	0.02%	2.0
Nov	15	0.04%	3.6	Dec	31	0.02%	2.0
Nov	16	0.04%	3.5				
Nov	17	0.04%	3.5				
Nov	18	0.04%	3.5				
Nov	19	0.04%	3.4				
Nov	20	0.03%	3.2				
Nov	21	0.03%	3.1				

Table F-2. Sediment TMDLs expressed as an average annual load (tons/year).

Stream Segment	Water Body #	TMDL expressed as average annual load (tons/year)
Big Hole River between Divide Cr and Pintlar Cr (Middle segment)	MT41D001_020	137,984
Birch Creek headwaters to the National Forest Boundary	MT41D002_090	1,749
Birch Creek from National Forest Boundary to mouth (Big Hole R)	MT41D002_100	3,010
California Creek from headwaters to mouth (French Cr-Deep Cr)	MT41D003_070	907
Camp Creek from headwaters to mouth (Big Hole R)	MT41D002_020	2,464
Corral Creek from headwaters to mouth (Deep Cr)	MT41D003_130	341
Deep Creek from headwaters to mouth (Big Hole R)	MT41D003_040	7,647
Delano Creek from headwaters to mouth (Jerry Cr)	MT41D003_030	107
Divide Creek from headwaters to mouth (Big Hole R)	MT41D002_040	4,210
Elkhorn Creek headwaters to mouth (Jacobson Cr-Wise R)	MT41D003_220	383
Fishtrap Creek confluence of West & Middle Fks to mouth (Big Hole)	MT41D003_160	2,649
French Creek headwaters to mouth (Deep Creek)	MT41D003_050	2,928
Gold Creek from headwaters to mouth (Wise R)	MT41D003_230	592
Grose Creek from headwaters to mouth (Big Hole R)	MT41D002_060	174
Jerry Creek from headwaters to mouth (Big Hole R)	MT41D003_020	2,159
Lost Creek in the Lower Big Hole Watershed	MT41D002_180	584
Moose Creek from headwaters to mouth (Big Hole R at Maiden Rock)	MT41D002_050	1,778
Oregon Creek headwaters to mouth (California Cr - French Cr - Deep)	MT41D003_080	131
Pattengail Creek from headwaters to mouth (Wise R)	MT41D003_210	2,412
Rochester Creek from headwaters to mouth (Big Hole R)	MT41D002_160	1,555
Sawlog Creek tributary to Big Hole R	MT41D004_230	307
Sevenmile Creek from headwaters to mouth (Deep Cr)	MT41D003_110	384
Sixmile Creek from headwaters to mouth (California Cr)	MT41D003_090	401
Soap Creek from headwaters to mouth (Big Hole R)	MT41D002_140	1,011
Trapper Creek from headwaters to mouth (Big Hole R)	MT41D002_010	2,589
Wise River from headwaters to mouth (Big Hole R)	MT41D003_200	9,358

F.2 TEMPERATURE DAILY TMDLS AND INSTANTANEOUS TEMPERATURE LOADS

The temperature TMDLs are the sum of waste load allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources (**Equation F-1**). Although there are no point sources in this watershed and therefore are no WLAs. In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream.

Equation F-1.

$$\text{TMDL} = \Sigma\text{WLA} + \Sigma\text{LA} + \text{MOS}.$$

Where:

ΣWLA = Waste Load Allocation = Pollutants from NPDES Point Sources

ΣLA = Load Allocation = Pollutants from Nonpoint Sources + Natural Sources

MOS = Margin of Safety

Total maximum daily loads are based on the loading of a pollutant to a water body. Federal Codes indicate that for each thermally listed water body the total maximum daily thermal load cannot be exceeded in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife. Such estimates shall take into account the water temperatures, flow rates, seasonal variations, existing sources of heat input, and the dissipative capacity of the identified waters. The following approach for setting numeric temperature TMDLs considers all of the factors listed above.

The numeric daily thermal loads (TMDLs) and instantaneous thermal load (ITLs) presented in this appendix apply to all portions of the temperature impaired waters in Middle and Lower Big Hole River TMDL Planning Areas. This appendix provides daily and instantaneous heat loading limits for the middle and lower segments of Big Hole River and Divide Creek. All waters in this planning area are classified as A-1 or B-1. Montana's temperature standard for A-1 or B-1 water body classifications are depicted in **Figure F-3**.

