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WATER QUALITY AND DISCHARGE DATA FROM SELECTED SITES IN THE FORTYMILE AND TOLOVANA DRAINAGES SUMMER 1987

By

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Alaska Division of
Geological and Geophysical Surveys

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Water Quality and Discharge Data from Selected Sites in the Fortymile and Tolovana Drainages Summer 1987

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EXECUTIVE SUMMARY

Alaska Division of Geological and Geophysical Surveys investigators and cooperators collected samples for water quality analyses, measured discharges, and observed water levels at selected sites in the Fortymile and Tolovana River drainages to assist the U.S. Bureau of Land Management (BLM) complete environmental impact statements on the cumulative impacts of placer mining in those drainages.

In the Fortymile drainage at all sites with ten or more observations, turbidity averaged less than four NTU's for the field season. No primary maximum contaminant concentrations established by the Alaska Department of Environmental Conservation were exceeded in the samples examined for dissolved constituents. For the samples examined for total recoverable constituents, the maximum contaminant concentration for chromium was exceeded at Walker Fork above the South Fork and at the West Fork Dennison sites, and for mercury at the South Fork at Taylor Highway Bridge site.

In the Tolovana drainage average turbidity was higher, ranging from 10 to 27 NTU's for the field season. Water chemistry done in 1986 by the Alaska Department of Environmental Conservation showed primary maximum contaminant concentrations for arsenic and cadmium exceeded at one site on Livengood Creek.

The complete data from this summer are included in appendices attached to the report.

INTRODUCTION

This report presents and discusses data collected by the Alaska Division of Geological and Geophysical Surveys (DGGS) from selected sites in the Fortymile and Tolovana River drainages in interior Alaska during 1987. DGGS collected these data under a cooperative agreement with the U.S. Bureau of Land Management (BLM) in response to BLM's data needs for environmental impact statements on the cumulative impact of placer mining in these drainages. Starting July 14 five sites in the Fortymile drainage were monitored periodically for turbidity, total suspended solids (TSS) and discharge. At two of these sites water samples were collected by automatic samplers and river water levels monitored by automatic water level recorders. At the other three sites water levels were periodically recorded by observers at which time grab samples for turbidity and TSS analyses also were taken. One of those sites, West Fork Dennison at the Taylor Highway has no mining upstream. During August 18 through August 22, samples for water chemistry analysis were collected at 11 sites within the drainage.

Starting July 8, three sites in the Tolovana drainage were monitored for turbidity, TSS, and discharge. At one of those sites automatic equipment was used to collect daily water samples and record water levels. At the other two sites water levels were recorded and grab samples taken periodically by observers in the same manner as in the Fortymile drainage. The Tolovana at campground site has no mining upstream. Figures 1 and 2 show the locations of sample sites in the Fortymile and Tolovana drainages, respectively.

We would like to acknowledge the valuable assistance of the many people who made the assembling of these data possible. From the Alaska Department of Environmental Conservation, John Bauer in the Fortymile drainage and Leslie Simmons in the Tolovana drainage were essential in the collection of water samples and maintenance of the automatic equipment. In the Fortymile drainage Lon Kelly of BLM and BLM recreation rangers working with him provided valuable background information: collected water samples and recorded water levels numerous times; and provided needed logistical and personal assistance for the trip to downriver sites for sampling water chemistry. Also important were Shirley Liss of DGGS who collected all samples analyzed for water chemistry and Scott Ray of the University of Alaska Water Research Center who assisted with the water chemistry analyses.

METHODS

A. Discharge. Velocities used to calculate discharge in most cases were measured with a Marsh McBirney Model 201 Flowmeter. At sites with bridges (Walker Fork, South Fork at Bridge, and Mosquito Fork) when wading the stream was not possible, velocities were measured from the bridge using a Price AA meter suspended from a hand line or a crane.

Figure 1.

