Appendix M. Total Suspended Solids and Bedload Data

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Appendix M. Total Suspended Solids and Bedload Data

The total suspended solids (TSS) and bedload data reported herein are the results of several different efforts on the part of the Department of Environmental Quality (DEQ), the Nez Perce Tribe (NPT), and the U.S. Environmental Protection Agency (USEPA). The USEPA provided funding for some of these efforts. DEQ collected instantaneous flow, TSS, and turbidity data for Threemile Creek as part of its detailed monitoring of that water body. The NPT collected instantaneous flow, TSS, turbidity, and bedload data for Butcher Creek as part of its monitoring of that water body. DEQ contracted with Western Watershed Analysts of Lewiston, Idaho, to provide flow and bedload data for the main stem South Fork Clearwater River (SF CWR) and Threemile Creek.

Unfortunately, flows in Threemile Creek and Butcher Creek over the sample period were below the level where significant bedload moved or could be sampled. Therefore, bedload for these streams was estimated from the sediment budget. Similarly, for the year when the contractor was to sample bedload in the upper main stem SF CWR, flows did not allow the bedload to be sampled. The result is that sampled bedload data exist only for the Stites and Harpster sites.

Other TSS and turbidity data exist for the SF CWR subbasin, but come from such diverse locations and time periods as to make them difficult to use for a subbasin wide analysis. DEQ collected turbidity and flow for a number of streams in the SF CWR subbasin (Thomas 1991) and these data provide a comparison for the results of our calculations. The Nez Perce National Forest (NPNF) collected TSS, turbidity and flow data at the Mt. Idaho bridge from 1988-1992, analyzed these data, and extrapolated them using the data from Thomas (1991). These results were also used to help validate the results from the 1991-2001 stochastic flow data used in the sediment loading calculations in Chapter 5.

Sediment yield curves were developed from the TSS and bedload data. The data and sediment yield curves for the Threemile, Butcher, Stites, and Harpster sites are presented in the tables and figures on the following pages (Tables M-1 through M-6 and Figures M-1 through M-4).

Table M-1. Threemile Creek turbidity and total suspended solids (TSS) data.

Date	Discharge (cfs)*	TSS (mg/L)**	TSS (tons/day)	Turbidity (NTU)***
03/08/2001	48	55	7.089	107
03/09/2001	163	153	67.335	175
03/10/2001	73	80	15.727	142
03/13/2001	43	43	5.004	82
02/22/2000	10	56	1.501	9
03/07/2000	9	1	0.025	12
03/21/2000	8	1	0.021	10
04/04/2000	8	1	0.021	14
04/18/2000	7	8	0.152	10
05/02/2000	7	5	0.094	8
05/16/2000	17	5	0.231	22
05/30/2000	10	5	0.136	11
06/13/2000	9	8	0.200	13
06/27/2000	3	1	0.007	4
07/11/2000	2	3	0.018	1
07/25/2000	1	3	0.007	3
08/08/2000	1	5	0.011	2
08/22/2000	2	2	0.008	2
09/05/2000	2	2	0.012	4
09/19/2000	2	1	0.004	2
10/03/2000	4	2	0.021	5
11/16/2000	3	3	0.023	nd
12/11/2000	3	1	0.007	nd
01/17/2001	4	1	0.011	nd

