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HYDROLOGIC AND WATER QUALITY INVESTIGATIONS RELATED TO PLACER MINING IN INTERIOR ALASKA; SUMMER 1998

by

Jim Vohden
Alaska Division of Mining & Water Management

May 1999

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Division of Geological & Geophysical Surveys
794 University Avenue, Suite 200
Fairbanks, Alaska 99709-3645

INTRODUCTION

Monitoring of Interior Alaska streams in placer mined areas continued during the 1998 field season by Alaska Hydrologic Survey investigators. This study is a combined effort of the Alaska Department of Natural Resources Division of Mining and Water Management (ADNR/DMWM), and the Alaska Department of Environmental Conservation (ADEC). Results from similar studies carried out in previous field seasons can be found in Ray (1992), Ray (1991), Ray (1990), Ray (1989), Mack et al. (1988), Mack et al. (1987), Mack and Moorman (1987), and Mack and Moorman (1986).

Sampling sites were selected based on location, proximity to current mining activities, and past history of sampling. Automated water samplers were used to collect samples from each site on a daily basis, which were then analyzed for turbidity and total suspended solids. Though not a conclusive measure of overall water quality, turbidity and total suspended solids are a good measure for quantifying the visual clarity of water. During 1998 four waterbodies were monitored, the results of which are contained in this report.

METHODS

Field

As shown in Figure 1, four locations were selected for monitoring in 1998:

- Birch Creek at Mile 147 Steese Highway Bridge
- Crooked Creek in Central
- Birch Creek at 98 Mile Steese Highway
- Little Chena River at Mile 12 Chena Hot Springs Road

Birch Creek at Mile 147 Bridge is located approximately 25 road miles east of Central, and has been a long term monitoring station throughout these continuing studies. The basin area is approximately 2,150 square miles, and includes flows from the north and south sides of Eagle Summit, including the Crooked Creek basin. Crooked Creek in Central is monitored from a location upstream of the Steese Highway Bridge, and has a basin area of 167 square miles. The Crooked Creek drainage includes Porcupine, Bonanza, Boulder, Bedrock as well as numerous other creeks. Birch Creek at 98 Mile Steese is located at the downstream end of what is commonly referred to as the "98 Mile reclamation site". This site was reclaimed in 1995 in conjunction with the resurfacing of the Steese Highway, as gravel was authorized for use by the contractor from this location. The site is just upstream of the previous "Birch Creek above Twelve Mile Creek" location, and has a combined basin area of 67 square miles, combining Eagle, Ptarmigan, Gold Dust, Butte Creeks, as well as others. The traditional "Birch Creek above Twelve Mile Creek" monitoring site would have been used, but a new parking/canoe launch area was constructed and provides good access to the creek. While that has advantages from a

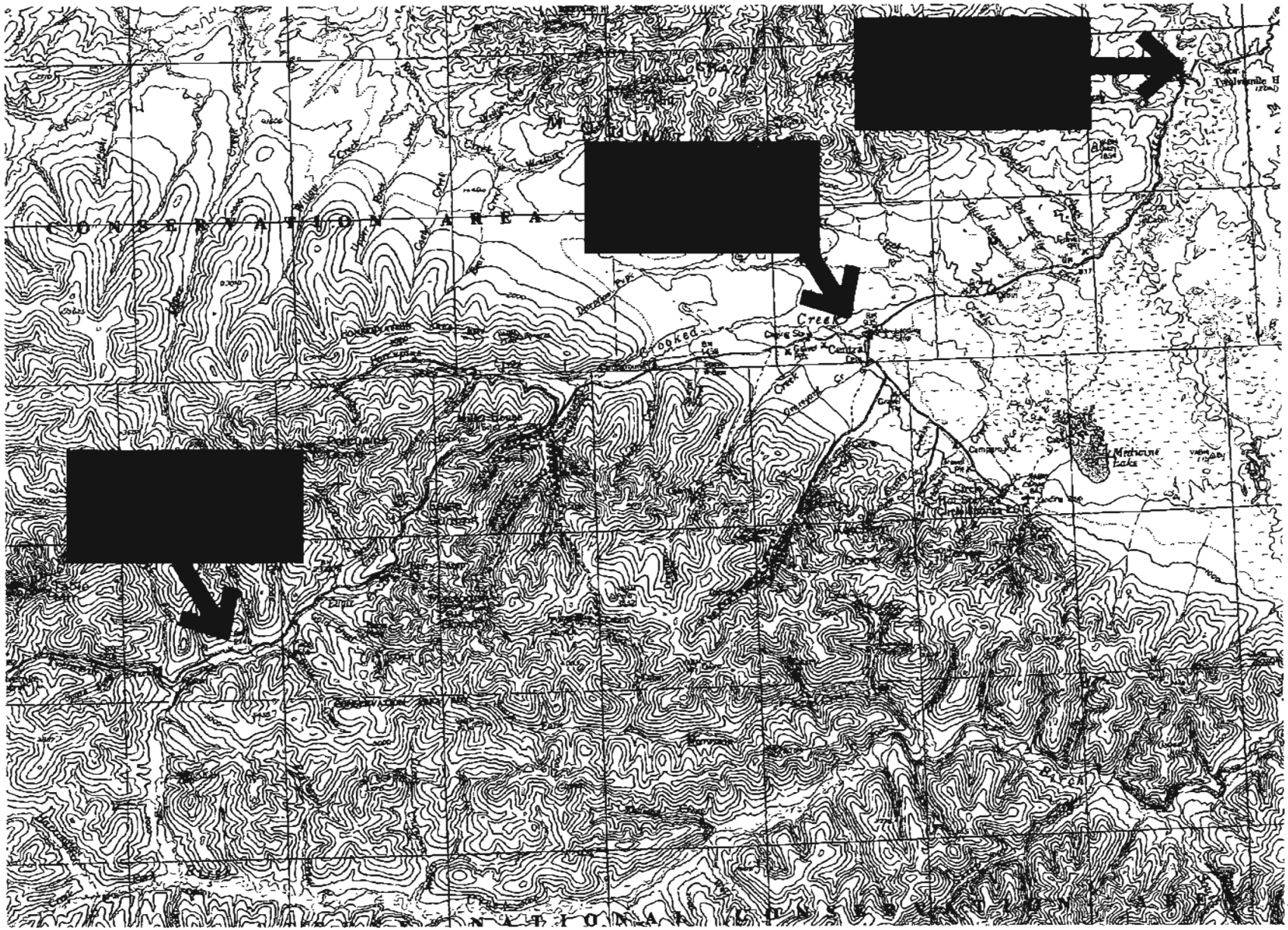

Figure 1a. Map of monitoring sites, located approximately 100 miles northeast of Fairbanks, Alaska.

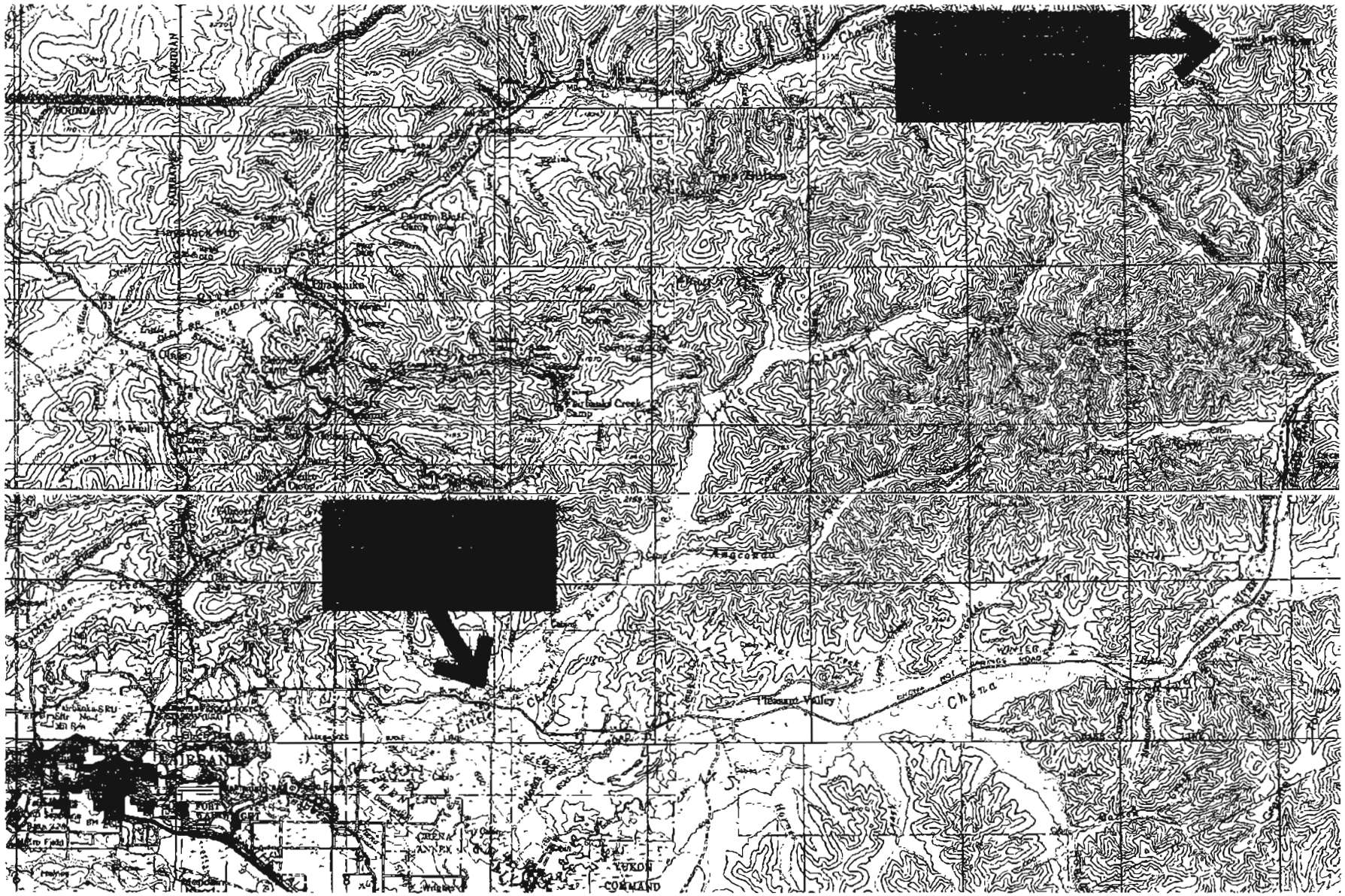

Figure 1b. Map of monitoring sites, located approximately 15 miles east of Fairbanks, Alaska.

site servicing point of view, it also makes it easier for the general public to access the sampling location and would increase the probability of vandalism. The more remote site at 98 Mile Steese Highway was chosen. The Little Chena River site is located at Mile 12 on Chena Hot Springs Road, east of Fairbanks. The basin area is 372 square miles.