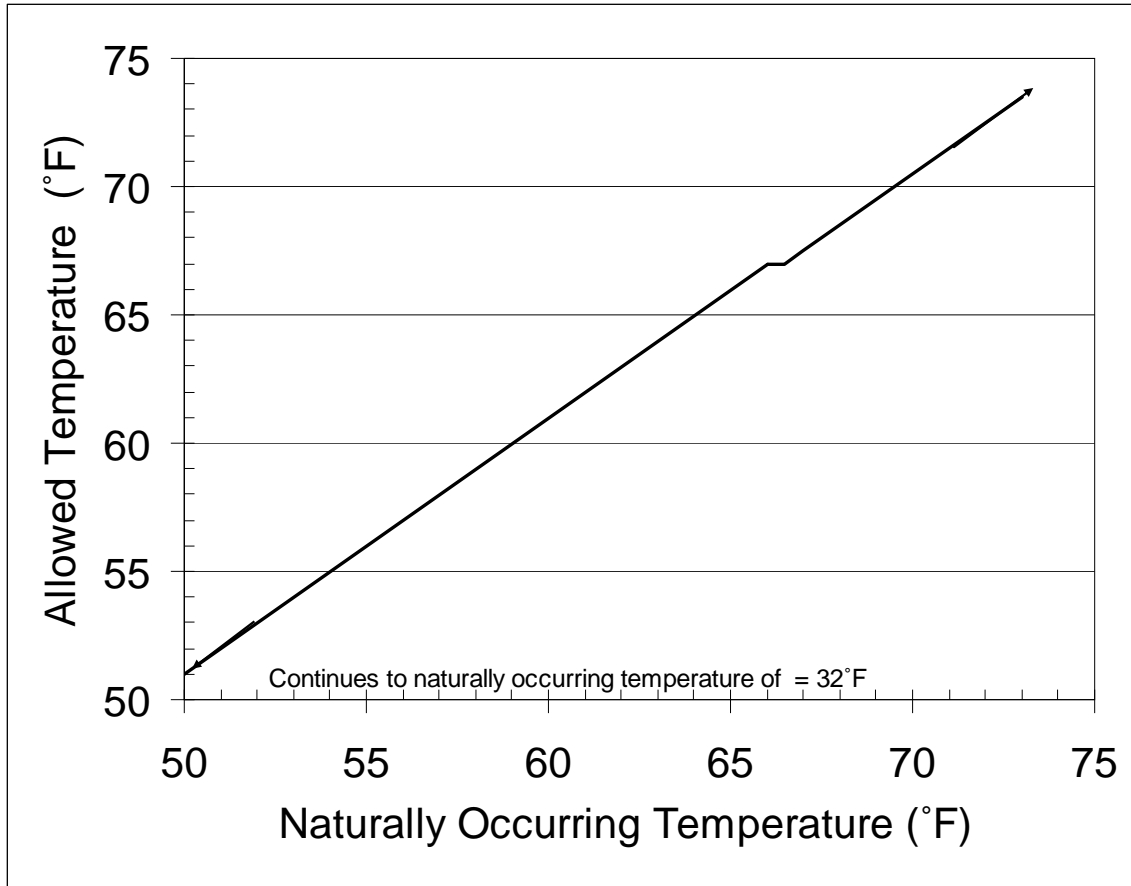


Figure F-3. In-stream Temperatures Allowed by Montana's A-1 and B-1 Classification Temperature Standard

F.2.1 Daily Thermal Load

The allowed temperature can be calculated using Montana’s A-1 classification temperature standards (**Figure F-3**) and using a modeled or estimated naturally occurring daily average temperature. The daily average total maximum load at any location in the water body is provided **Equation F-2**. The daily allowable loading is expressed as the allowable loading to the liquid form of the water in the stream. This is defined as the kilocalorie increase associated with the warming of the water from 32°F to the temperature that represents compliance with Montana's temperature standard as determined from **Figure F-3**.