* cubic feet per second
** milligrams per liter
*** nephlometric turbidity units

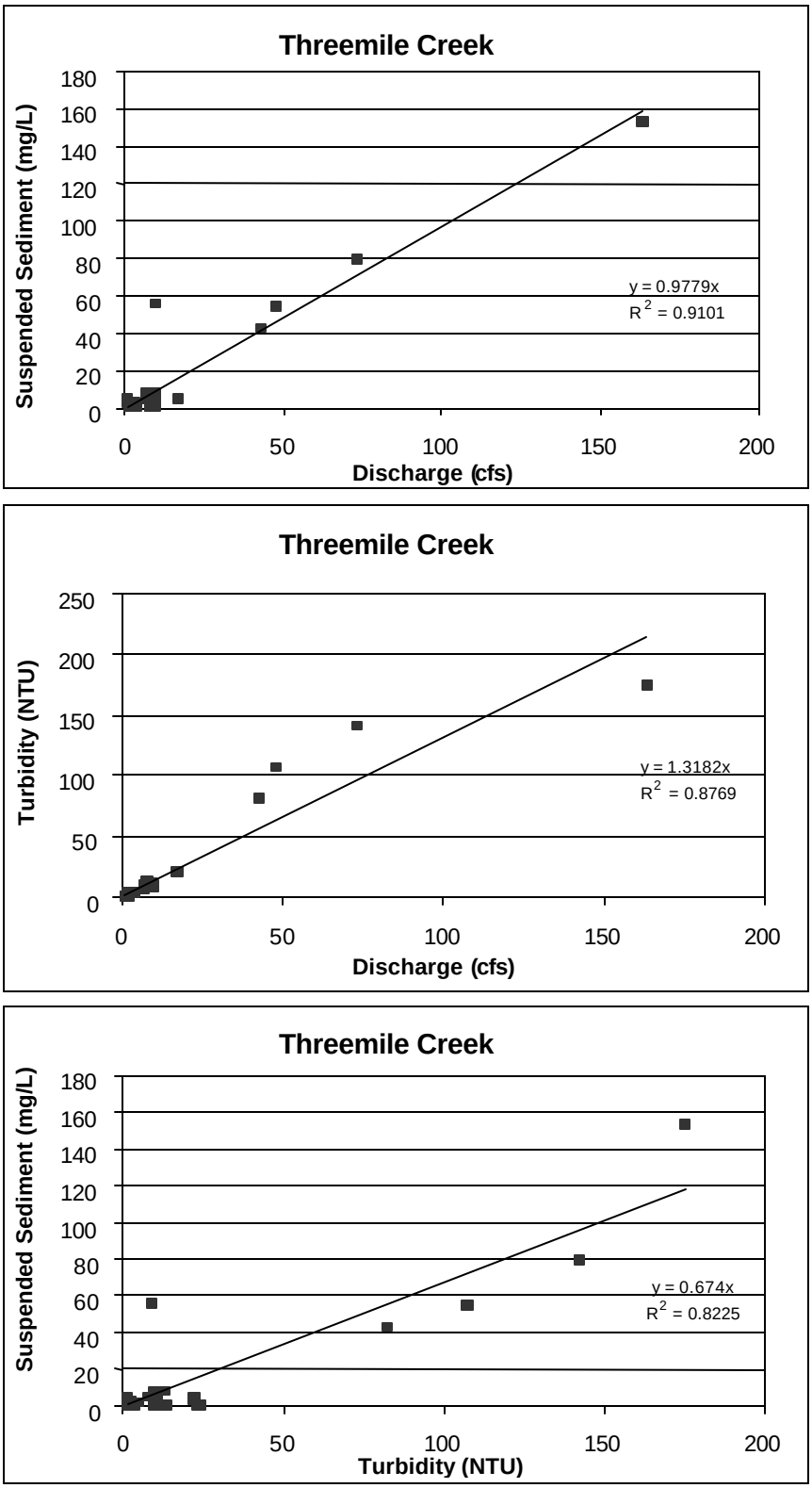
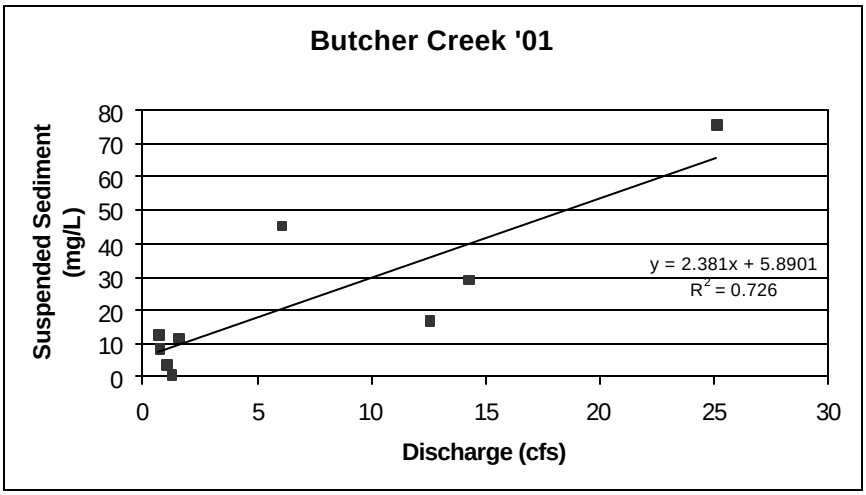


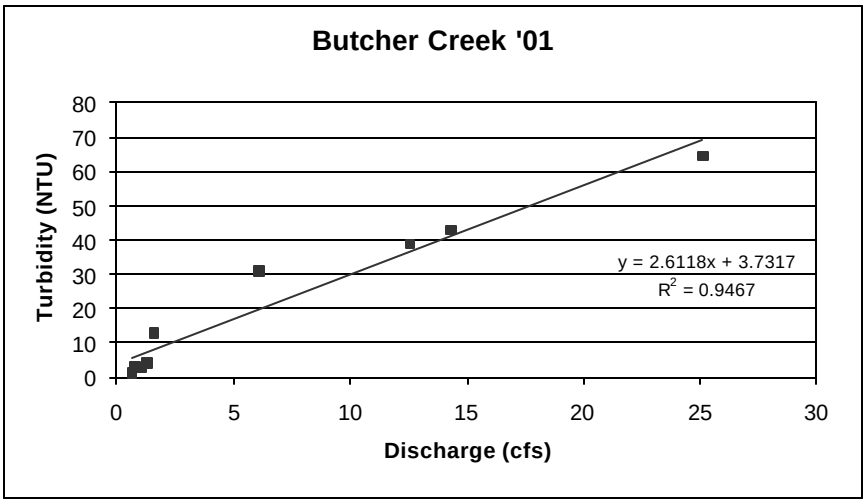
Figure M-1. Threemile Creek Sediment Yield Curves

Table M-2. Butcher Creek turbidity and total suspended solids (TSS) data.

Date	Discharge (cfs)*	TSS (mg/L)**	TSS (tons/day)	Turbidity (NTU)***
01/07/02	6.1	45.3	0.745	31.0
01/16/02	1.3	0.6	0.002	4.1
02/27/02	12.6	16.7	0.568	39.0
03/27/02	1.6	11.5	0.049	12.8
04/30/02	14.3	29.0	1.120	43.2
05/01/02	25.1	75.8	5.137	64.4
10/31/02	0.8	8.1	0.017	2.9
11/26/02	0.7	12.7	0.024	1.5
12/12/02	0.8	8.8	0.018	3.2
12/19/02	1.0	3.3	0.009	3.00