Equipment for this project includes an automated water sampler commonly referred to as an "ISCO", which derives its name from ISCO, Inc. (Lincoln, Nebraska), the manufacturer of these particular samplers (the use of brand or trade names in this report is for descriptive purposes only and does not constitute endorsement). The samplers are programmed to collect a sample of water four times a day, at six hour intervals, into one bottle. Each day, a new sample bottle is filled with four aliquots of stream water. This one sample bottle from each day represents a "daily average" sample to be analyzed for selected parameters. Unless the sampling location is on the power grid, as is the case at the Little Chena River station, the samplers are powered by common 12 volt lead-acid batteries. The sampling pump is a simple peristaltic pump using a length of silicon tubing, connected to a longer length of vinyl tubing which is secured in the creek. At a pre-determined time, the pump turns on in reverse to purge the sample line, then pumps forward to collect a sample into the appropriate bottle. Depending on the model , sample bottles hold either 500 mL or 1000 mL, and each sampler holds either 24 or 28 bottles. The sites are serviced regularly to collect the samples for lab analysis.

The field installation is designed on a site-by-site basis, depending on the stream morphology and the particular situation. For the extent of this project, a typical installation is shown in Figure 2. The ideal location for the sampling site is a relatively

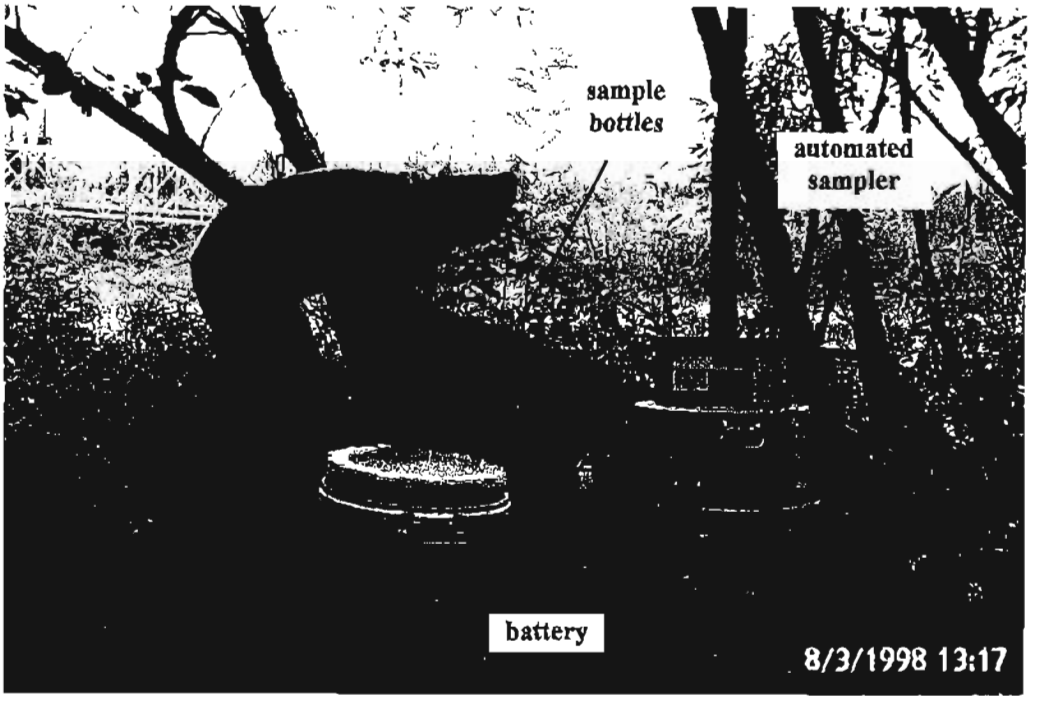

Figure 2. Monitoring equipment at Birch Creek at Mile 147 Bridge.

straight reach of the creek in which the thalweg is located near the bank selected to put the equipment on. An alternative is to place the equipment in a flood protected backwater. If such a location is utilized, care must be taken to ensure that the sample is not taken in stagnant water. In either case, it is desirable that the equipment be chained in place to deter theft and protect against equipment loss in case of an extreme flood event.

For stabilization purposes, a 7-foot steel fence post is driven into the stream bed at the desired location. A 3-foot steel staff gage is wired to a length of ¾-inch pvc pipe. The end of the vinyl suction tube is also wired to the pvc pipe such that the end of the hose is approximately six inches above the stream bed. Finally, the pvc pipe is connected to the fence post with hose clamps. This method provides a functional location from which to collect data, which is easily serviced when necessary.

A volunteer weather observer from the National Weather Service measured precipitation at Crooked Creek in Central during the summer of 1998. The observer recorded daily readings and reported them to the National Weather Service in Fairbanks on a monthly basis. Data was also utilized from a gage operated by the National Weather Service atop Mt. Ryan, located near the headwaters of the Little Chena River. These data were gathered by a remotely operated tipping bucket and relayed by way of satellite communications.

Laboratory

Laboratory analysis of the water samples was contracted to Boreochem Mobile Lab & Consulting, of Fairbanks, Alaska. Analytical methods followed those developed by the U.S. Environmental Protection Agency (EPA). Specifically, turbidity was analyzed using EPA method 180.1, which specifies use of a nephelometer calibrated against standard solutions. Analyses are reported in nephelometric turbidity units (NTU). Total suspended solids were analyzed using the gravimetric procedure outlined in EPA method 160.2 whereby a known volume of the sample is filtered through a tared glass fiber filter. The filter is dried in an oven at 105^{o}C until a constant weight is obtained, usually overnight. The filter is then weighed and the mass of the remaining residue is reported with respect to the initial volume sampled for analysis, in milligrams per liter (mg/L).

RESULTS

Each sampling location has its own characteristics which can govern the quantity and quality of data that can be reasonably collected. Summary statistics for turbidity and total suspended solids analyses are found in Tables 1 and 2. Complete results are found in Appendix A for each site monitored. Precipitation data are shown in Figure 3 for the Crooked Creek at Central site and in Figure 4 for the Mt. Ryan site; the numerical values are found in Appendix B.

DISCUSSION

As would be expected in an area of regional non-point sediment inputs, rainfall plays a major role in the explanation of stream sediment values at our monitoring locations. In the area covered by the four gage sites, orographic conditions, basin aspect, storm track direction, atmospheric conditions and basin effects maximize the variability of location and intensity of any given rain event. As seen in Figure 3, a fairly large storm event occurred in the Central area between 7 July and 13 July; 2.97 inches of rain fell over the seven days. This storm approximates the five year–7 day precipitation event (Miller, 1965). This rainfall was mirrored in the sediment graphs of Birch Creek at Mile 147 Bridge, Crooked Creek and Birch Creek at 98 Mile Steese as shown in Figures 6, 7, and 8. The storm event did not involve the Little Chena basin and there is no sign of sediment increase over that period of time in Figure 5.

Increased flow resulted from the intense rainstorm in the Crooked Creek basin, causing a failure of the stream bank where the sampling equipment was located . The ISCO sampler was chained to a large tree, and was not swept away. However, the fence post, staff gage, sample tubing and other monitoring devices were washed away and not recovered. Overall, 23 sampling days were lost due to this event. Because of this stream modification, the gage site was relocated approximately 150 feet upstream. As seen in Figures 5 through 8, there are some short term data gaps. These are primarily the result of operator or equipment malfunction, and are on the order of one to three days lapsed sampling time.

Table 1. Summary statistics for turbidity analyses, summer 1998 data.

	Birch Creek at Mile 147 Bridge	Crooked Creek at Central	Birch Creek at 98 Mile Steese	Little Chena River
Mean	39	76	127	14
Median	18	50	38	1.0
Maximum	280	500	2000	130
Minimum	2.3	0.54	0.45	0.64
n	88	86	110	119

Table 2. Summary statistics for total suspended solids analyses, summer 1998 data.

	Birch Creek at Mile 147 Bridge	Crooked Creek at Central	Birch Creek at 98 Mile Steese	Little Chena River
Mean	151	304	501	33
Median	61	148	102	21
Maximum	1070	3390	11050	294
Minimum	2.2	7.1	<1.0	3.5
n	88	86	110	119

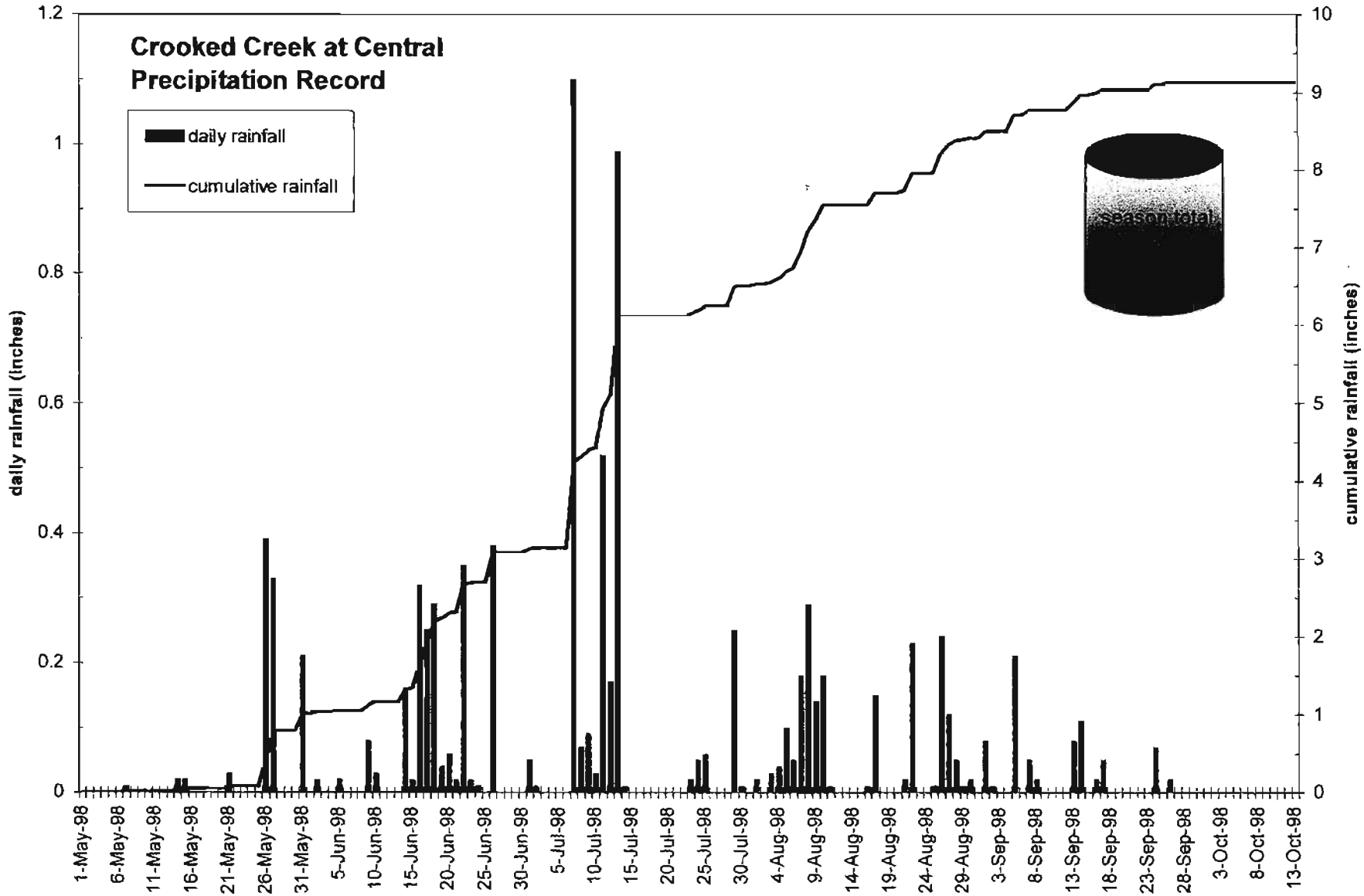

Figure 3. Precipitation record from Crooked Creek near Central, Alaska, Summer 1998. Data courtesy of National Weather Service.