Equation F-2

$$(\Delta - 32) * (Q) * (1.36 * 10^6) = \text{TMDL}$$

Where:

Δ = allowed temperatures from **Figure F-3** using daily temperature condition

Q = average daily discharge in cubic feet per second (CFS)

TMDL = daily TMDL in Calories (kilocalories) per day above water’s melting point

Conversion factor = 1359209

There are no point sources that increase water temperatures, and therefore, no wasteload allocations for the watershed. The TMDL load allocation for each stream is a combination of the ½ °F allowable loading shared between the human caused sources without reasonable land, soil, and water conservation practices in addition to the naturally occurring loading as defined in state law. Because temperatures are estimated to be naturally above 66 °F at times, one-half degree allowable increase in temperature is used for the TMDL and allocations. See the main document for more information about surrogate allocations, which are more applicable to restoration approaches. The surrogate allocations should meet the daily thermal load. The daily numeric TMDL allocation is equal to the load allocation shared by all human-caused sources without reasonable land, soil, and water conservation practices plus the load allocated to naturally occurring temperatures as shown in **Equation F-3**.

Equation F-3

$$\text{Load Allocation} = \text{Allowable Human Sources} + \text{Naturally Occurring Thermal Loads}$$

Where:

$$\text{Naturally Occurring Thermal Loads} = (\text{Naturally Occurring Temperature (°F) from Modeling Scenarios} - 32) * (\text{Discharge (CFS)}) * (1.36 * 10^6)$$

$$\text{Allowable Human Sources above naturally occurring conditions} = (1/2^\circ\text{F}) * (1.36 * 10^6) * (\text{Discharge (CFS)})$$

F.2.2 Instantaneous Thermal Load

Because of the dynamic temperature conditions during the course of a day, an instantaneous thermal load (ITL) is also provided for temperature. For temperature, the daily average thermal conditions are not always an effective indicator of impairment to fisheries. The heat of the day is usually the most stressful timeframe for salmonids and char. Also, in high altitudes, thermal impacts that heat during the day may produce advanced cooling conditions during the night so that the daily temperature fluctuations increase greatly, with potentially significant negative impacts to fish without much impact on daily average temperature conditions. Therefore, Montana provides an instantaneous thermal load to protect during the hottest timeframes in mid to late afternoon when temperatures are most stressful to the fishery, which is the most sensitive use in reference to thermal conditions.

The instantaneous load is computed by the second. The allowed temperature can be calculated using Montana’s A-1 or B-1 classification temperature standards (**Figure F-3**) and using a modeled or estimated naturally occurring instantaneous temperature. The instantaneous total maximum load (per second) at any location in the water body is provided by **Equation F-4**. The allowable loading over a second is expressed as the allowable loading to the liquid form of the water in the stream. This is defined as the kCal increase associated with the warming of the water from 32°F to the temperature that represents compliance with Montana's temperature standard as determined from **Figure F-3**.

Equation F-4

$$(\Delta-32)*(Q)*(15.73) = \text{Instantaneous Thermal Load (ITL)}$$

Where:

Δ = allowed temperatures from **Figure F-3** using daily temperature condition

Q = instantaneous discharge in CFS

ITL = Allowed thermal load per second in kilocalories per day above water's melting point

Conversion factor = 15.73

There are no point sources that increase water temperatures, and therefore, no instantaneous wasteload allocations for the watershed. The ITL load allocation for each stream is a combination of the 1/2°F allowable loading shared between the human caused sources without reasonable land, soil, and water conservation practices in addition to the naturally occurring loading as defined in state law. Because temperatures are estimated to be naturally above 66 °F at times, one-half degree allowable increase in temperature is used for the TMDL and allocations. See the main document for more information about surrogate allocations, which are more applicable to restoration approaches. The surrogate allocations should meet the ITL. The ITL allocation is equal to the load allocation shared by all human caused sources without reasonable land, soil and water conservation practices plus the load allocated to naturally occurring temperatures as shown in **Equation F-5**.

Equation F-5

$$\text{Load Allocation} = \text{Allowable Human Sources} + \text{Naturally Occurring Thermal Loads}$$

Where:

Naturally Occurring Thermal Loads = (Naturally Occurring Temperature (°F) from Modeling Scenarios -32)*(Discharge (CFS))*(15.73)

Allowable Human Sources above naturally occurring conditions =
(1/2°F)*(15.73)*(Discharge (CFS))

F.2.3 Margins of Safety, Seasonal Variations and Future Sources

See **Section 7** of the main document for this discussion.