LOCATION OF FORTYMILE DRAINAGE SAMPLING SITES

◆ AUTOMATED SAMPLER AND WATER LEVEL RECORDER SITES

0 NON-AUTOMATED MONITORING SITES

◆ WATER CHEMISTRY SAMPLING SITES

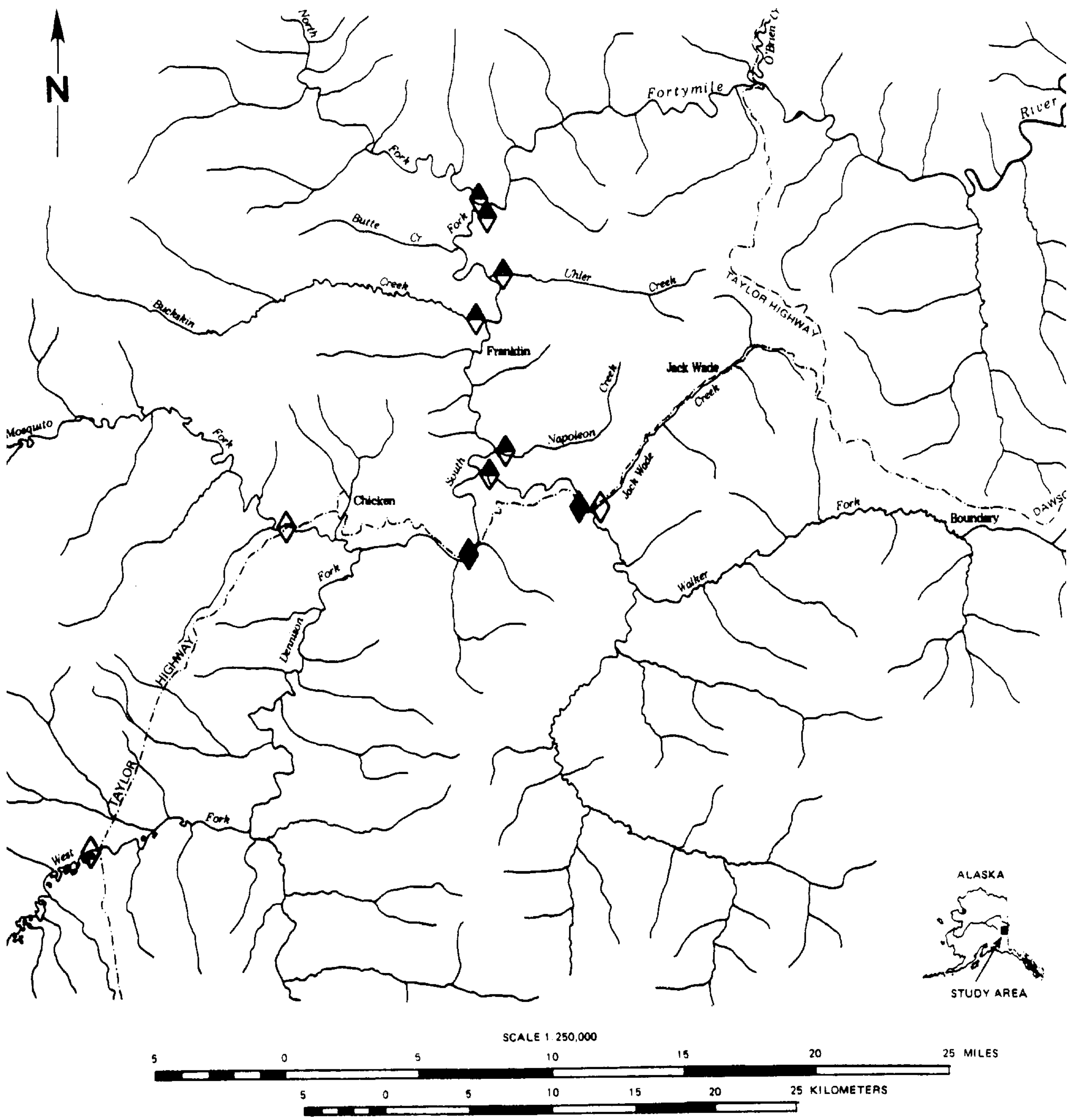
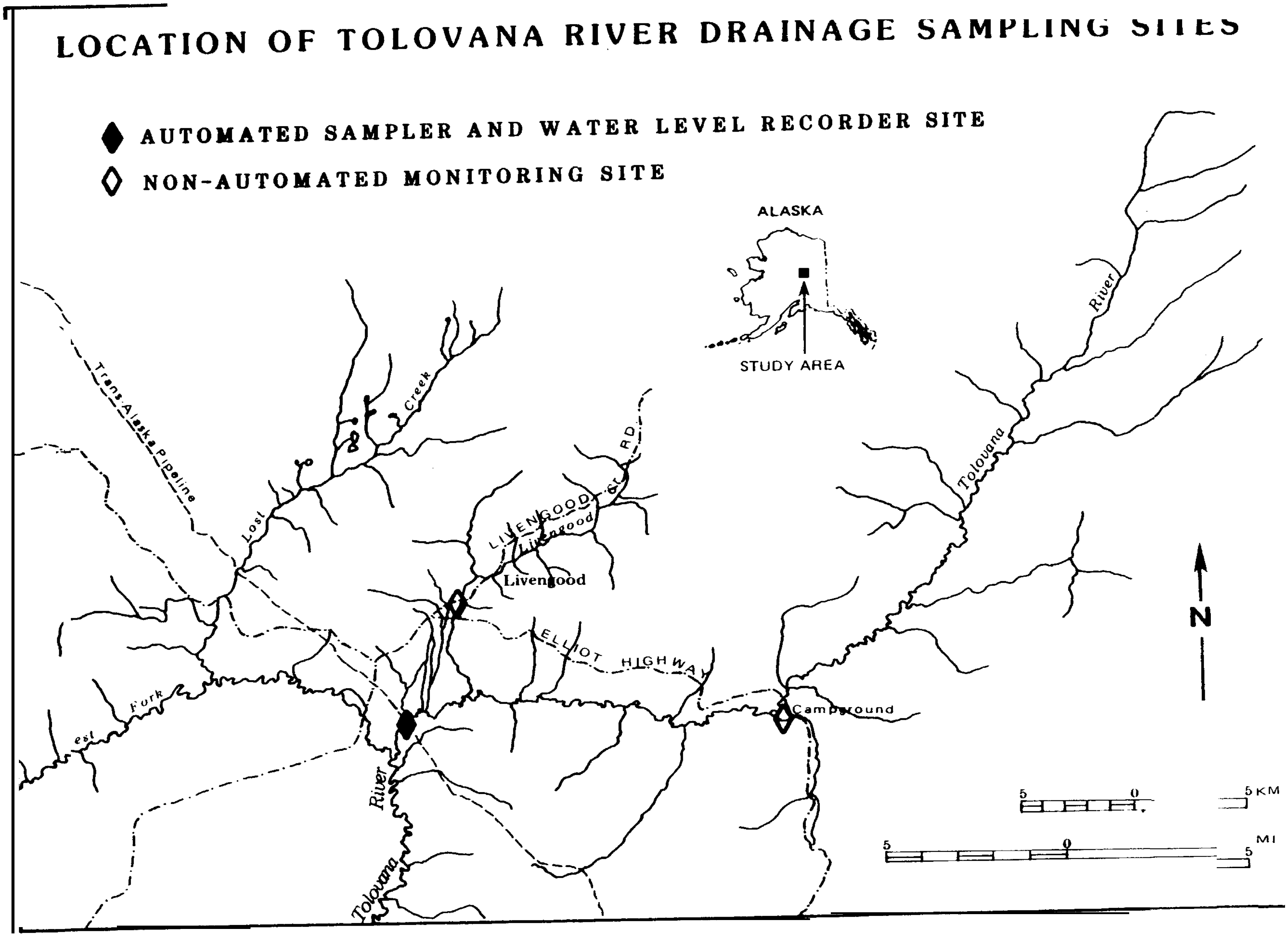


Figure 2.