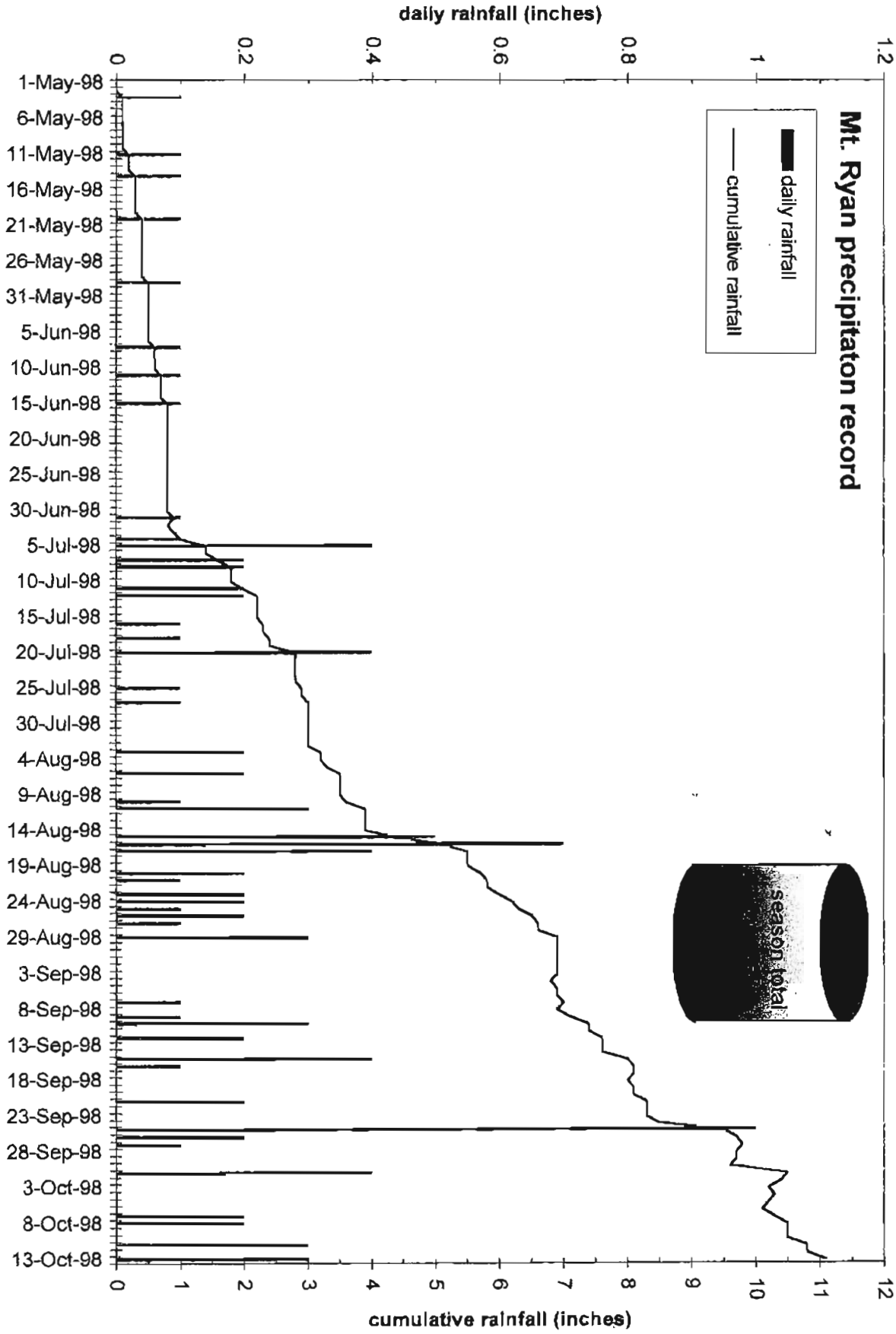

Figure 4. Precipitation record from Mt. Ryan, Summer 1998. Data courtesy of River Forecast Center.

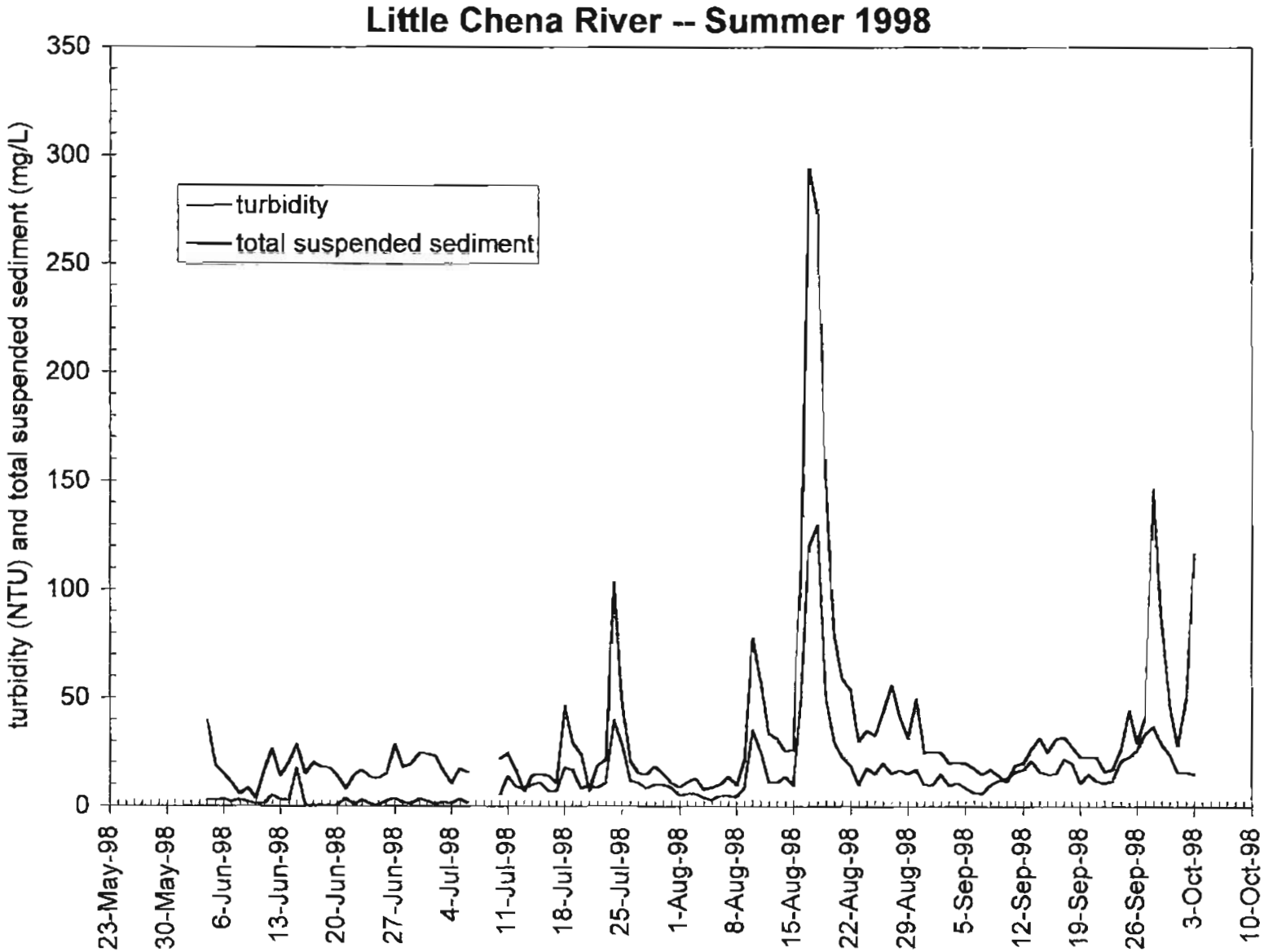

Figure 5. Turbidity and total suspended solids, Little Chena River, Summer 1998.

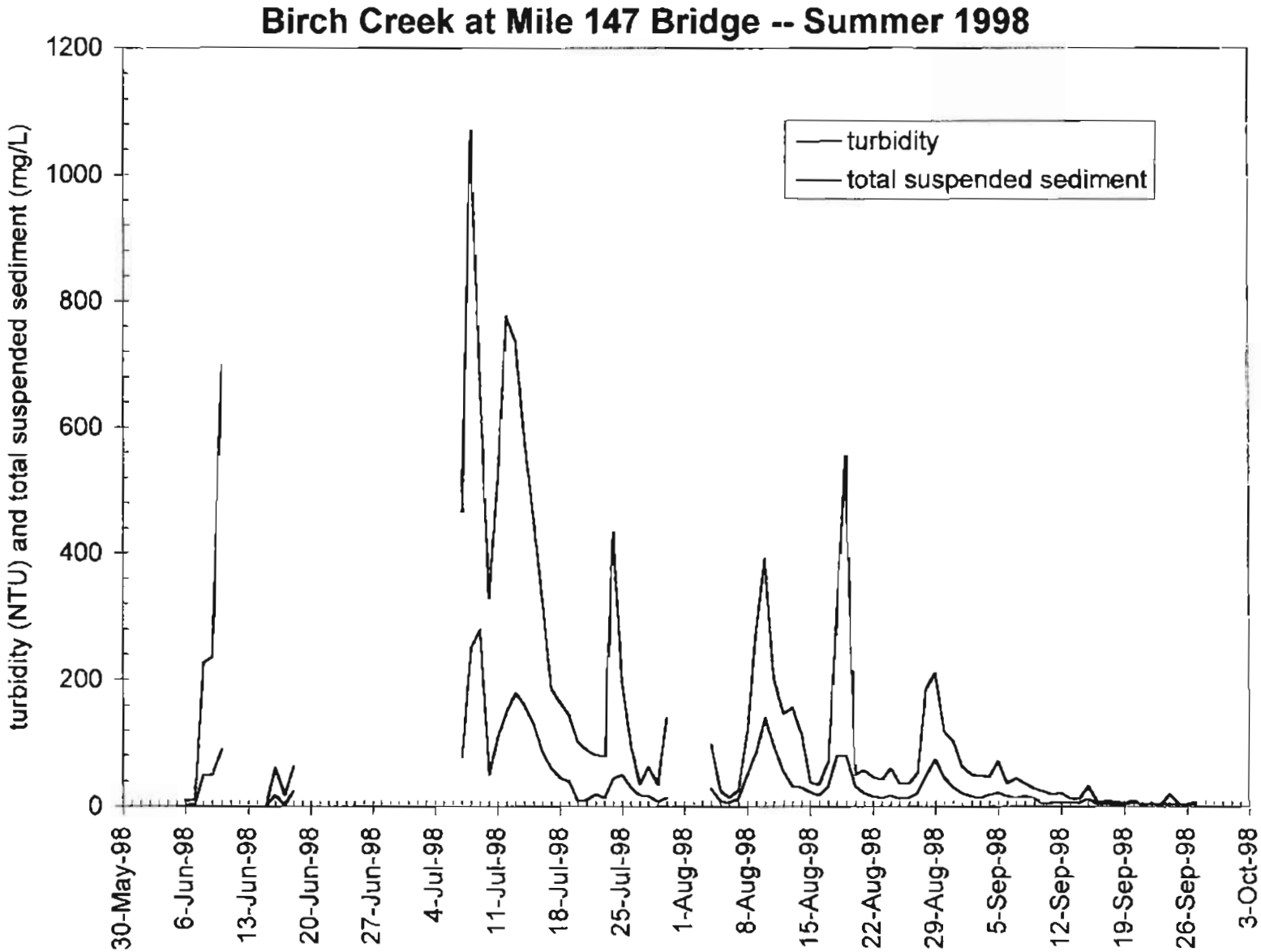

Figure 6. Turbidity and total suspended solids, Birch Creek at Mile 147 Bridge, Summer 1998.