* cubic feet per second
** milligrams per liter
*** nephlometric turbidity units





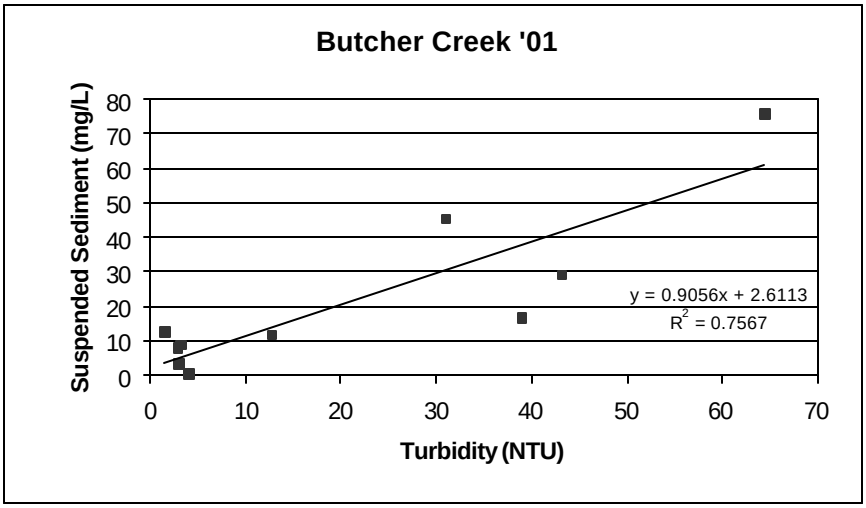


Figure M-2. Butcher Creek Sediment Yield Curves

Table M-3. Stites Bridge turbidity and total suspended solids (TSS) data.

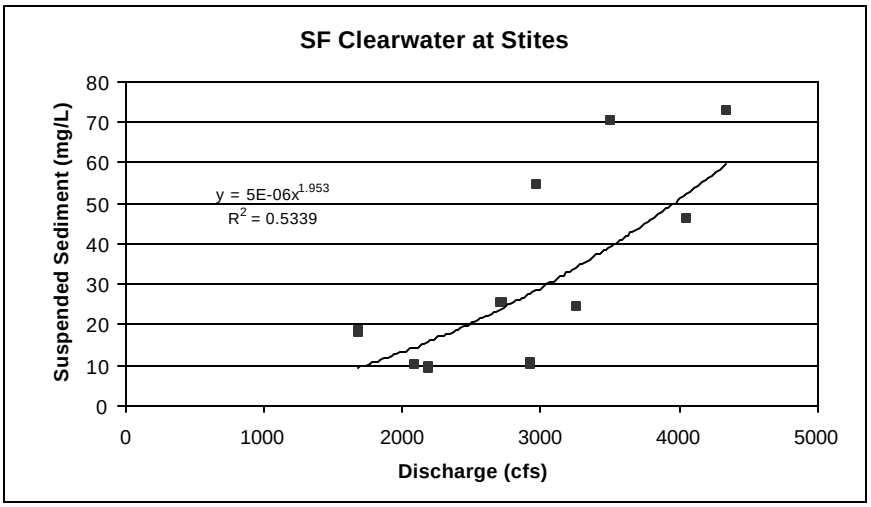
Date	Discharge (cfs)*	TSS (mg/L)**	TSS (tons/day)	Turbidity (NTU)***
03/27/2001	1,680	18.4	83	17.1
04/26/2001	2,960	54.7	437	19.4
05/01/2001	4,330	73.1	855	53.4
05/02/2001	3,500	70.6	667	22.9
05/05/2001	2,710	25.6	187	6.9
05/14/2001	3,250	24.6	216	5.5
05/15/2001	4,040	46.2	504	19.3
05/18/2001	2,920	10.4	82	5.7
05/21/2001	2,080	10.2	57	3.9
05/24/2001	2,180	9.5	56	3.3

* cubic feet per second
** milligrams per liter
*** nephlometric turbidity units

Table M-4. Stites bridge bedload data.

Date*	Discharge (cfs)**	Bedload (grams)	Bedload (tons/day)	TSS*** (tons/day)	Total Sediment (tons/day)
03/27/2001	1,570	24.79	1.4	83	84
03/27/2001	1,550	53.66	2.9	83	86
04/26/2001	2,970	132.22	14.0	437	451
04/26/2001	2,950	146.23	15.5	437	452
05/14/2001	3,330	253.85	25.0	216	241
05/14/2001	3,300	237.67	23.4	216	239
05/15/2001	4,020	261.29	27.2	504	531
05/15/2001	3,980	740.51	77.0	504	581
05/18/2001	2,950	206.07	10.1	82	92
05/18/2001	2,950	157.74	7.7	82	90
05/21/2001	2,060	24.91	1.2	57	58
05/24/2001	2,140	62.48	3.1	56	59
05/24/2001	2,140	89.20	4.4	56	60

* duplicate dates indicate two samples from same site on the same day
** cubic feet per second
*** total suspended solids


SF Clearwater at Stites
Suspended Sediment (mg/L)
Discharge (cfs)
y = 5E-06x^1.953
R^2 = 0.5339
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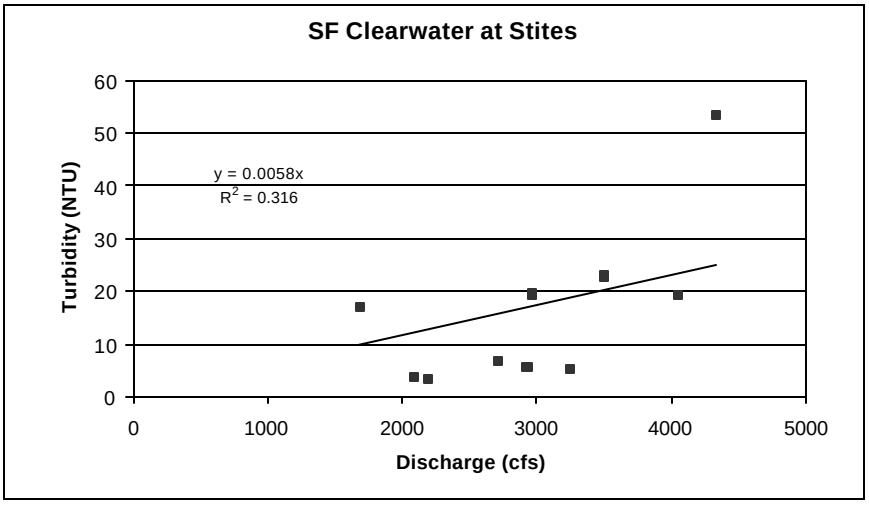
10
20
30
40
50
60
70
80
0
1000
2000
3000
4000
5000