LOCATION OF TOLOVANA RIVER DRAINAGE SAMPLING SITES
AUTOMATED SAMPLER AND WATER LEVEL RECORDER SITE
NON-AUTOMATED MONITORING SITE
ALASKA
STUDY AREA
Trans Alaska Pipeline
Lost
Creek
LIVENGOOD CR. RD.
Livengood
Livengood
ELLIOT HIGHWAY
Campground
Tolovana
River
River
Tolovana
Fork
N
5 0 5 KM
5 0 5 MI

Where depth was greater than 2.5 feet, velocities were measured at two and eight tenths of the depth from the surface. At depths less than 2.5 feet, velocities were measured six tenths of the depth from the surface. Discharges were calculated using the standard midpoint method (USDOI 1981) from at least twenty velocity measurements taken across the stream cross section where width permitted (most cases).

Gage locations were chosen based on having a history of previous monitoring and on proximity to bridges for high flow measurements. The sites were situated sufficiently downstream of any mining or tributary so that the stream was well mixed at the sampling site. At each location the specific site was chosen by looking for a cross section that would provide the most change in stage for change in stream discharge and the least turbulence around the staff gage. Staff gage water surface levels were recorded whenever agency personnel were in the vicinity. At the South Fork at the Taylor Highway Bridge, Walker Fork at the Taylor Highway Bridge, and Tolovana River at the TAPS crossing, continuous water surface levels were recorded with Omnidata DP320 Stream Stage Recorders. The DP320 is a small, battery operated device with a submersible pressure transducer which measures and records water levels between 0 to ten feet to the nearest hundredth of a foot. Water level data are stored in a solid state memory called a data storage module. At all sites the water level recorders monitored water levels at 30 minute intervals.

Rating curves were developed for each site by taking at least four discharge measurements at different water levels throughout the season. At the Tolovana River at TAPS crossing and at the West Fork of the Dennison Fork in the Fortymile drainage, peak flows were estimated using the slope-area method (Dalrymple and Benson 1984). The rating curves were then used to estimate discharge from the observed or recorded water levels.

B. Water Quality. Water quality analyses done in 1987 for this report were conducted in the field and in the DGGS hydrology lab located on the University of Alaska, Fairbanks campus in the Water Research Center. Some trace metal analyses were also performed with the generous help and use of equipment of the UAF Forest Soils Laboratory.

Procedures prescribed in the EPA publication no. EPA-600/ 4-79-020, "Methods for Chemical Analyses of Water and Wastes," were followed whenever possible (EPA 1983). Other sources of methods were the USGS "Techniques of Water-Resources Investigations, Book 5, Chapter A1"; the APHA-AWWA-WPCF "Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition"; and procedures outlined in the user manuals of certain instrumentation (Skougstad et al. 1979, APHA 1985). The lab is a participant in EPA analytical quality assurance studies, and has participated in the USGS Standard Reference Water Sample Quality Assurance program since 1980. For all analyses calibrations were performed using in-house analytical standards and blanks, and were monitored and verified by running previously analyzed Standard Reference Water Samples along with the water samples collected for this study.

1. Turbidity and total suspended solids. Samples for these analyses were collected from automated samplers or by grab methods in well-mixed reaches at sampling sites. When automated samplers were employed, the intake hose for the sampler was installed at a well-mixed location in the stream at middepth with the intake nozzle pointing upstream. The automated samplers were programmed to composite into one bottle four samples taken six hours apart each day.

Most turbidity determinations were done in the lab because the lab served as a receiving point for samples coming in from more than one collecting agency, and because some of the more turbid samples required several serial dilutions to bring their turbidity down to readable levels. During 1987 the instrument used was a Turner Designs Model 40 laboratory turbidimeter.

Total suspended solids samples were filtered through prewashed, dried and weighed glass fiber filters, according to EPA specifications. The size of the aliquot was dependent upon the amount of material suspended, but ranged from 25 ml to a liter. Sediment load is calculated by multiplying discharge (in cfs) by TSS (in mg/L) and a constant of 0.0027 to convert the units into tons per day.

2. Fortymile drainage water chemistry. For the Fortymile . drainage water chemistry analyses, field determinations conducted at each sampling site included temperature using an Omega Model 727C handheld digital thermocouple, and pH using a Corning Model 3D portable pH meter and Orion Ross combination electrode. The pH meter was calibrated at each site and used for electrometric titrations of alkalinity using standardized dilute sulfuric acid.

Samples collected at each site were: filtered untreated and filtered acidified aliquots for determining dissolved major anions, cations and trace metals: nonfiltered untreated aliquots for determining turbidity and total suspended solids: and nonfiltered acidified samples for determining total recoverable metals. All acidified samples were collected in pre-acid-washed bottles, and acidified with Ultrex grade nitric acid, to a concentration of 1.5 ml acid per liter sample. The filtered samples passed through 0.45 micron membrane filters.