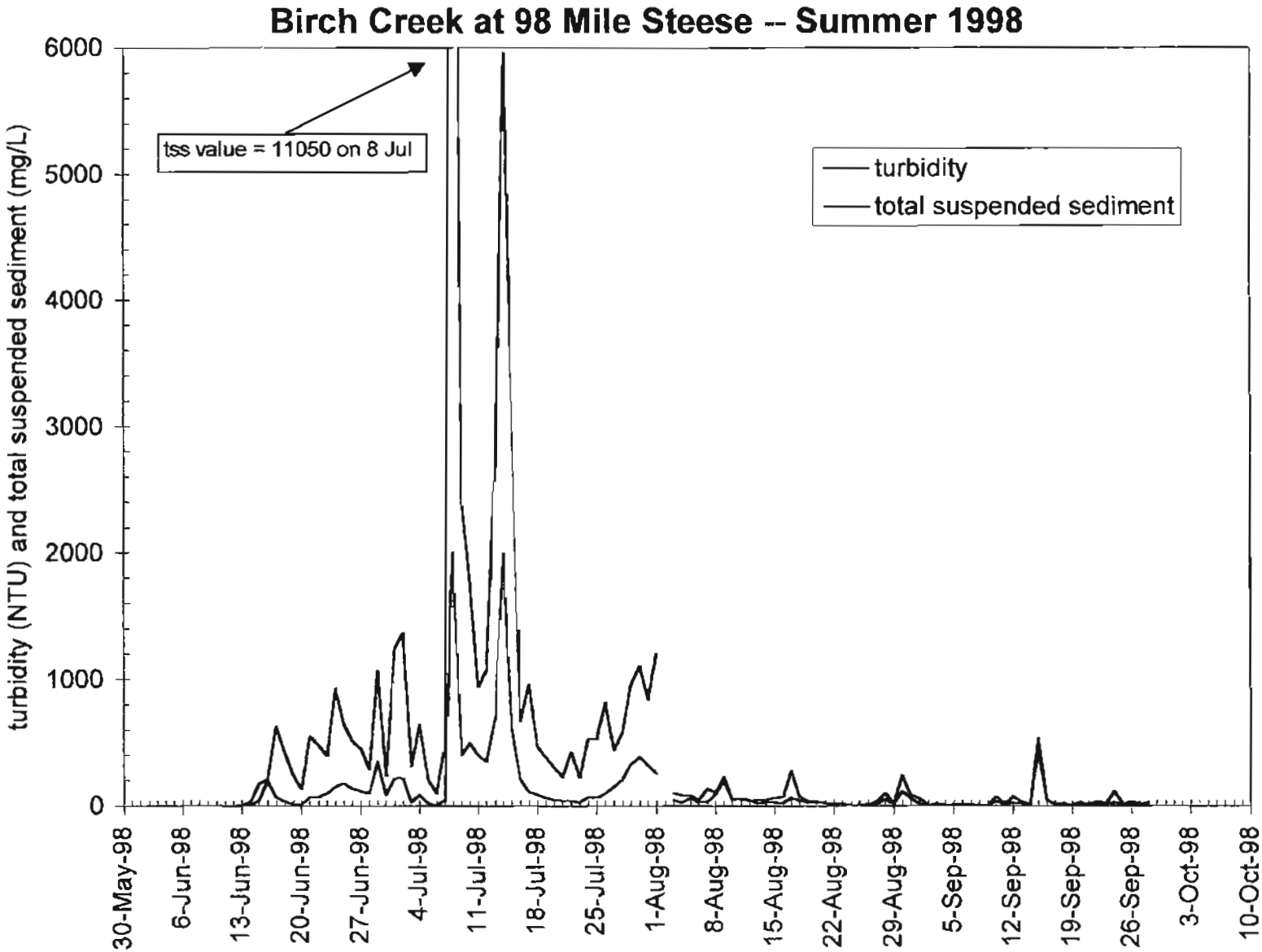

Figure 7. Turbidity and total suspended solids, Birch Creek at 98 Mile Steese, Summer 1998.

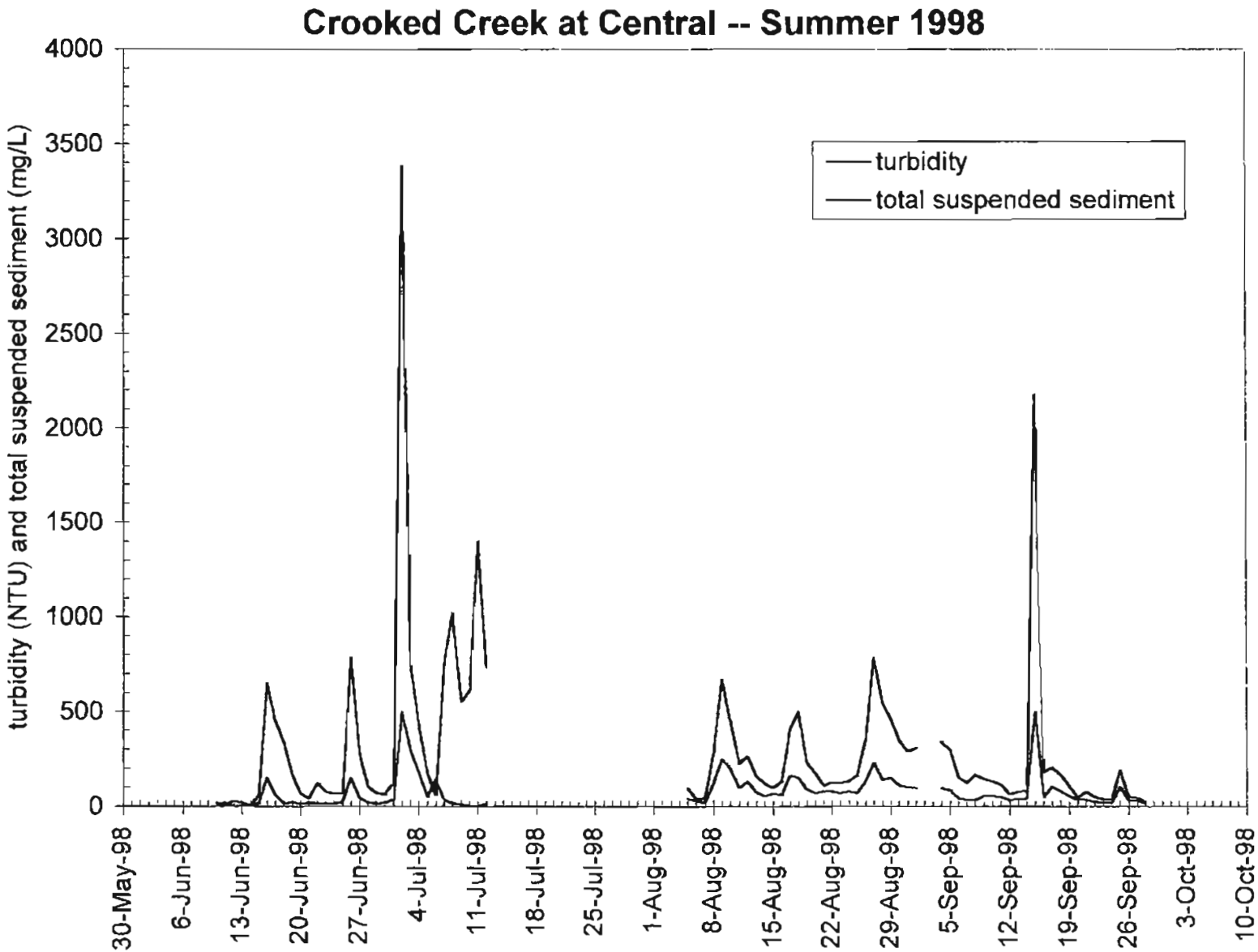

Figure 8. Turbidity and total suspended solids, Crooked Creek at Central, Summer 1998.

There is a record of historical monitoring at three of the four sites monitored in 1998. The trends of the median turbidity for each year monitored are shown in Figure 9, and are found in tabulated form in Appendix C. Birch Creek at Mile 147 Bridge has the longest period of record and it appears that while great progress has been made in minimizing the turbidity in the past few years, the trend was not sustained in 1998. Crooked Creek appears to be following a similar trend of lower turbidity until 1998, where a very dramatic increase in median turbidity is seen. The initial thought is that this could be attributed in part to the bank collapse at the gage site. But in reality, that served to minimize the turbidity values represented in Figure 9 because the sampler was not operational for the period of time when sediment input was the greatest. It should be

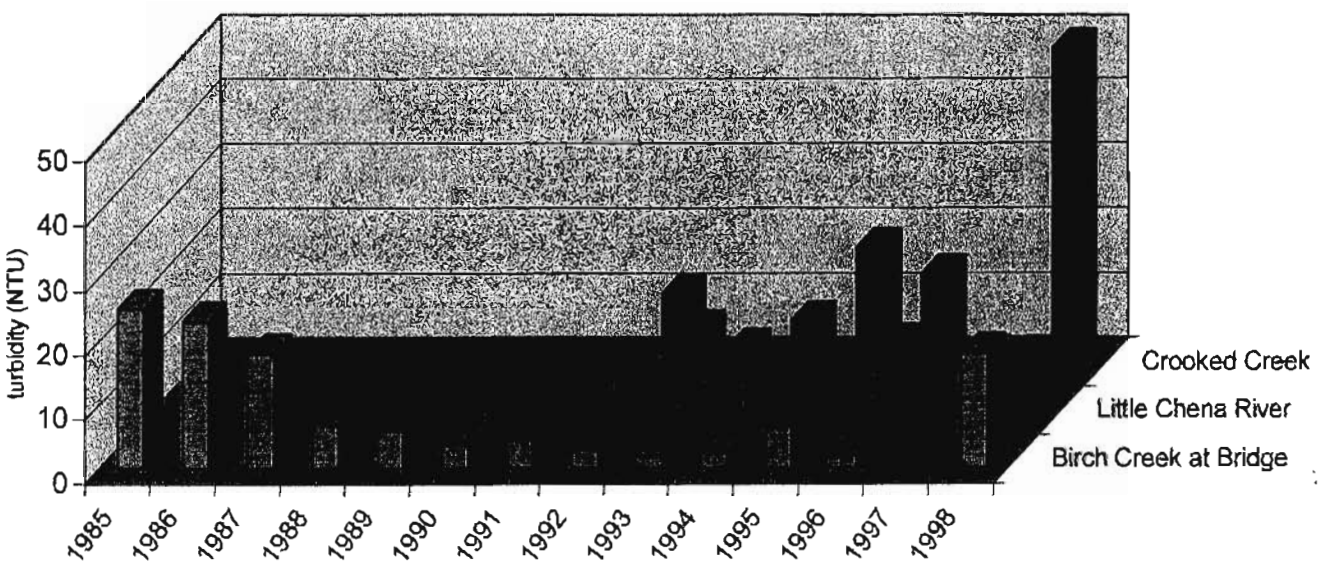

Figure 9. Historical record at three long-term gage sites, showing annual median turbidity values over time (no samples collected in 1997).

realized that bank failures such as that which occurred at the gage site on Crooked Creek are a normal part of stream dynamics. There will always be a storm event of a magnitude great enough to adjust the morphology of any stream. Sediment analyses in the Little Chena River appear to be somewhat consistent since monitoring began in 1990.