SF Clearwater at Stites
Turbidity (NTU)
Discharge (cfs)
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R^2 = 0.316
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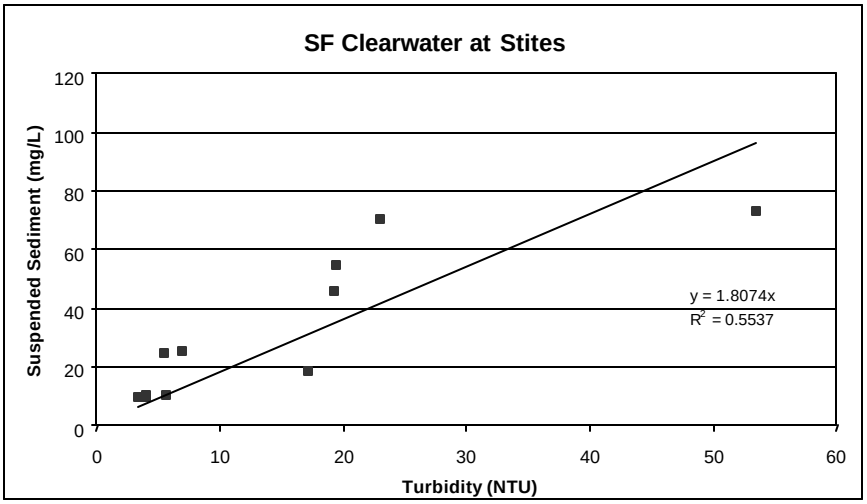
60
0
1000
2000
3000
4000
5000


SF Clearwater at Stites
Suspended Sediment (mg/L)
Turbidity (NTU)
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R^2 = 0.5537
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120
0
10
20
30
40
50
60

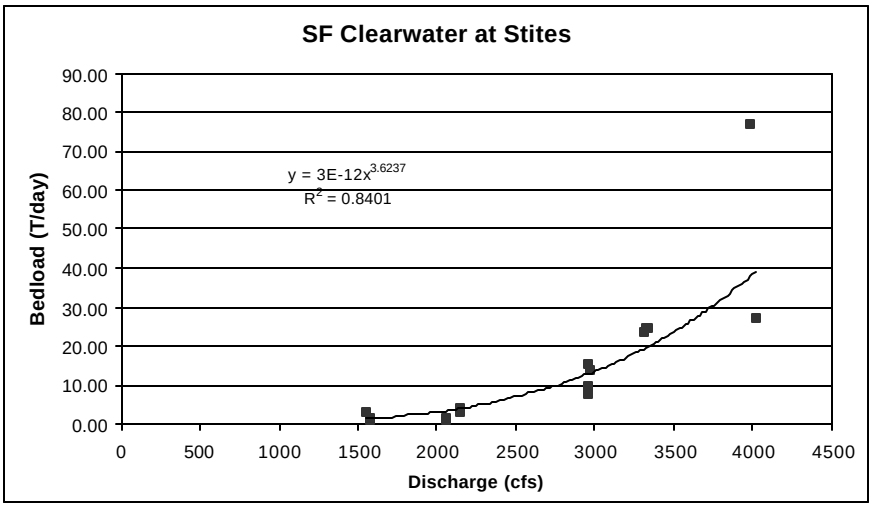


Figure M-3. Stites Bridge Sediment Yield Curves

Table M-5. Harpster total suspended solids (TSS) data.

Date	Discharge (cfs)*	TSS (mg/L)**	TSS (tons/day)	Turbidity (NTU)***
03/26/01	1,450	43.6	171	22
04/27/01	2,710	51.8	379	22
05/01/01	3,250	27.8	244	11
05/02/01	2,560	16.9	117	8
05/05/01	2,010	11.0	60	5
05/13/01	2,350	14.2	90	5
05/15/01	2,890	23.4	183	7
05/18/01	2,150	10.9	63	3
05/21/01	1,580	6.8	29	2
05/24/01	1,650	10.7	48	3
03/21/88	498	9.1	12	7
03/31/88	615	10.7	18	8
04/05/88	1,010	13.5	37	12
04/11/88	1,190	24.0	77	11
04/19/88	4,030	84.0	914	13
04/25/88	2,740	15.0	111	8
05/03/88	2,030	6.7	37	6
05/09/88	2,750	10.8	80	10
05/16/88	3,140	11.5	97	5

Date	Discharge (cfs)*	TSS (mg/L)**	TSS (tons/day)	Turbidity (NTU)***
05/31/88	2,430	13.0	85	10
06/06/88	2,456	3.4	23	4
06/27/88	1,300	3.6	13	5
03/15/89	1,057	8.5	24	8
03/28/89	1,610	12.1	53	10
04/11/89	1,830	10.6	52	9
04/25/89	3,410	19.3	178	6
05/08/89	4,810	31.0	403	9
05/16/89	2,410	15.7	102	2
05/22/89	2,090	12.6	71	8
06/07/89	2,410	14.5	94	3
06/16/89	3,120	39.3	331	8
07/05/89	722	2.6	5	2
04/11/90	1,420	2.8	11	3.6
04/18/90	1,990	15.3	82	4
04/25/90	1,830	7.9	39	3
05/10/90	4,410	2.9	35	4
05/16/90	2,410	9.3	61	5
05/24/90	2,190	39.0	231	nd
06/01/90	4,000	12.0	130	nd
06/06/90	2,510	24.0	163	nd
06/13/90	2,160	7.0	41	nd
07/01/90	779	2.7	6	nd
07/26/90	583	13.0	20	nd
04/05/91	1,470	27.0	107	10
04/12/91	1,240	4.9	16	8
04/19/91	1,090	6.5	19	6
05/03/91	1,230	4.1	14	5
05/09/91	3,620	88.0	860	20
05/17/91	2,740	13.0	96	6
05/23/91	3,230	14.0	122	7
05/31/91	2,850	12.0	92	7
06/10/91	2,220	7.3	44	4
06/14/91	1,990	8.3	45	2