One hundred ml aliquots of unfiltered acidified samples were heated with 2 ml 1:1 nitric acid and 10 ml 1:1 hydrochloric acid until they were reduced to 25 ml. They were then filtered through 0.45 micron membrane filters and the filtrate volume adjusted to 100 ml with distilled deionized water. These samples were analyzed for total recoverable trace metals. Also included in these analyses were filtered acidified samples to determine the dissolved concentrations of these constituents. Sodium (Na), potassium (K), strontium (Sr), arsenic (As), and mercury (Hg) were analyzed by atomic absorption spectrophotometry using various techniques and instruments. Na and K were analyzed on a Perkin-Elmer (P-E) 5000 using an air-acetylene flame: Sr on a P-E 4000 using a nitrous oxide-acetylene flame: and As and Hg on a P-E 603 using a hydride system (MHS-1) with 5% $NaBH_4$ in 2% NaOH as the reductant. Beryllium was determined using the flame emission mode on a P-E 4000 and a nitrous oxide-acetylene flame. The remaining trace elements and major cations were determined on a Beckman SpectroSpan V DCP plasma located in UAF Forest Soils Laboratory. They include aluminum (Al), boron (B), barium (Ba), chromium (Cr), cadmium (Cd), iron (Fe), manganese (Mn), lead (Pb), selenium (Se), silicon (Si), zinc (Zn), calcium (Ca), and magnesium (Mg). DCP spectrophotometry has been favorably received throughout the scientific community and is being reviewed by EPA for certification in the very near future as an acceptable analytical technique for trace metals.

Total dissolved anions were determined in filtered untreated samples on a DIONEX ion chromatograph according to method 429 of Standard Methods for the Examination of Water and Wastewater (APHA 1985). Detectable levels of Cl, NO_3, and SO_4 only were found.

Hardness and total dissolved solids were calculated from the above analytical data.

3. DEC Tolovana River Drainage Use Attainability Study water chemistry. During July 28-August 15, 1986, investigators from the Alaska Department of Environmental Conservation collected water samples for analysis of several water chemistry constituents as part of a use attainability analysis of the many streams in the drainage. DEC had received petitions to reclassify the streams in the drainage to industrial uses. The use attainability analysis study is a requirement of the reclassification procedure. The use attainability study has not been completed as of the date of this report: however, we have received permission from DEC to include the data collected in 1986 in this report (Simmons, 1987). Temperature and dissolved oxygen were measured in the field with a YSI Model 57 dissolved oxygen meter. pH was measured _in situ_ with a gel-filled combination Orion pH electrode: total hardness and total alkalinity with the appropriate Hach kits. Turbidity analyses were done at the Livengood DOT Maintenance Camp or at Fairbanks accommodations with a Hach Model 16800 Portable Turbidimeter. TSS (called total nonfiltrable residue (TNFR) in report) were done by Northern Testing Laboratories in Fairbanks.

The total and total recoverable trace metal analyses included Hg, As, Pb, Cd, Ni, Zn, and Cu. Total differs from total recoverable in that the former is a complete digestion of suspended material while the latter is a partial digestion. These analyses were done in the DEC Juneau Douglas Laboratory. Hg was detected using cold vapor AA (EPA method 245), As with EPA method 206.2, and Pb with flame/graphite furnace (EPA methods 239.1/239.2). Cd, Ni, Zn, and Cu were detected with ICP plasma (EPA method 200.7) (DEC 1987).

RESULTS AND DISCUSSION

We have included all the data collected this summer and the DEC use attainability data in four separate appendices: Appendix 1 includes the sediment (TSS, turbidity and sediment load) and discharge data from the Fortymile drainage; Appendix 2 includes the sediment and discharge data from the Tolovana drainage: Appendix 3 includes the water chemistry data from the Fortymile drainage; and Appendix 4 includes the data collected by DEC in 1986 for the Tolovana River Drainage Use Attainability Study. Appendix 5 has the meridian-township-range-section descriptions of the 1987 sampling sites.

A. Discharge. Table 1 shows the drainage area, monthly and seasonal averages, and seasonal discharge per square mile (runoff) at the sites we monitored in the Fortymile and Tolovana drainages. Figures 3 and 4 show the seasonal discharges at the Walker Fork site in the Fortymile drainage and at the three monitoring sites in the Tolovana drainage, respectively. As demonstrated in Figure 3 we started the monitoring in the Fortymile drainage after the peak of a bankfull flood that affected all of our monitoring sites. Later rainfall storms raised water levels some, but the peaks we experienced at the start of the

Figure 3. Daily average discharge at Walker Fork at Bridge.