As shown in Figure 10, each of the four locations exhibits a characteristic pattern of turbidity values. Analysis of the Little Chena River samples indicates that more than 80% of the data are less than 20 NTU. This implies generally good water quality, with some outliers that are most likely the result of storm events. At Birch Creek at 98 Mile Steese however, only slightly more than 30% of the data are less than 20 NTU, indicating that more of a chronic elevation of turbidity exists in the samples from this season at this location.

It should be noted that site-specific conditions can serve to increase the variables that might alter these frequencies from season to season. These can include monitoring locations, monitoring frequency, surface activities, and rainfall regime. Although the best effort is made to collect as many samples as possible at a given site, there are some gaps in the data which would tend to add variability when comparing data over the course of several seasons. The gap in data from the Birch Creek at Mile 147 Bridge between 19 June and 6 July was the result of vandalism. At this location, the cable connecting the battery to the sampler was disconnected, interrupting the sampling routine until the site was serviced and the damage repaired.

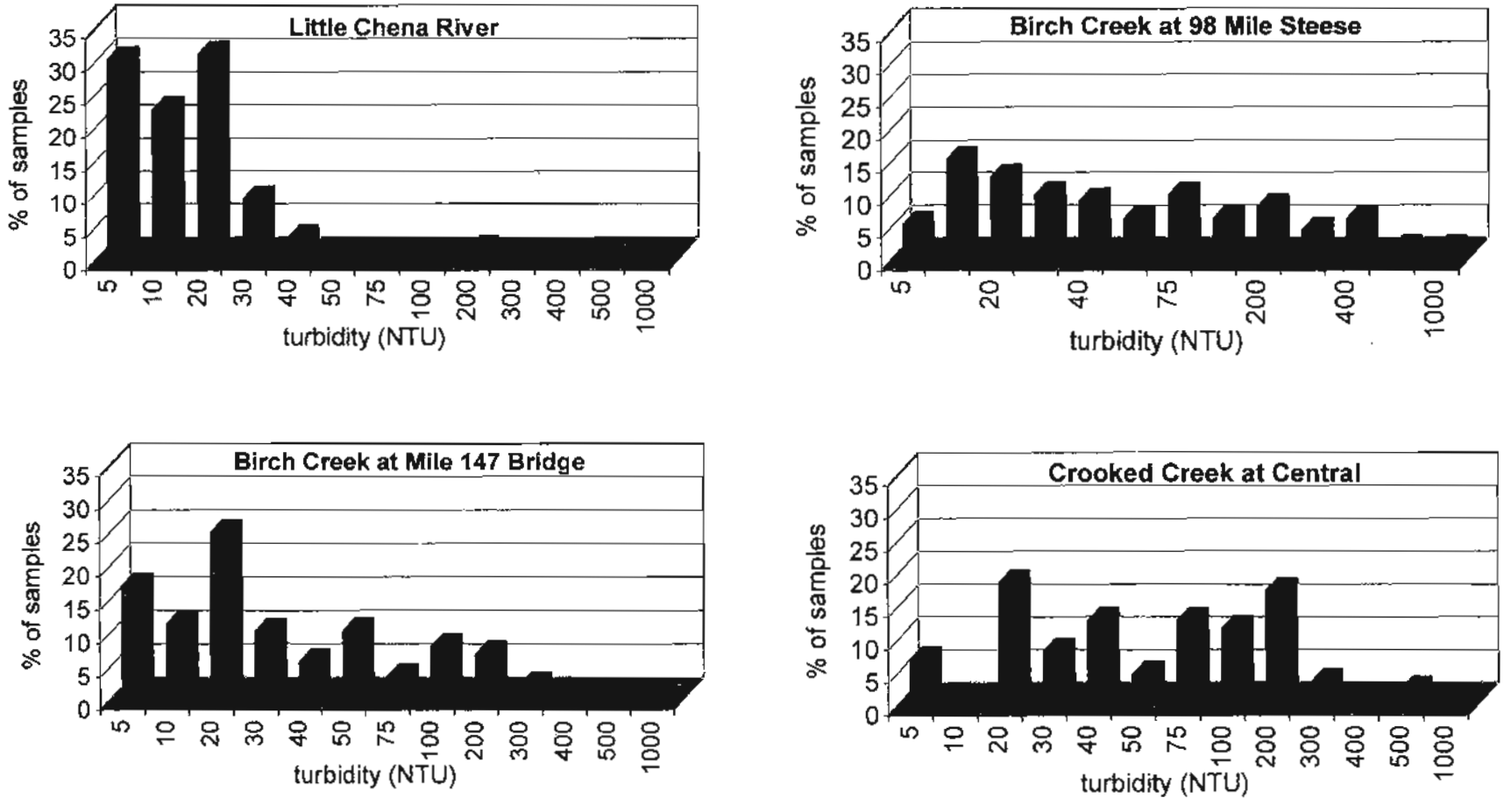

Figure 10. Frequency of occurrence of various levels of turbidity.

As shown in Figure 11, surface activity has changed over the years in the Circle Mining District. Due to gradual depletion of ore reserves and a decrease in the price of gold, the number of active placer mines in the district has continued to fall. Despite this decreasing trend in surface activity, the water quality appeared to decrease in 1998. Although this study cannot conclusively identify whether the main source of this degradation is from point or non-point pollution, historic or active placer mining, natural conditions, or a combination of these, it is a common perception that enforcement of water quality standards and best management practices by the appropriate agencies (i.e. Department of Natural Resources, Department of Environmental Conservation, Bureau of Land Management, among others) is a critical requisite for the water quality to improve at these monitoring sites.

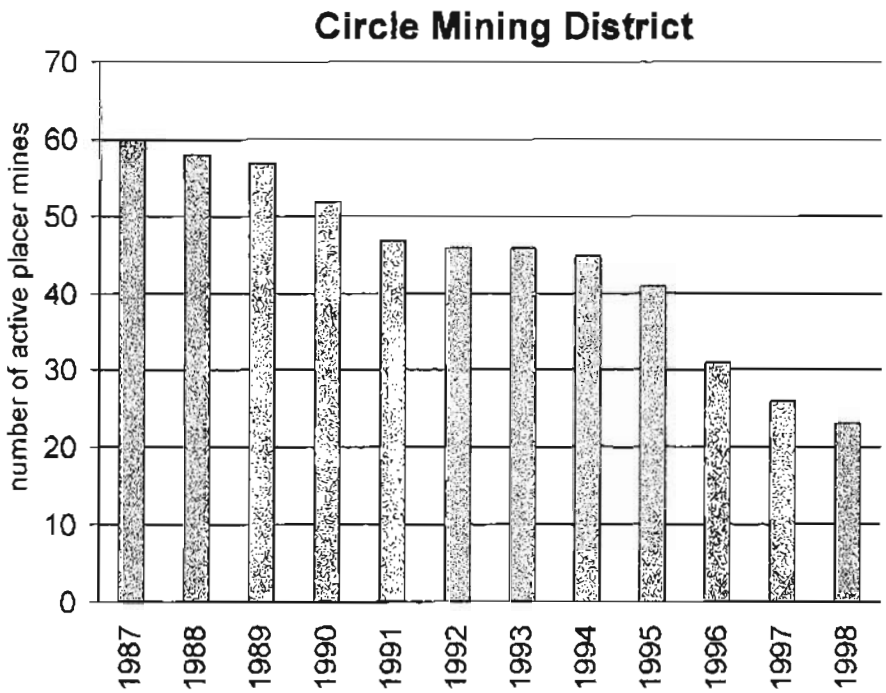

Figure 11. Number of active placer mines, Circle District, 1987-1998.

CONCLUSIONS and RECOMMENDATIONS

- Although a storm-induced bank collapse temporarily interrupted the monitoring at the Crooked Creek at Central location, the large rise in median turbidity at this site as compared to previous years is not attributed to the bank failure.

- Data collected may not show a change in historic trends, but rather an anomalous year. Changes in long term trends should be documented over the "long term". This may be an indicator of such a change, and suggests that further monitoring is warranted.

- The frequency of various levels of turbidity reflect more of a persistent water quality issue than would be expected at three of the locations where monitoring took place in 1998.

- Although the number of active placer mines continues to decrease in the Circle Mining District, it is recommended that water quality standards be actively enforced to assure consistency with the State's water quality standards.

Acknowledgments

Field assistance was provided by Amy Ash of the Alaska Department of Environmental Conservation.

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Appendix A

Laboratory Reports – Turbidity and Total Suspended Solids Analyses

BOREOCHEM MOBILE LAB & CONSULTING, Inc.
3529 College Road, Suite 204
Fairbanks, Alaska 99709-3741
phones: (907) 479-5459 , (800) 764-2536 , fax: (907) 479-9544

July 28, 1998

Mr. Jim Vohden
Alaska Department of Natural Resources
Division of Mining and Water Management
Alaska Hydrologic Survey
3700 Airport Way
Fairbanks, Alaska 99709

Mr. Jim Vohden:

RE: Report # 1738: results of Total Suspended Solids and Turbidity analysis of aqueous samples.

Following are results of the Total Suspended Solids,(TSS), and Turbidity analysis of aqueous samples delivered to Boreochem on July 9, 1998 , tested by SM 2540D and SM 2130B, respectively . Total Suspended Solids results are reported in mg/L; turbidity results are reported in nephelometric turbidity units, (NTU) .

Turbidity tests were conducted on July 14, 1998; TSS analyses were conducted on July 16, 1998.

Results presented here are identical to those transmitted to you electronically at an earlier date.

Please Note:

LCR = Lower Chena River.
CCR= Crooked Creek.
BCAB= Birch Creek At Bridge.
BCB98= Birch Creek Below 98 Mile.

If you have any questions or comments about these results, please do not hesitate to give me a call.

Sincerely,

Boreochem Laboratories, Inc.