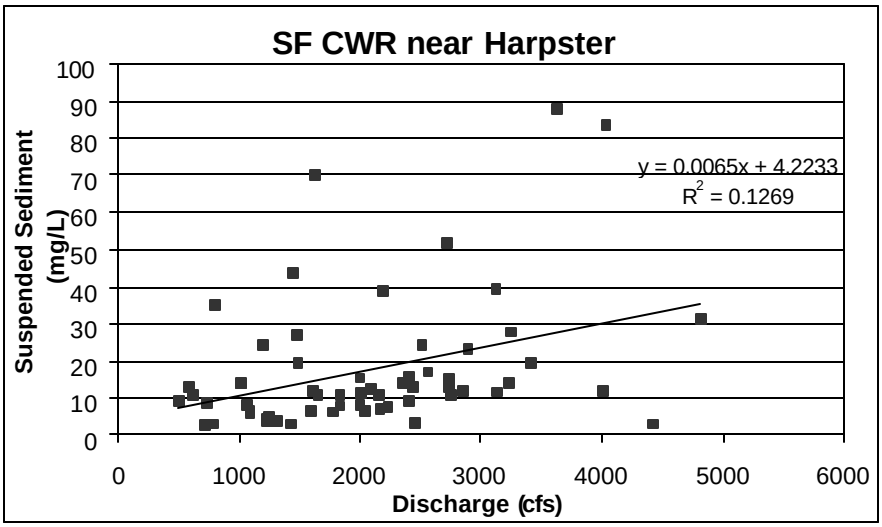
Date	Discharge (cfs)*	TSS (mg/L)**	TSS (tons/day)	Turbidity (NTU)***
06/19/91	1,630	70.0	308	6
07/02/91	1,780	6.1	29	4
03/17/92	1,010	14.2	39	10
04/10/92	1,230	3.7	12	16
04/24/92	1,090	5.7	17	4
04/30/92	1,490	19.6	79	7
05/29/92	729	8.7	17	3
07/09/92	799	34.9	75	18

* cubic feet per second
** milligrams per liter
*** nephlometric turbidity units

Table M-6. Harpster bedload data.

Date	Discharge (cfs)*	Bedload (grams)	Bedload (tons/day)	TSS (tons/day)	Total Sediment (tons/day)
03/26/01	1,450	60	2.8	171	174
03/26/01	1,450	73	3.4	171	174
05/05/01	2,010	185	4.3	60	64
05/05/01	2,010	211	5.0	60	65
05/13/01	2,350	339	15.9	90	106
05/13/01	2,350	207	9.7	90	100
05/15/01	2,890	347	16.3	183	199
05/15/01	2,890	356	16.8	183	200
05/18/01	2,150	118	5.5	63	69
05/18/01	2,150	119	5.6	63	69
05/21/01	1,580	59	2.8	29	32
05/21/01	1,580	71	3.4	29	32
05/24/01	1,650	67	3.2	48	51
05/24/01	1,650	60	2.9	48	51

* cubic feet per second
** total suspended solids


SF CWR near Harpster
Suspended Sediment (mg/L)
Discharge (cfs)
y = 0.0065x + 4.2233
R2 = 0.1269
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30
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50
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70
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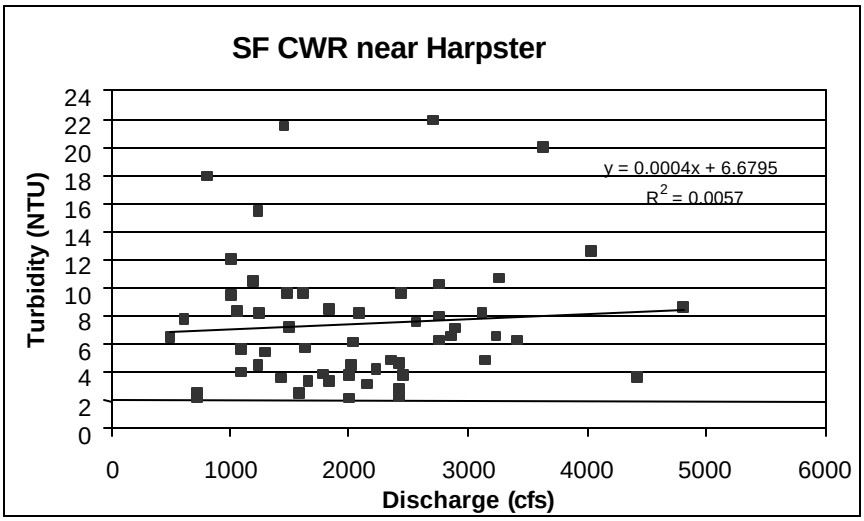
0
1000
2000
3000
4000
5000
6000