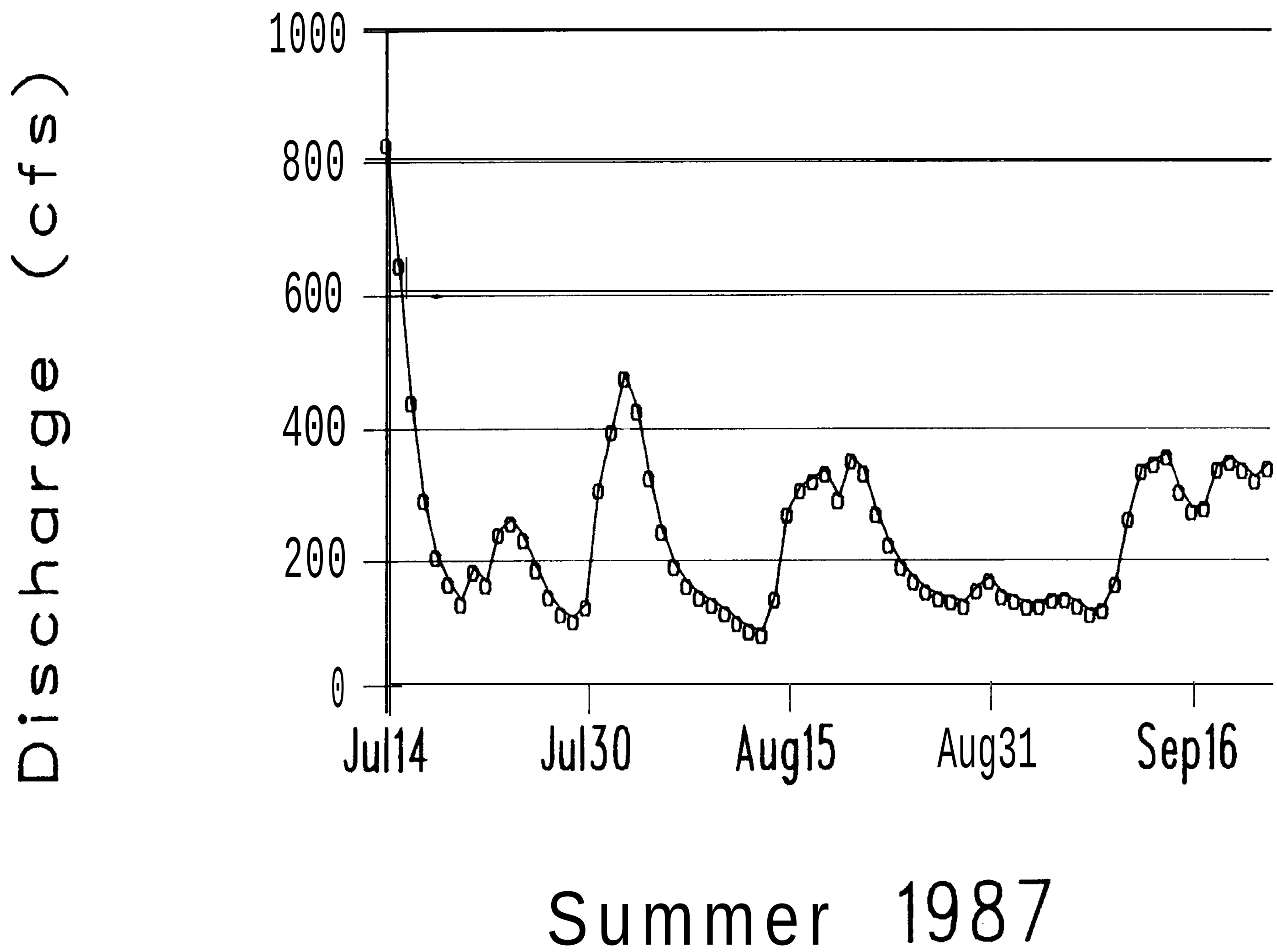
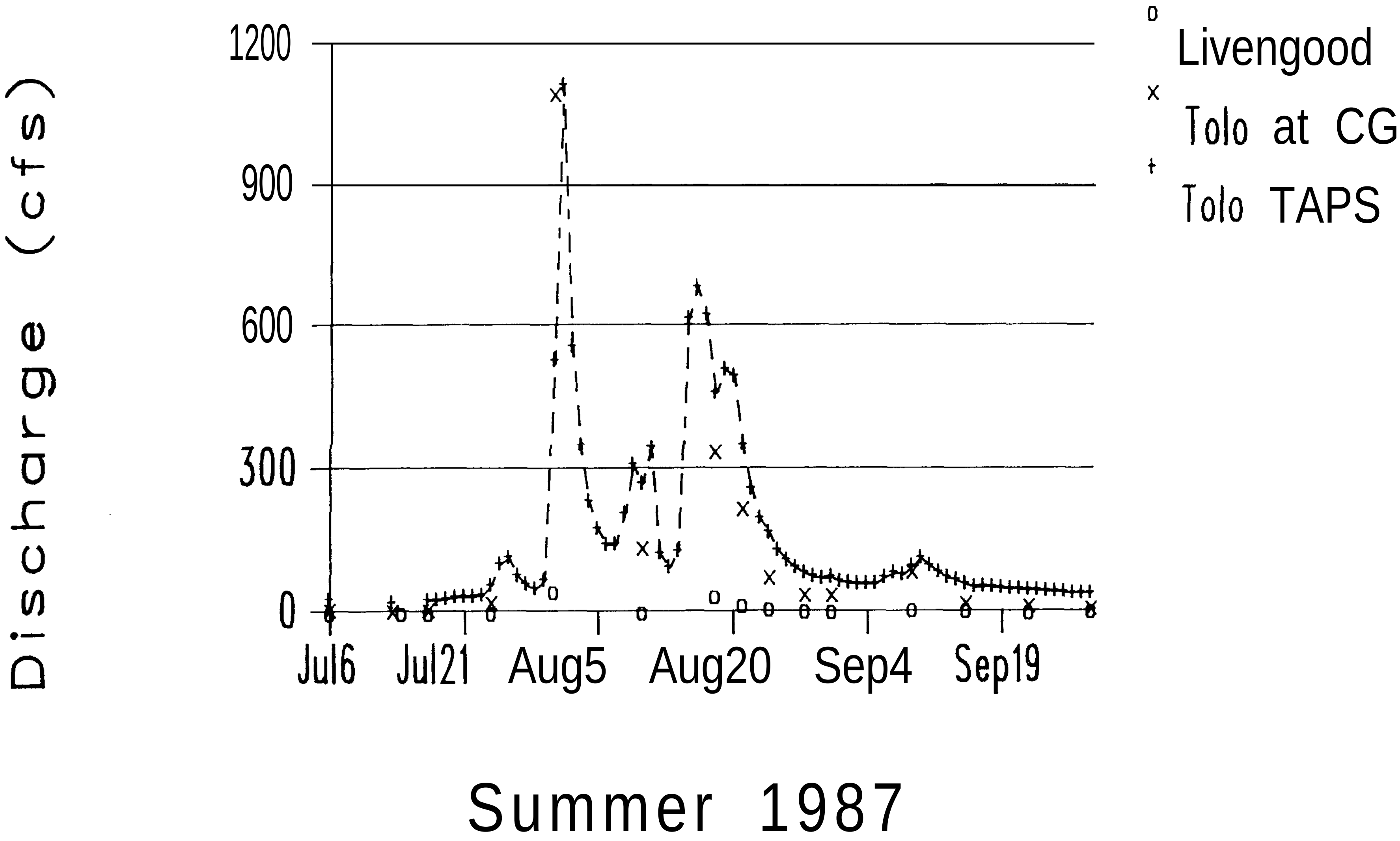