Tim Thomas
Laboratory Director

ADEC/ADNR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
1	98070901	LCR 6/4/98	39.5	2.8
2	98070902	LCR 6/5/98	19	2.8
3	98070903	LCR 6/6/98	15	3.5
4	98070904	LCR 6/7/98	11	2.2
5	98070905	LCR 6/8/98	5.75	3.4
6	98070906	LCR 6/9/98	8.67	2.1
7	98070907	LCR 6/10/98	3.5	1.5
8	98070908	LCR 6/11/98	17	1.4
9	98070909	LCR 6/12/98	26.5	5.2
10	98070910	LCR 6/13/98	14	3.1
11	98070911	LCR 6/14/98	20.5	3.2
12	98070912	LCR 6/15/98	28.7	18
13	98070913	LCR 6/16/98	15	0.70
14	98070914	LCR 6/17/98	20.4	0.64
15	98070915	LCR 6/18/98	18.2	0.70
16	98070916	LCR 6/19/98	18	0.64
17	98070917	LCR 6/20/98	14.2	0.68
18	98070918	LCR 6/21/98	8.11	3.8
19	98070919	LCR 6/22/98	14.7	0.78
20	98070920	LCR 6/23/98	16.9	3.1
21	98070921	LCR 6/24/98	13.3	1.1
22	98070922	LCR 6/25/98	13.2	0.75
23	98070923	LCR 6/26/98	15.2	2.7
24	98070924	LCR 6/27/98	28.8	3.9
25	98070925	LCR 6/28/98	18.3	2.0
26	98070926	LCR 6/29/98	19.6	1.1
27	98070927	LCR 6/30/98	24.7	3.5
28	98070928	LCR 7/1/98	24.5	2.6
29	98070929	LCR 7/2/98	23.3	0.97
30	98070930	LCR 7/3/98	16.4	2.1
31	98070931	LCR 7/4/98	10.8	1.5
32	98070932	LCR 7/5/98	17.6	3.5
33	98070933	LCR 7/6/98	15.9	1.6
34	98070934	BCB98 6/10/98	5.57	0.62
35	98070935	BCB98 6/11/98	< 1.00	0.62
36	98070989	BCB98 6/12/98	1.35	0.50
37	98070936	BCB98 6/13/98	2.4	0.45
38	98070937	BCB98 6/14/98	35.6	6.8
39	98070938	BCB98 6/15/98	177	40
40	98070939	BCB98 6/16/98	210	200
41	98070940	BCB98 6/17/98	631	75
42	98070941	BCB98 6/18/98	421	37
43	98070942	BCB98 6/19/98	242	18
44	98070943	BCB98 6/20/98	135	16
45	98070944	BCB98 6/21/98	555	70
46	98070945	BCB98 6/22/98	481	75
47	98070946	BCB98 6/23/98	394	100
48	98070947	BCB98 6/24/98	930	150
49	98070948	BCB98 6/25/98	652	180
50	98070949	BCB98 6/26/98	517	140
51	98070950	BCB98 6/27/98	450	120

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52	98070951	BCB98 6/28/98	290	100
53	98070952	BCB98 6/29/98	1072	350
54	98070990	BCB98 6/30/98	241	90
55	98070953	BCB98 7/1/98	1246	220
56	98070954	BCB98 7/2/98	1368	220
57	98070955	BCB98 7/3/98	314	31
58	98070956	BCB98 7/4/98	645	90
59	98070957	BCB98 7/5/98	206	20
60	98070958	CCR 6/10/98	19.5	1.5
61	98070959	CCR 6/11/98	7.32	20
62	98070960	CCR 6/12/98	29.7	0.54
63	98070961	CCR 6/13/98	20.4	2.3
64	98070962	CCR 6/14/98	7.07	1.9
65	98070963	CCR 6/15/98	56.1	17
66	98070964	CCR 6/16/98	650	150
67	98070965	CCR 6/17/98	450	60
68	98070966	CCR 6/18/98	331	14
69	98070967	CCR 6/19/98	164	21
70	98070968	CCR 6/20/98	67.1	14
71	98070969	CCR 6/21/98	40.2	18
72	98070970	CCR 6/22/98	123	16
73	98070971	CCR 6/23/98	76.7	16
74	98070972	CCR 6/24/98	67.7	14
75	98070973	CCR 6/25/98	70.5	25
76	98070974	CCR 6/26/98	788	150
77	98070975	CCR 6/27/98	272	45
78	98070976	CCR 6/28/98	105	23
79	98070977	CCR 6/29/98	69.9	13
80	98070978	CCR 6/30/98	62.9	18
81	98070979	CCR 7/1/98	131	39
82	98070980	CCR 7/2/98	3385	500
83	98070981	CCR 7/3/98	744	290
84	98070982	CCR 7/4/98	432	180
85	98070983	CCR 7/5/98	175	50
86	98070984	BCAB 6/6/98	9.5	2.5
87	98070985	BCAB 6/7/98	10.5	3.5
88	98070986	BCAB 6/8/98	226	50
89	98070987	BCAB 6/9/98	236	50
90	98070988	BCAB 6/10/98	699	90
91	98070991	BCAB 6/15/98	3.99	2.5
92	98070992	BCAB 6/16/98	61.7	18
93	98070993	BCAB 6/17/98	17.1	2.3
94	98070994	BCAB 6/18/98	62.9	25

Phone: (907) 479-5459 BOREOCHEM LABORATORY Fax: (907) 479-9544

BOREOCHEM MOBILE LAB & CONSULTING, Inc.
3529 College Road, Suite 204
Fairbanks, Alaska 99709-3741
phones: (907) 479-5459 , (800) 764-2536 , fax: (907) 479-9544

August 24, 1998

Mr. Jim Vohden
Alaska Department of Natural Resources
Division of Mining and Water Management
Alaska Hydrologic Survey
3700 Airport Way
Fairbanks, Alaska 99709

Mr. Jim Vohden:

RE: Report # 1758: Results of Total Suspended Solids and Turbidity analysis of aqueous samples.

Following are results of the Total Suspended Solids,(TSS), and Turbidity analysis of aqueous samples delivered to Boreochem on August 4, 1998 , tested by SM 2540D and SM 2130B, respectively . Total Suspended Solids results are reported in mg/L; turbidity results are reported in nephelometric turbidity units, (NTU) .

Turbidity tests were conducted on August 13, 1998; TSS analyses were conducted on August 17, 1998.

Results presented here are identical to those transmitted to you electronically at an earlier date.

Please Note:

LCR = Little Chena River.
CCR= Crooked Creek.
BCAB= Birch Creek At Bridge.
BCB98= Birch Creek Below 98 Mile.

If you have any questions or comments about these results, please do not hesitate to give me a call.

Sincerely,

Boreochem Laboratories, Inc.

Tim Thomas
Laboratory Director

ADEC/AONR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
1	98080405	BCAB 7/7/98	466	79
2	98080406	BCAB 7/8/98	1070	250
3	98080407	BCAB 7/9/98	677	280
4	98080408	BCAB 7/10/98	330	50
5	98080409	BCAB 7/11/98	515	110
6	98080410	BCAB 7/12/98	776	150
7	98080411	BCAB 7/13/98	737	180
8	98080412	BCAB 7/14/98	586	160
9	98080413	BCAB 7/15/98	455	130
10	98080414	BCAB 7/16/98	326	85
11	98080415	BCAB 7/17/98	186	60
12	98080416	BCAB 7/18/98	164	45
13	98080417	BCAB 7/19/98	144	40
14	98080418	BCAB 7/20/98	102	9
15	98080419	BCAB 7/21/98	89.5	11
16	98080420	BCAB 7/22/98	80.8	20
17	98080421	BCAB 7/23/98	79.8	14
18	98080422	BCAB 7/24/98	435	45
19	98080423	BCAB 7/25/98	198	50
20	98080424	BCAB 7/26/98	96.6	30
21	98080425	BCAB 7/27/98	35.6	18
22	98080426	BCAB 7/28/98	63.3	17
23	98080427	BCAB 7/29/98	35.4	8.0
24	98080428	BCAB 7/30/98	140	14
25	98080429	CCR 7/6/98	60.9	140
26	98080430	CCR 7/7/98	748	35
27	98080431	CCR 7/8/98	1022	16
28	98080432	CCR 7/9/98	552	9.7
29	98080433	CCR 7/10/98	613	4.0
30	98080434	CCR 7/11/98	1400	4.0
31	98080435	CCR 7/12/98	736	15
32	98080436	BC@98 7/6/98	97.2	3.0
33	98080437	BC@98 7/7/98	477	50
34	98080438	BC@98 7/8/98	11050	2000
35	98080439	BC@98 7/9/98	2440	400
36	98080440	BC@98 7/10/98	1770	500
37	98080441	BC@98 7/11/98	942	400
38	98080442	BC@98 7/12/98	1070	350
39	98080443	BC@98 7/13/98	2720	700
40	98080444	BC@98 7/14/98	5960	2000
41	98080445	BC@98 7/15/98	3220	600
42	98080446	BC@98 7/16/98	672	210
43	98080447	BC@98 7/17/98	963	110
44	98080448	BC@98 7/18/98	473	90
45	98080449	BC@98 7/19/98	386	65
46	98080450	BC@98 7/20/98	308	50
47	98080451	BC@98 7/21/98	228	40
48	98080452	BC@98 7/22/98	429	40
49	98080453	BC@98 7/23/98	227	30
50	98080454	BC@98 7/24/98	528	70
51	98080455	BC@98 7/25/98	528	65

rp1758

ADEC/ADNR Turbidity and TSS Data

52	98080456	BC@98 7/26/98	819	100
53	98080457	BC@98 7/27/98	441	150
54	98080458	BC@98 7/28/98	577	210
55	98080459	BC@98 7/29/98	952	330
56	98080460	BC@98 7/30/98	1110	390
57	98080461	BC@98 7/31/98	843	320
58	98080462	BC@98 8/1/98	1200	260

Phone: (907) 479-5459 BOREOCHEM LABORATORY Fax: (907) 479-9544

BOREOCHEM MOBILE LAB & CONSULTING, Inc.
3529 College Road, Suite 204
Fairbanks, Alaska 99709-3741
phones: (907) 479-5459 , (800) 764-2536 , fax: (907) 479-9544

September 4, 1998

Mr. Jim Vohden
Alaska Department of Natural Resources
Division of Mining and Water Management
Alaska Hydrologic Survey
3700 Airport Way
Fairbanks, Alaska 99709

Mr. Jim Vohden:

RE: Report # 1761: Results of Total Suspended Solids and Turbidity analysis of aqueous samples.

Following are results of the Total Suspended Solids,(TSS), and Turbidity analysis of aqueous samples delivered to Boreochem on August 19, 1998 , tested by SM 2540D and SM 2130B, respectively . Total Suspended Solids results are reported in mg/L; turbidity results are reported in nephelometric turbidity units. (NTU) .

Turbidity tests were conducted on August 20, 1998; TSS analyses were conducted on August 20, 1998 and August 31,1998.

Results presented here are identical to those transmitted to you electronically at an earlier date.

Please Note:

LCR = Little Chena River.
BC@B= Birch Creek At Bridge.
BC@98= Birch Creek Below 98 Mile.

If you have any questions or comments about these results, please do not hesitate to give me a call.

Sincerely,

Boreochem Laboratories, Inc.