F.2.4 Example Numeric TMDL Application for the Big Hole River above Pintlar Creek

Big Hole River Daily Thermal Load Example Application

Monitoring along with Heatsource and SNTEMP (Stream Network Temperature Model) models were completed on the Big Hole River and Divide Creek (**Appendices I and J**). Modeling scenarios used reference riparian shade conditions throughout the watershed along with an estimated increase of 15 percent irrigation efficiency increase during warm summer months to

estimate naturally occurring temperatures where all reasonable land, soil, and water conservation practices are in place with existing land use. Naturally occurring average daily temperature at the Big Hole River’s confluence with Pintlar Creek during a hot day of summer 2006 was estimated at 67.3°F using SNTMP modeling. This temperature is then used to determine the allowable temperature according to **Figure F-3**, Montana’s temperature standard. The allowable mean daily temperature is estimated at 67.8°F during the hottest days of the summer. **Equation F-2** from above is used to calculate the upper portion of the Middle segment Big Hole River TMDL during the hottest days of the summer. This location was one of the most heavily impacted thermal areas found along the Middle Segment of the Big Hole River during the source assessment.

Example:

$$(\Delta-32)*(Q)*(1.36*10^6) = \text{TMDL}$$

Where:

- Δ = allowed temperatures from **Figure F-3** using daily temperature condition = **67.8°F**
- Q = average daily discharge in cubic feet per second (CFS) = **101cfs**
- TMDL = daily TMDL in Calories (kilocalories) per day above water’s melting point = **4.92*10⁹ kilocal/day**

The Upper Big Hole River load allocation to human caused heat sources not addressed by reasonable land, soil, and water conservation practices for the TMDL is 6.87*10⁷ kilocalories per day. The remainder of the TMDL is appropriated to naturally occurring thermal load. Since there are no NPDES permits that affect water temperature, there is zero waste load allocation. During warm summer days the mean daily temperature of this site exceeds the average daily TMDL. Similar exercises could be completed for the middle reaches of Divide Creek and the lower reaches lower section of the Big Hole River, but these examples are not provided because they lack utility.

Big Hole River Instantaneous Thermal Load

The instantaneous thermal load (ITL) is described as the heat passing a monitoring location per second. The most sensitive timeframe for the fishery occurs during the heat of the day for the hottest period of the year. The same modeling described earlier in this appendix was used to model daily maximum temperatures. The naturally occurring daily maximum temperature in the Big Hole River near Pintlar Creek’s confluence during one of the hottest days of summer 2006 was estimated at 73.5°F using a SNTMP model. This temperature is then used to determine the allowable temperature according to **Figure F-3**, Montana’s temperature standard. Therefore, the allowable maximum temperature during this timeframe is estimated at 74.0°F during a hot summer day. **Equation F-4** from above is used to calculate the upper portion of the Middle Big Hole River’s ITL during one of the hottest days of the summer.

Example:

$$(\Delta-32)*(Q)*(15.73) = \text{Instantaneous Thermal Load (ITL)}$$

Where:

Δ = allowed temperatures from **Figure F-3** using instantaneous temperature condition = **74.0°F**

Q = average daily discharge in cubic feet per second (CFS) = **101cfs**

ITL = Allowed thermal load per second in kilocalories per day above water's melting point = **66,700 kilocal/second**

The Middle Big Hole River's load allocation to human caused heat sources not addressed by reasonable land, soil, and water conservation practices for the ITL is 794 kilocalories per second. Since there are no NPDES permits that affect water temperature, there is zero waste load allocation. The remainder of the load allocation for the ITL is apportioned to naturally occurring thermal loading. During the hottest days of the summer the ITL is greatly surpassed in the Big Hole River near the confluence with Pintlar Creek (near the upstream limit of the middle Big Hole River Segment). This is the most heavily impacted reach of the Big Hole River regarding thermal impacts. This indicates that Montana's temperature standard at this site is not being met during an important timeframe for the most sensitive use. Similar exercises could be completed for the middle reaches of Divide Creek and the lower reaches lower section of the Big Hole River and the ITL would be exceeded, but these examples are not provided because they lack utility. Any measured location on the temperature impaired streams could apply to the ITL.