Figure 4. Discharge at Tolovana River drainage sites.



monitoring were never again approached. Water levels were high in late September due to melting snow. For the period we monitored runoff at the various sites ranged from 0.37 to 0.63 cubic feet per second (cfs) per square mile (mi2).

Discharge in the Tolovana drainage had a different pattern. We started monitoring during a period of normal flows. We had large peaks in late July-early August and another mid-August peak as shown in Figure 4. Because of the periodic nature of the monitoring at the Tolovana at campground site and because we caught the July 31 peak, the seasonal average and runoff at that site are high compared to the other sites in the Tolovana drainage. The other sites in the Tolovana drainage have runoff values similar to those in the Fortymile drainage.

Table 1. Monthly and Seasonal Discharge at Monitoring Sites. 'm' indicates mining upstream, 'u' indicates unmined.

Location	drainage area (mi2)	July (cfs)	August (cfs)	September (cfs)	Season Average (cfs)	Discharge per area (cfs/mi2)
Fortymile Drainage						
Jack Wade Creek(m)	48.6	51.5	28.0	22.9	30.7	0.63
Mosquito Fork (m)	1170	1270	368	445	598	0.51
West Fork (u)	579	553	226	191	299	0.52
Walker Fork (m)	394	272	232	243	246	0.62
South Fork (m)	2750	1800	821	677	1010	0.37
Tolovana Drainage						
Livengood Creek(m)	20.1	11.1	13.9	6.2	10.9	0.54
Tolovana at CG (m)	140	230	145	36.7	145	1.04
Tolovana at TAPS(m)	249	73.3	293	57.9	158	0.63

B. Turbidity. Table 2 shows the monthly and seasonal turbidity averages at all sites in the Fortymile and Tolovana drainages with ten or more samples. In general, turbidity at all sites in the Fortymile drainage was low. Figure 5 shows the seasonal variation at the sites with automated equipment and Figure 6 shows the seasonal variation at the non-automated sites. The relatively high initial levels correspond with the high water levels that existed at all sites when we started monitoring in mid-July. For the rest of the summer at only Jack Wade Creek and Walker Fork were turbidity levels above 5 NTU at any time.

Table 2. Monthly and Season Turbidity at Sampling Sites.
units in NTU.
'm' indicates mining upstream, 'u' indicates unmined.

Location		July	August	September	Season Average
Fortymile Drainage					
Jack Wade Creek	(m)	3.9	1.7	5.1	3.5
Mosquito Fork	(m)	3.7	1.0	0.9	1.7
West Fork	(u)	2.7	1.3	1.5	1.8
Walker Fork	(m)	2.1	2.9	2.5	2.6
South Fork	(m)	3.7	1.8	1.7	2.2
Tolovana Drainage					
Livengood Creek	(m)	54.6	17.5	7.9	27.3
Tolovana at CG	(u)	25.4	3.2	1.1	10.1
Tolovana at TAPS	(m)	6.7	32.3	4.9	16.4

Turbidity levels were higher in the Tolovana drainage. Figure 7 shows the seasonal turbidity variation (in logarithmic scale). Much of the variability can be related to the two rainfall events which raised water levels in the drainage. The discharge peaks shown in Figure 4 correspond with higher turbidity levels. If the July 31 peak is

Figure 5. Seasonal turbidity at automated Fortymile sites.