Tim Thomas
Laboratory Director

ADEC/ADNR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
1	98081901	LCR 8/1/98	8.87	5.0
2	98081902	LCR 8/2/98	11.3	6.0
3	98081903	LCR 8/3/98	13.2	6.0
4	98081904	LCR 8/4/98	7.88	4.0
5	98081905	LCR 8/5/98	8.87	3.0
6	98081906	LCR 8/6/98	10.2	5.0
7	98081907	LCR 8/7/98	14.2	5.1
8	98081908	LCR 8/8/98	9.86	4.5
9	98081909	LCR 8/9/98	21.6	8.9
10	98081910	LCR 8/10/98	78.0	36
11	98081911	LCR 8/11/98	57.5	25
12	98081912	LCR 8/12/98	33.7	11
13	98081913	LCR 8/13/98	31.3	11
14	98081914	LCR 8/14/98	25.5	14
15	98081915	LCR 8/15/98	26.2	10
16	98081916	LCR 8/16/98	117	50
17	98081917	LCR 8/17/98	294	120
18	98081918	LCR 8/18/98	273	130
19	98081919	LCR 8/19/98	148	50
20	98081920	BC@B 8/4/98	99.0	29
21	98081921	BC@B 8/5/98	24.5	8.1
22	98081922	BC@B 8/6/98	15.1	7.3
23	98081923	BC@B 8/7/98	26.5	13
24	98081924	BC@B 8/8/98	118	50
25	98081925	BC@B 8/9/98	274	85
26	98081926	BC@B 8/10/98	392	140
27	98081927	BC@B 8/11/98	203	95
28	98081928	BC@B 8/12/98	147	55
29	98081929	BC@B 8/13/98	156	32
30	98081930	BC@B 8/14/98	116	31
31	98081931	BC@B 8/15/98	38.2	23
32	98081932	BC@B 8/16/98	34.1	18
33	98081933	BC@B 8/17/98	70.1	32
34	98081934	BC@B 8/18/98	292	80
35	98081935	BC@98 8/3/98	101	50
36	98081936	BC@98 8/4/98	86.9	27
37	98081937	BC@98 8/5/98	84.6	60
38	98081938	BC@98 8/6/98	51.2	32
39	98081939	BC@98 8/7/98	138	34
40	98081940	BC@98 8/8/98	102	95
41	98081941	BC@98 8/9/98	232	200
42	98081942	BC@98 8/10/98	50.4	50
43	98081943	BC@98 8/11/98	58.0	60
44	98081944	BC@98 8/12/98	40.9	50
45	98081945	BC@98 8/13/98	50.7	25
46	98081946	BC@98 8/14/98	48.8	31
47	98081947	BC@98 8/15/98	65.5	30
48	98081948	BC@98 8/16/98	71.1	23
49	98081949	BC@98 8/17/98	280	65

Phone: (907) 479-5459 $c_{1-c\,50}$ BOREOCHEM LABORATORY $c_{1-c\,50}$ Fax: (907) 479-9544

BOREOCHEM MOBILE LAB & CONSULTING, Inc.
3529 College Road, Suite 204
Fairbanks, Alaska 99709-3741
phones: (907) 479-5459 , (800) 764-2536 , fax: (907) 479-9544

October 28, 1998

Mr. Jim Vohden
Alaska Department of Natural Resources
Division of Mining and Water Management
Alaska Hydrologic Survey
3700 Airport Way
Fairbanks, Alaska 99709

Mr. Jim Vohden:

RE: Report # 1799: Results of Total Suspended Solids and Turbidity analysis of aqueous samples.

Following are results of the Total Suspended Solids.(TSS), and Turbidity analysis of aqueous samples delivered to Boreochem on October 1, 1998 , tested by SM 2540D and SM 2130B, respectively . Total Suspended Solids results are reported in mg/L; turbidity results are reported in nephelometric turbidity units. (NTU) .

Turbidity tests were conducted on October 16, 1998; TSS analyses were conducted on October 21, 1998.

Results presented here are identical to those transmitted to you electronically at an earlier date.

Please Note:

LC = Little Chena River.
CC= Crooked Creek.
BC@B= Birch Creek At Bridge.
B@98M= Birch Creek Below 98 Mile.

If you have any questions or comments about these results, please do not hesitate to give me a call.

Sincerely,

Boreochem Laboratories, Inc.

Tim Thomas
Laboratory Director

ADEC/ADNR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
1	98100101	LC 8/20/98	79.9	30
2	98100102	LC 8/21/98	59.2	23
3	98100103	LC 8/22/98	53.7	19
4	98100104	LC 8/23/98	30.1	10
5	98100105	LC 8/24/98	35.2	18
6	98100106	LC 8/25/98	32.7	15
7	98100107	LC 8/26/98	43.5	20
8	98100108	LC 8/27/98	56.3	15
9	98100109	LC 8/28/98	41.8	17
10	98100110	LC 8/29/98	31.5	15
11	98100111	LC 8/30/98	49.8	17
12	98100112	LC 8/31/98	24.8	10
13	98100113	LC 9/1/98	25.4	10
14	98100114	LC 9/2/98	25.2	15
15	98100115	LC 9/3/98	20.0	10
16	98100116	LC 9/4/98	20.3	11
17	98100117	LC 9/5/98	20.2	8.5
18	98100118	LC 9/6/98	17.7	6.5
19	98100119	LC 9/7/98	14.8	6.0
20	98100120	LC 9/8/98	17.2	10
21	98100121	LC 9/9/98	14.4	12
22	98100122	B@98M 8/18/98	73.1	45
23	98100123	B@98M 8/19/98	39.6	27
24	98100124	B@98M 8/20/98	35.8	30
25	98100125	B@98M 8/21/98	19.8	23
26	98100126	B@98M 8/22/98	10.8	22
27	98100127	B@98M 8/23/98	18.8	15
28	98100128	B@98M 8/24/98	5.80	7.1
29	98100129	B@98M 8/25/98	4.40	10
30	98100130	B@98M 8/26/98	11.5	16
31	98100131	B@98M 8/27/98	32.1	16
32	98100132	B@98M 8/28/98	102	55
33	98100133	B@98M 8/29/98	16.7	16
34	98100134	B@98M 8/30/98	247	120
35	98100135	B@98M 8/31/98	87.6	60
36	98100136	B@98M 9/1/98	63.5	18
37	98100137	B@98M 9/2/98	2.45	9.2
38	98100138	B@98M 9/3/98	19.8	8.0
39	98100139	B@98M 9/4/98	7.08	6.7
40	98100140	B@98M 9/5/98	11.1	4.0
41	98100141	B@98M 9/6/98	15.7	6.0
42	98100142	B@98M 9/7/98	17.3	6.2
43	98100143	B@98M 9/8/98	7.60	5.8
44	98100144	B@98M 9/9/98	7.20	7.8
45	98100145	CC 8/5/98	95.0	40
46	98100146	CC 8/6/98	38.8	26
47	98100147	CC 8/7/98	42.3	20
48	98100148	CC 8/8/98	288	120
49	98100149	CC 8/9/98	670	250
50	98100150	CC 8/10/98	451	200
51	98100151	CC 8/11/98	223	95

52	98100152	CC 8/12/98	265	130
53	98100153	CC 8/13/98	158	75
54	98100154	CC 8/14/98	120	55
55	98100155	CC 8/15/98	95.6	65
56	98100156	CC 8/16/98	130	60
57	98100157	CC 8/17/98	408	160
58	98100158	CC 8/18/98	499	150
59	98100159	CC 8/19/98	231	90
60	98100160	CC 8/20/98	173	70
61	98100161	CC 8/21/98	109	80
62	98100162	CC 8/22/98	125	80
63	98100163	CC 8/23/98	123	70
64	98100164	CC 8/24/98	130	80
65	98100165	CC 8/25/98	165	70
66	98100166	CC 8/26/98	354	130
67	98100167	CC 8/27/98	785	230
68	98100168	CC 8/28/98	544	140
69	98100169	CC 8/29/98	463	150
70	98100170	CC 8/30/98	348	110
71	98100171	CC 8/31/98	287	100
72	98100172	CC 9/1/98	307	95
73	98100173	BC@B 8/19/98	555	80
74	98100174	BC@B 8/20/98	50.9	32
75	98100175	BC@B 8/21/98	57.7	21
76	98100176	BC@B 8/22/98	47.1	16
77	98100177	BC@B 8/23/98	42.6	14
78	98100178	BC@B 8/24/98	60.6	17
79	98100179	BC@B 8/25/98	37.2	13
80	98100180	BC@B 8/26/98	36.7	14
81	98100181	BC@B 8/27/98	53.3	21
82	98100182	BC@B 8/28/98	186	50
83	98100183	BC@B 8/29/98	211	75
84	98100184	BC@B 8/30/98	118	45
85	98100185	BC@B 8/31/98	102	30
86	98100186	BC@B 9/1/98	63.2	21
87	98100187	BC@B 9/2/98	51.3	16
88	98100188	BC@B 9/3/98	48.5	14
89	98100189	BC@B 9/4/98	47.2	19
90	98100190	BC@B 9/5/98	72.0	22
91	98100191	BC@B 9/6/98	37.0	17
92	98100192	BC@B 9/7/98	44.9	14
93	98100193	BC@B 9/8/98	36.7	17
94	98100194	BC@B 9/9/98	28.4	13
95	98100195	BC@B 9/10/98	24.6	5.0

BOREOCHEM MOBILE LAB & CONSULTING, Inc.
3529 College Road, Suite 204
Fairbanks, Alaska 99709-3741
phones: (907) 479-5459 , (800) 764-2536 , fax: (907) 479-9544

December 3, 1998

Mr. Jim Vohden
Alaska Department of Natural Resources / Division of Mining and Water Management
Alaska Hydrologic Survey
3700 Airport Way
Fairbanks, Alaska 99709

Mr. Jim Vohden:

RE: Report # 1825: Results of Total Suspended Solids and Turbidity analysis of aqueous samples.

Following are results of the Total Suspended Solids,(TSS), and Turbidity analysis of aqueous samples delivered to Boreochem on November 19, 1998 , tested by SM 2540D and SM 2130B, respectively . Total Suspended Solids results are reported in mg/L; turbidity results are reported in nephelometric turbidity units. (NTU) .

Turbidity tests were conducted on November 20, 1998; TSS analyses were conducted on November 21, 1998.

Results presented here are identical to those transmitted to you electronically at an earlier date.

Please Note:

LCR = Little Chena River.
CC= Crooked Creek.
B@BR= Birch Creek At Bridge.
BC@98= Birch Creek Below 98 Mile.

The following sample bottles did not contain aqueous sample for testing :

BC@98 9/28/98	BC@98 9/29/98	BC@98 10/1/98
BC@98 10/2/98	BC@98 10/3/98	BC@98 10/4/98
BC@98 10/5/98	BC@98 10/6/98	BC@98 10/7/98
CC 9/29/98	CC 9/30/98	

If you have any questions or comments about these results. please do not hesitate to give me a call.

Sincerely.

Boreochem Laboratories, Inc.