SF CWR near Harpster
Turbidity (NTU)
Discharge (cfs)
y = 0.0004x + 6.6795
R2 = 0.0057
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12
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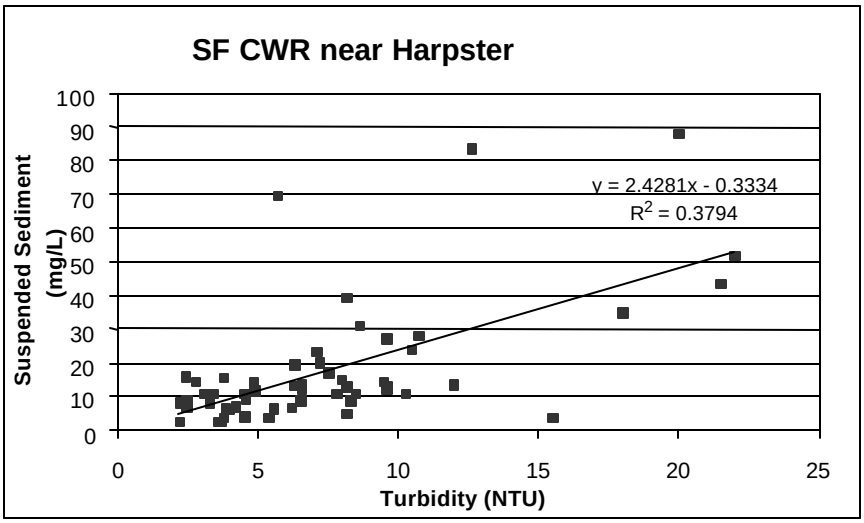
5000
6000


SF CWR near Harpster
Suspended Sediment (mg/L)
Turbidity (NTU)
y = 2.4281x - 0.3334
R2 = 0.3794
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100
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5
10
15
20
25

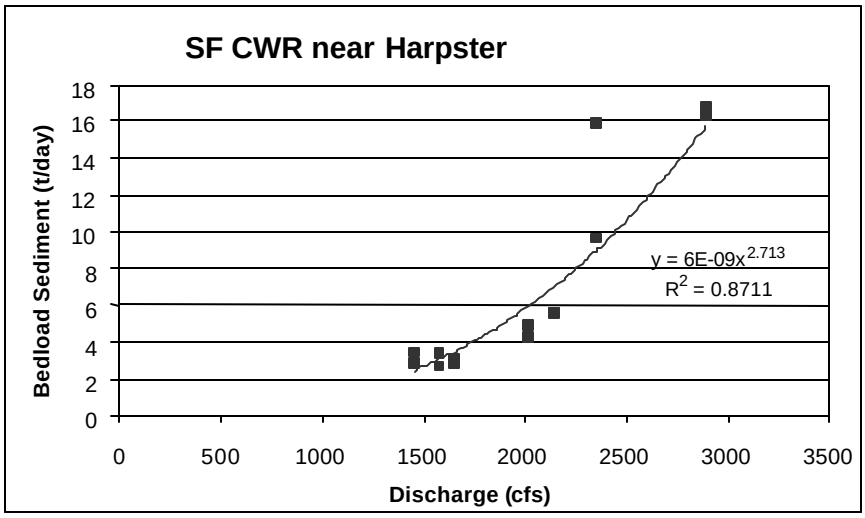


Figure M-4. Harpster Sediment Yield Curves

The TSS and bedload yield curves were coupled with daily flow data in the spreadsheet to predict TSS loads and bedloads on a daily basis. At this point, the estimates of daily flow were coupled with the sediment yield curves to produce estimates of average daily TSS sediment load in milligrams per liter (mg/L), which were then converted to tons of sediment per day and tons of sediment per year. Average daily nephlometric turbidity unit (NTU) values were calculated from a similarly developed relationship. The NTU to TSS relationships for the four locations are presented in Figures M-1 through M-4 as well.

The TSS sediment load capacity and excess load capacity were then calculated based on the Idaho water quality standard (WQS) of "turbidity … shall not exceed background turbidity by more than fifty NTU instantaneously or more than twenty-five NTU for more than ten consecutive days" (IDAPA 58.01.02.250.02.d). Plots of the sediment loadings at the Threemile, Butcher, and Stites sites show that turbidity is elevated for periods considerably greater than 10 days. Loading calculations are based, therefore, on the 25 NTU above background WQS. Assuming that as sediment loading reductions are accomplished, selection of this standard with which to make the calculations results in a large margin of safety for loading reductions as turbidity begins to be reduced to less than 10 consecutive days of exceedances.

Background sediment loading was developed from the sediment budget (Appendix L). The background ratio for each watershed was calculated using an assumed background erosion rate, multiplied by the routing coefficient, and divided by the total tons of sediment routed from a watershed. Background erosion rates have been developed for all federally managed watersheds and range from 16 to 90 tons per square mile per year. After reviewing the range of background figures from the federally-managed lands, background figures used in other total maximum daily load reports (TMDLs), erosion studies at Washington State University, predictions by the RUSLE model, and best professional judgement, a background erosion rate of 30 tons per square mile per year was assigned for the non-federal lands. The routing coefficient was that used by the NPNF to route sediment using the NEZSED model (Roehl

1962), and which has been used throughout the sediment budget calculations. The background ratio developed from the sediment budget for each of the four sites is presented in the loading calculations in Chapter 5.

Using the background ratio, the amount of daily load that is attributed to background was calculated by multiplying the daily load by the background ratio. Note that this results in different background loads depending on flow, as would be expected naturally, as higher flows naturally result in greater movement of sediment.