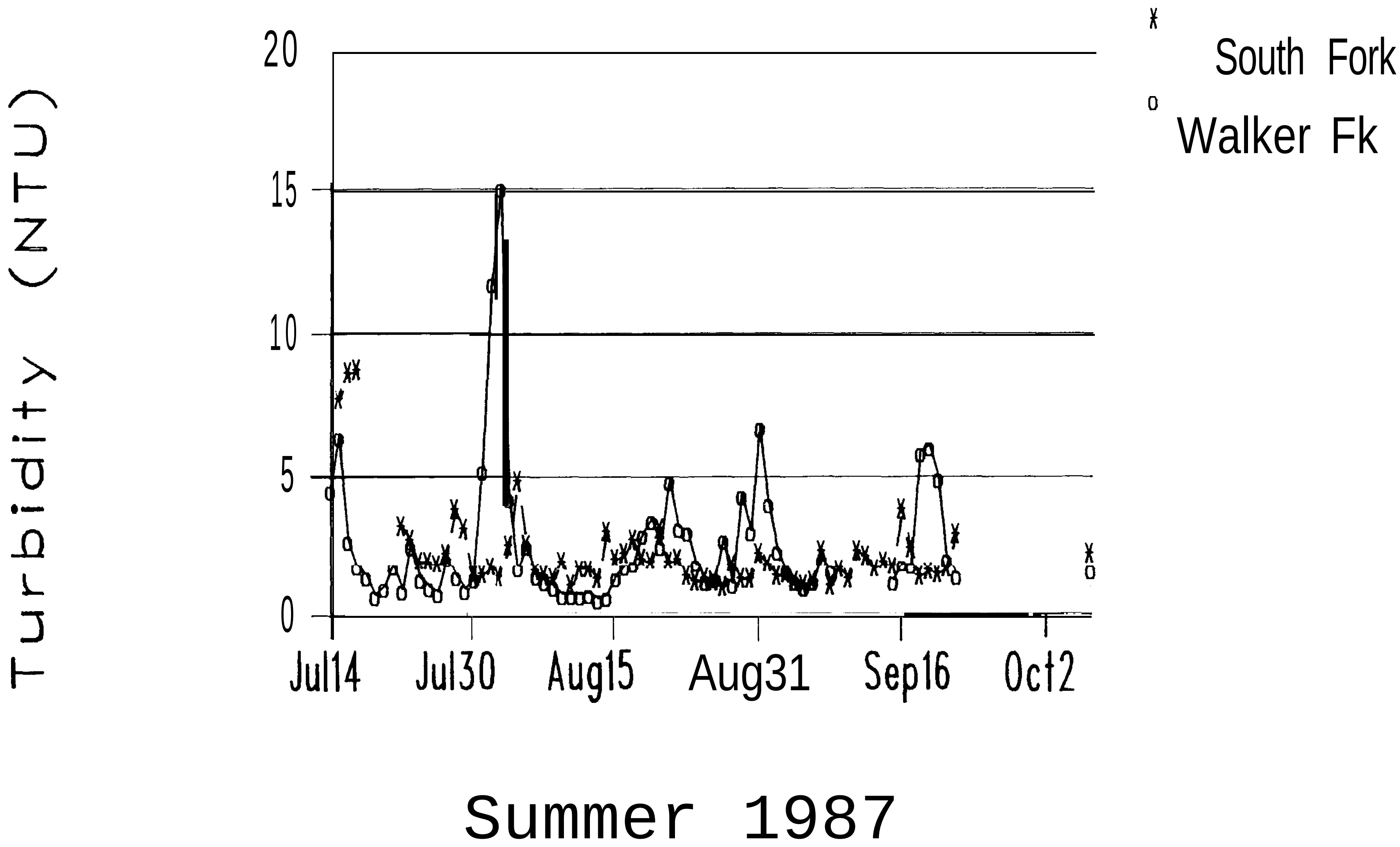


Figure 6. Seasonal turbidity at non-automated Fortymile sites.