Tim Thomas
Laboratory Director

ADEC/ADNR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
1	981119001	LCR 9/10/98	11.4	13
2	981119002	LCR 9/11/98	19.3	16
3	981119003	LCR 9/12/98	20.0	17
4	981119004	LCR 9/13/98	26.5	21
5	981119005	LCR 9/14/98	31.8	16
6	981119006	LCR 9/15/98	25.1	15
7	981119007	LCR 9/16/98	31.2	15
8	981119008	LCR 9/17/98	32.3	22
9	981119009	LCR 9/18/98	27.6	20
10	981119010	LCR 9/19/98	23.0	11
11	981119011	LCR 9/20/98	23.0	15
12	981119012	LCR 9/21/98	22.9	12
13	981119013	LCR 9/22/98	16.4	11
14	981119014	LCR 9/23/98	17.1	12
15	981119015	LCR 9/24/98	26.6	21
16	981119016	LCR 9/25/98	44.5	23
17	981119017	LCR 9/26/98	29.7	26
18	981119018	LCR 9/27/98	41.5	34
19	981119019	LCR 9/28/98	147	37
20	981119020	LCR 9/29/98	86.3	29
21	981119021	LCR 9/30/98	46.2	24
22	981119022	LCR 10/1/98	28.3	16
23	981119023	LCR 10/2/98	50.0	16
24	981119024	LCR 10/3/98	117	15
25	981119025	CC 9/3/98	310	100
26	981119026	CC 9/4/98	338	95
27	981119027	CC 9/5/98	294	85
28	981119028	CC 9/6/98	153	40
29	981119029	CC 9/7/98	124	36
30	981119030	CC 9/8/98	167	33
31	981119031	CC 9/9/98	143	55
32	981119032	CC 9/10/98	132	55
33	981119033	CC 9/11/98	114	50
34	981119034	CC 9/12/98	63.3	34
35	981119035	CC 9/13/98	75.3	38
36	981119036	CC 9/14/98	82.6	40
37	981119037	CC 9/15/98	2180	500
38	981119038	CC 9/16/98	181	50
39	981119039	CC 9/17/98	204	105
40	981119040	CC 9/18/98	165	80
41	981119041	CC 9/19/98	106	55
42	981119042	CC 9/20/98	45.7	35
43	981119043	CC 9/21/98	76.7	35
44	981119044	CC 9/22/98	49.6	25
45	981119045	CC 9/23/98	38.7	18
46	981119046	CC 9/24/98	39.2	20
47	981119047	CC 9/25/98	188	105
48	981119048	CC 9/26/98	48.1	30
49	981119049	CC 9/27/98	47.8	30
50	981119050	CC 9/28/98	22.4	20
51	981119053	BC@98 9/10/98	78.0	36

ADEC/ADNR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
52	981119054	BC@98 9/11/98	11.2	13
53	981119055	BC@98 9/12/98	77.2	25
54	981119056	BC@98 9/13/98	32.2	20
55	981119057	BC@98 9/14/98	20.3	9.2
56	981119058	BC@98 9/15/98	538	450
57	981119059	BC@98 9/16/98	43.3	45
58	981119060	BC@98 9/17/98	18.8	14
59	981119061	BC@98 9/18/98	16.7	8.0
60	981119062	BC@98 9/19/98	12.8	9.3
61	981119063	BC@98 9/20/98	28.7	11
62	981119064	BC@98 9/21/98	15.6	6.9
63	981119065	BC@98 9/22/98	37.5	21
64	981119066	BC@98 9/23/98	22.5	15
65	981119067	BC@98 9/24/98	118	27
66	981119068	BC@98 9/25/98	14.7	17
67	981119069	BC@98 9/26/98	35.0	10
68	981119070	BC@98 9/27/98	17.0	8.0
69	981119071	BC@98 9/28/98	30.7	10
70	981119081	LCR 7/11/98	24.6	14
71	981119082	LCR 7/12/98	16.5	9.2
72	981119083	LCR 7/13/98	6.86	8.2
73	981119084	LCR 7/14/98	14.3	10
74	981119085	LCR 7/15/98	15.0	11
75	981119086	LCR 7/16/98	14.3	7.2
76	981119087	LCR 7/17/98	10.7	7.2
77	981119088	LCR 7/18/98	46.5	18
78	981119089	LCR 7/19/98	29.5	17
79	981119090	LCR 7/20/98	24.3	8.3
80	981119091	LCR 7/21/98	7.25	9.9
81	981119092	LCR 7/22/98	19.0	8.7
82	981119093	LCR 7/23/98	21.8	11
83	981119094	LCR 7/24/98	104	40
84	981119095	LCR 7/25/98	48.0	29
85	981119096	LCR 7/26/98	21.0	12
86	981119097	LCR 7/27/98	15.5	11
87	981119098	LCR 7/28/98	14.8	8.4
88	981119099	LCR 7/29/98	18.8	10
89	981119100	LCR 7/30/98	15.3	10
90	981119101	LCR 7/31/98	11.0	8.9
91	981119102	B@BR 9/11/98	19.8	6.5
92	981119103	B@BR 9/12/98	22.0	6.2
93	981119104	B@BR 9/13/98	13.3	6.3
94	981119105	B@BR 9/14/98	12.2	6.4
95	981119106	B@BR 9/15/98	33.2	13
96	981119107	B@BR 9/16/98	7.50	3.7
97	981119108	B@BR 9/17/98	8.75	5
98	981119109	B@BR 9/18/98	8.50	4.4
99	981119110	B@BR 9/19/98	5.50	4.5
100	981119111	B@BR 9/20/98	10.5	7.3
101	981119112	B@BR 9/21/98	2.50	4.3
102	981119113	B@BR 9/22/98	5.50	4.8

ADEC/ADNR Turbidity and TSS Data

#	Lab ID #	Field ID #	TSS(mg/L)	Turbidity (NTU)
103	9811119114	B@BR 9/23/98	2.25	5.2
104	9811119115	B@BR 9/24/98	20.5	4.2
105	9811119116	B@BR 9/25/98	4.75	3.9
106	9811119117	B@BR 9/26/98	3.75	4.1
107	9811119118	B@BR 9/27/98	7.00	3.9
108	9811119119	LCR 7/10/98	22.0	5.6

Appendix B

Precipitation measured at Crooked Creek, near Central, Alaska: summer 1998

Device: manual rain gage, US Forest Service type, 0.01" resolution.
"0" indicates no measurable precipitation recorded. Values recorded in inches.
Data collected by National Weather Service.

Day	May	June	July	August	September
1	0	0	0.05	0.02	0.08
2	0	0.02	0.01	0	0.01
3	0	0	0	0.03	0
4	0	0	0	0.04	0
5	0	0.02	0	0.10	0.21
6	0	0	0	0.05	0
7	0.01	0	1.1	0.18	0.05
8	0	0	0.07	0.29	0.02
9	0	0.08	0.09	0.14	0
10	0	0.03	0.03	0.18	0
11	0	0	0.52	0.01	0
12	0	0	0.17	0	0
13	0	0	0.99	0	0.08
14	0.02	0.16	0.01	0	0.11
15	0.02	0.02	0	0	0
16	0	0.32	0	0.01	0.02
17	0	0.25	0	0.15	0.05
18	0	0.29	0	0	0
19	0	0.04	0	0	0
20	0	0.06	0	0	0
21	0.03	0.02	0	0.02	0
22	0	0.35	0	0.23	0
23	0	0.02	0.02	0	0
24	0	0.01	0.05	0	0.07
25	0	0	0.06	0.01	0
26	0.09	0.38	0	0.24	0.02
27	0.33	0	0	0.12	0
28	0	0	0	0.05	0
29	0	0	0.25	0.01	0
30	0	0	0.01	0.02	0
31	0.21		0	0	
monthly totals:	1.01	2.07	3.43	1.90	0.72

total for period: 9.13 inches

Appendix B (continued)

Precipitation measured at Mt. Ryan (Chena Basin): summer 1998

Device: automated tipping bucket, 0.1" resolution.
"0" indicates no measurable precipitation recorded. Values recorded in inches.
Data collected by National Weather Service, River Forecast Center.

Day	May	June	July	August	September
1	0	0	0.1	0	0
2	0	0	0	0	0
3	0.1	0	0	0.2	0
4	0	0	0.1	0	0
5	0	0	0.4	0	0
6	0	0	0	0.2	0
7	0	0.1	0.2	0	0.1
8	0	0	0.2	0	0
9	0	0	0	0	0.1
10	0	0	0	0.1	0.3
11	0.1	0.1	0. 2	0.3	0
12	0	0	0.2	0	0.2
13	0	0	0	0	0
14	0.1	0	0	0	0
15	0	0.1	0	0.5	0.4
16	0	0	0.1	0.7	0.1
17	0	0	0	0.4	0
18	0	0	0.1	0	0
19	0	0	0	0	0
20	0.1	0	0.4	0.2	0
21	0	0	0	0.1	0.2
22	0	0	0	0	0
23	0	0	0	0.2	0
24	0	0	0	0.2	0
25	0	0	0.1	0.1	1.0
26	0	0	0	0.2	0.2
27	0	0	0.1	0.1	0.1
28	0	0	0	0	0
29	0.1	0	0	0.3	0
30	0	0	0	0	0
31	0		0	0	
monthly totals:	0.5	0.3	2.2	3.8	2.7

total for period: 9.5 inches

Appendix C

Historic Record of Turbidity Results, 1985-1998

Birch Creek at Mile 147 Bridge

year	mean	median	n
1998	39.5	18	88
1997	*no samples collected*		
1996	4.7	2.1	74
1995	12	6.6	61
1994	4.8	2.6	74
1993	3.7	2.1	132
1992	5.8	3.0	86
1991	8.3	4.4	122
1990	5.8	3.8	121
1989	12	6.0	80
1988	11	7.1	98
1987	38	18	106
1986	54	23	54
1985	31	25	20

Crooked Creek at Central

year	mean	median	n
1998	76	50	86
1997	*no samples collected*		
1996	151	15	53
1995	68	19	102
1994	32	7.8	102
1993	9.0	3.6	108
1992	30	12	91

Little Chena River

year	mean	median	n
1998	14	10	119
1997	*no samples collected*		
1996	17	12	83
1995	*no samples collected*		
1994	7.8	4.6	90
1993	9.1	6.2	136
1992	31	14	88
1991	9.1	6.5	111
1990	8.5	4.6	94
1989	7.2	4.3	62

Appendix D

Turbidity Data -- Summer 1998 -- Frequency Data

Frequency of the occurrence of various levels of turbidity, grouped into the selected bins. A bin contains data that is greater than the previous bin value, but less than or equal to the bin value.

Birch Creek at Mile 147 Bridge

Bin	*Frequency*	*Cumulative %*
5	15	17.0%
10	10	28.4%
20	22	53.4%
30	9	63.6%
40	5	69.3%
50	9	79.6%
75	3	82.9%
100	7	90.9%
200	6	97.7%
300	2	100.0%
400	0	100.0%
500	0	100.0%
1000	0	100.0%
>1000	0	100.0%

Crooked Creek at Central

Bin	*Frequency*	*Cumulative %*
5	6	7.0%
10	1	8.1%
20	16	26.7%
30	7	34.9%
40	11	47.7%
50	4	52.3%
75	11	65.1%
100	10	76.7%
200	15	94.2%
300	3	97. 7%
400	0	97.7%
500	2	100.0%
1000	0	100.0%
>1000	0	100.0%

Birch Creek at 98 Mile Steese

Bin	*Frequency*	*Cumulative %*
5	6	5.4%
10	17	20.9%
20	14	33.6%
30	11	43.6%
40	10	52.7%
50	7	59.1%
75	11	69.1%
100	7	75.4%
200	9	83.6%
300	5	88.2%
400	7	94.6%
500	2	96.4%
1000	2	98.2%
>1000	2	100.0%

Little Chena River

Bin	*Frequency*	*Cumulative %*
5	36	30.2%
10	27	52.9%
20	37	84.0%
30	11	93.3%
40	4	96.6%
50	2	98.3%
75	0	98.3%
100	0	98.3%
200	2	100.0%
300	0	100.0%
400	0	100.0%
500	0	100.0%
1000	0	100.0%
>1000	0	100.0%

Appendix E

Circle Mining District – Active Placer Mines, 1987-1998

1987	60
1988	58
1989	57
1990	52
1991	47
1992	46
1993	46
1994	45
1995	41
1996	31
1997	26
1998	23