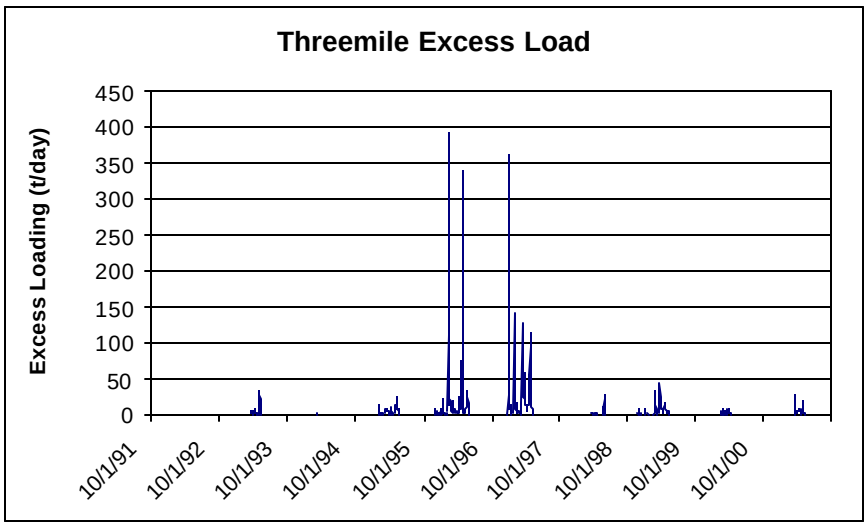
The load capacity was calculated by the relationship between turbidity in NTU to the TSS in milligrams per liter, resulting in a relationship then used to calculate the amount of TSS in milligrams per liter that the 25 NTU from the state WQS represent. For example, in Threemile Creek, 25 NTU are equivalent to 17 mg/L TSS. For each day then, the load capacity is the 17 mg/L plus the percentage of the load that is background. Since the background load varies with flow, the load capacity varies with flow as well.

Excess loading occurs when current loading is greater than the load capacity. Excess loading on a daily basis is the current load minus the load capacity. The excess load addressed by the TMDL for Threemile and Butcher Creeks and the Stites site on the SF CWR is shown in the following set of paired figures (Figures M-5 through M-7). The first figure for Threemile Creek shows the distribution and magnitude of excess loads over the 10 years of calculations, and the subsequent figure for Threemile Creek shows more detail of only two years of those same data. The point of the figures is to show that excess loading only occurs over short time frames, the same time frames as high flows, and that the episodes of excess loading are limited to January through May each year.

The excess load is summed over the 10 years of data, then divided by 10. The result is the amount of excess loading on a yearly basis. When divided by the average annual TSS yield per year, this results in the percent reduction needed in TSS sediment for a given water body. The summaries of these calculations are presented in Tables M-8 through M-11. These calculations indicate that significant load reductions in TSS are needed for Threemile Creek, Butcher Creek, and for the main stem SF CWR at Stites. The TSS-based sediment TMDLs for these water bodies are presented in Chapter 5.

The excess load calculations and resulting sediment reduction targets have a large margin of safety built in them based on the use of the 25 NTU over background over 10 days WQS vs. the 50 NTU over background instantaneous standard. As water bodies come closer into being in compliance with the turbidity standards, the periods of exceedance will become less than 10 days, and the 50 NTU over background standard will be in effect. For example, in only one event in the last 10 years has the Stites location exceeded the 25 NTU over background for greater than 10 days. So, one can conclude that the Stites location is close to the threshold where the 50 NTU over background standard should be in effect. Using the 50 NTU over background standard in the same calculations as above, excess load at Stites is only 3,578 tons per year, compared to 9,356 tons per year using the 25 NTU standard, and the percent load reduction required would be 9% compared to 25%. Similar calculations could be done for Threemile Creek and Butcher Creek. However, the point is that use of the

25 NTU over background as the basis for the loading calculations provides a very large margin of safety in the loading calculations. The use of the 25 NTU in the loading calculations is justified because that is the standard that should be applied for the current situation, but as compliance with the TMDL is accomplished, the 50 NTU over background standard likely will be the appropriate standard at that point.



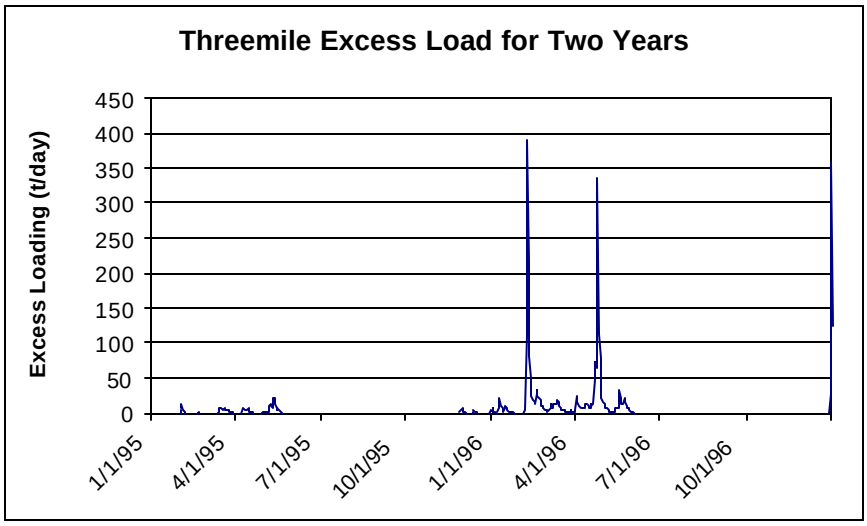


Figure M-5. Excess Sediment Loading for Threemile Creek

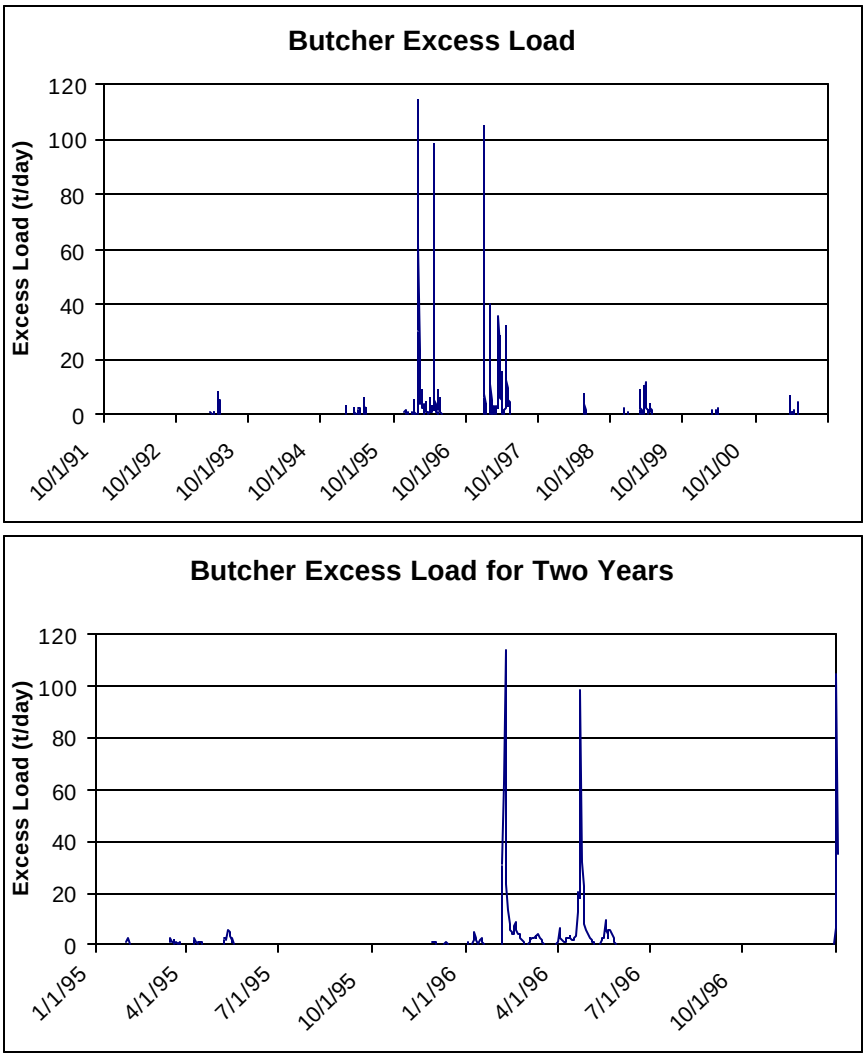


Figure M-6. Excess Sediment Loading for Butcher Creek

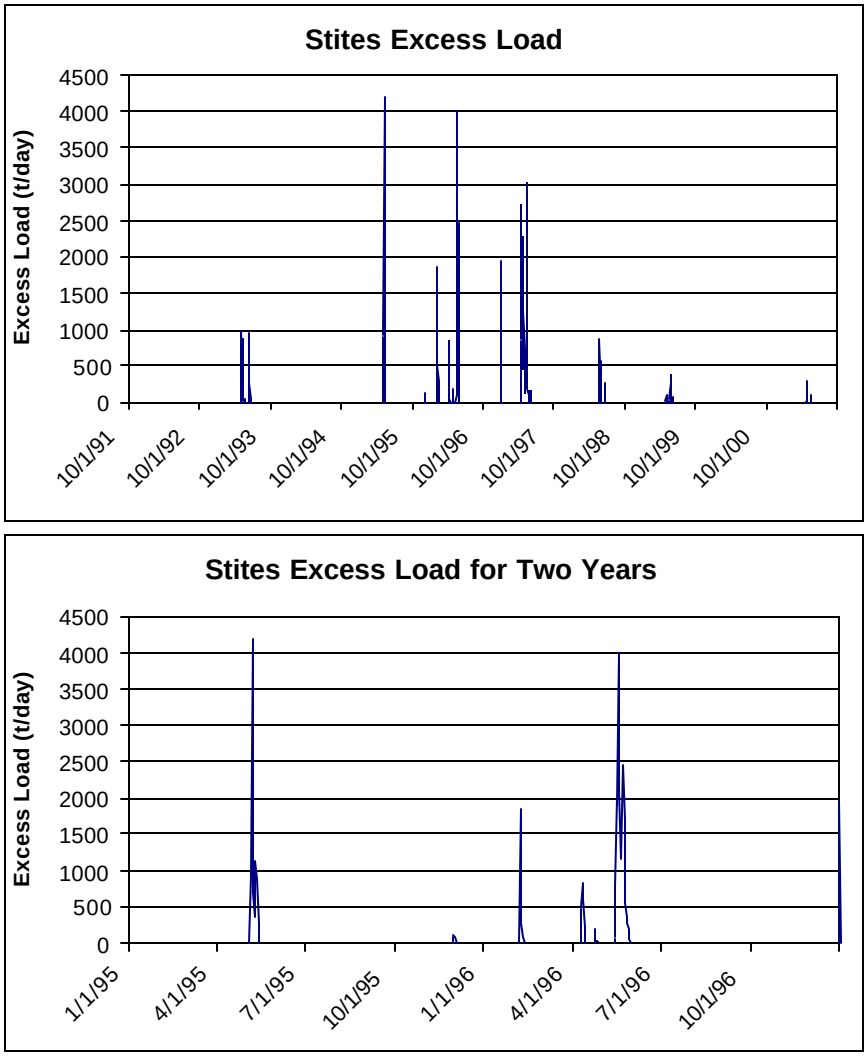


Figure M-7. Excess Sediment Loading at Stites

References

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Roehl, J.W. 1962. Sediment source areas, delivery ratios, and influencing morphological factors. Int'l. Assoc. Scientific Hydrology, Commission of Land Erosion, Publ. 59, pp 202-213.

Thomas, D.B. 1991. South Fork Clearwater River turbidity, Idaho County, Idaho, 1988. Water Quality Status Report no. 96. Idaho Dept. of Health and Welfare, Division of Environment, Boise, ID. 14 pp + app.