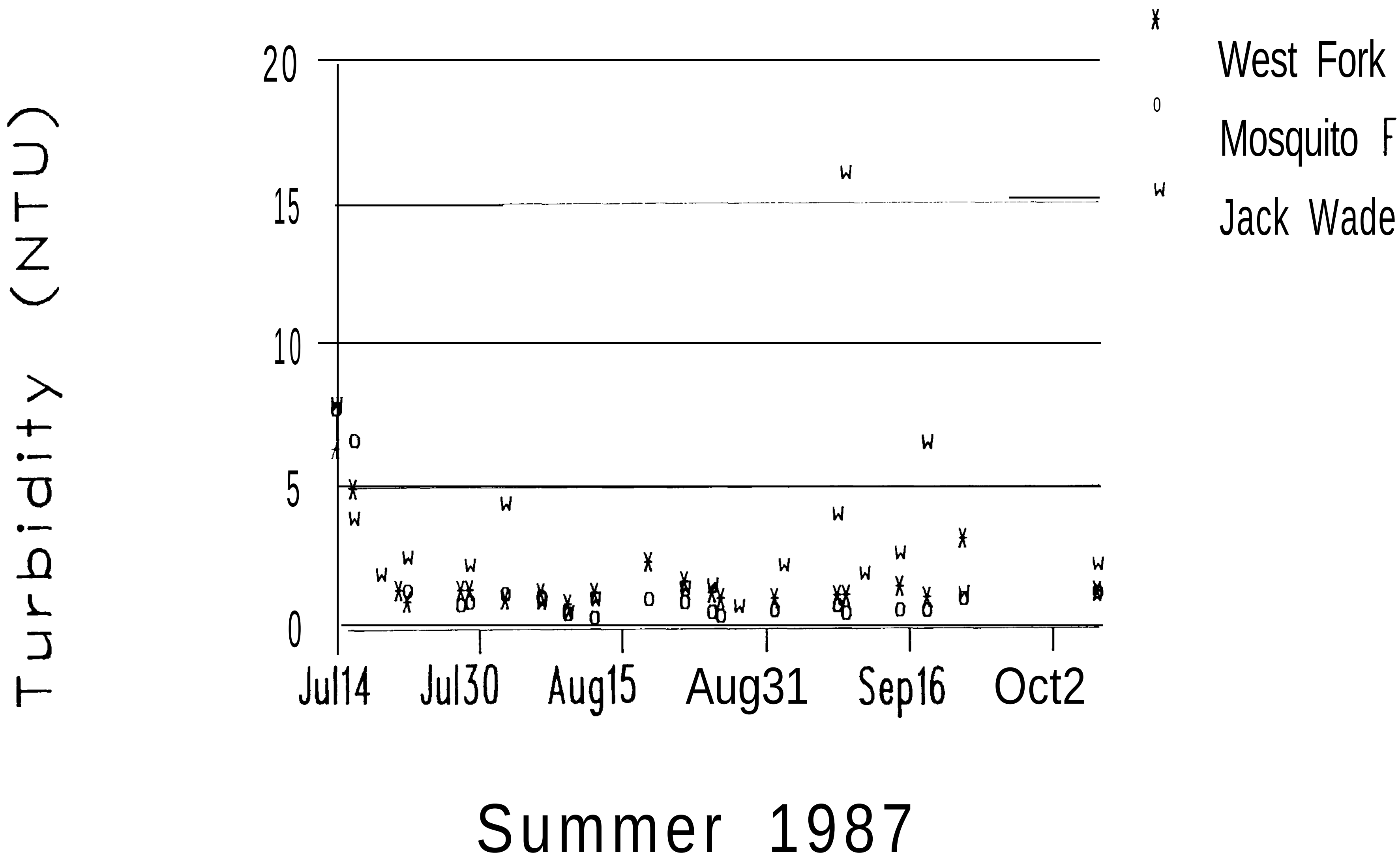
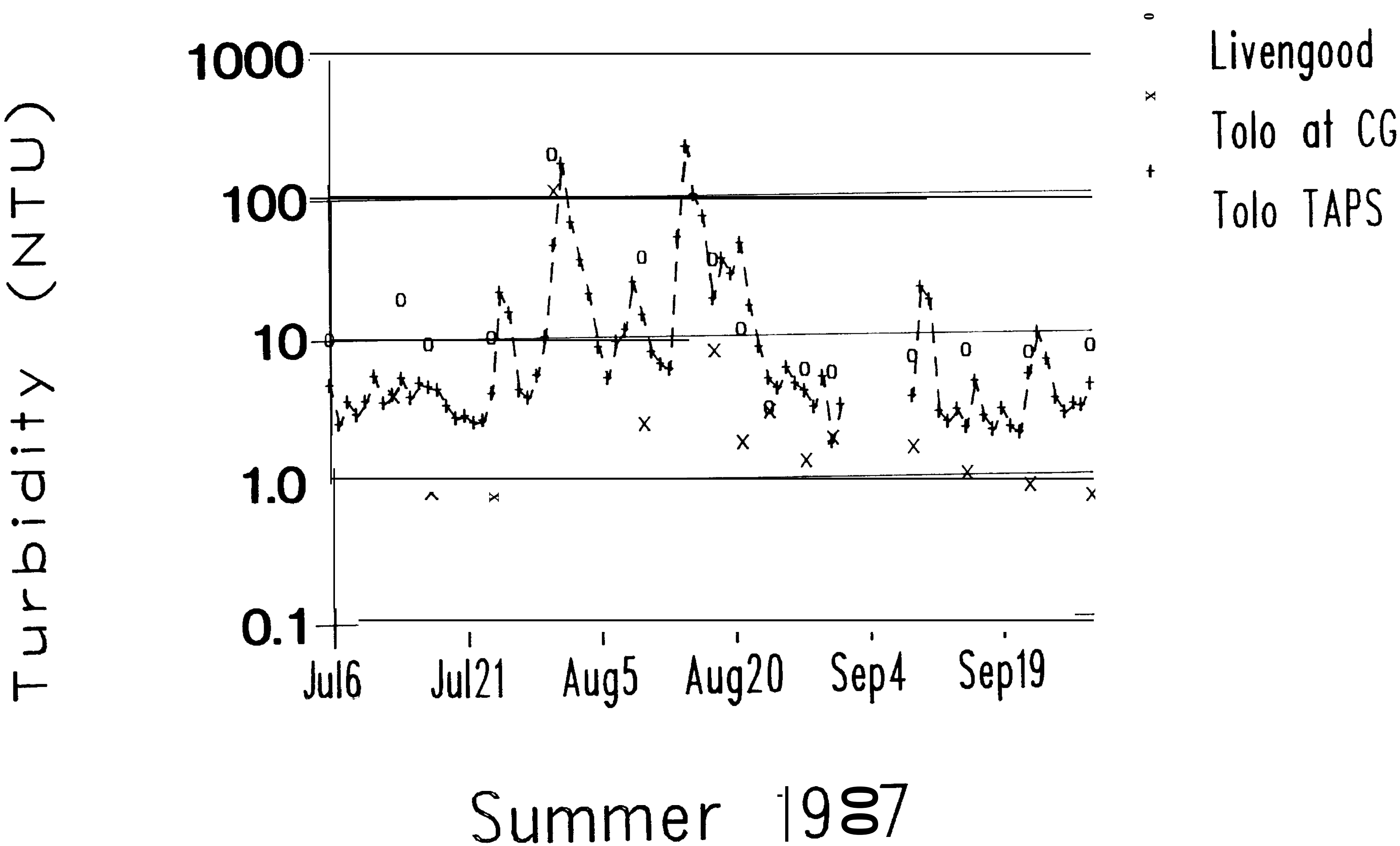


Figure 7. Seasonal turbidity at Tolovana drainage sites.



discounted, turbidity levels at the unmined site, Tolovana at campground, are all below ten NTU and the seasonal average becomes 2.2 NTU which is similar to averages in the Fortymile drainage.

C. Sediment Load. Sediment load represents the amount of material transported by streams and rivers. Table 3 shows monthly and seasonal suspended sediment load at the sampling sites in the Fortymile and Tolovana drainages. In the Fortymile drainage sediment load reflects the size of the drainage - larger streams carried more material. The effect of the high values during the high flows that were occurring at the start of the monitoring period is seen by the higher July averages and, to a lesser extent, by the seasonal averages.

Streams in the Tolovana drainage carried proportionately more material than those in the Fortymile. At the Tolovana at TAPS site with nine percent of the drainage area of the South Fork Fortymile site, 295 percent more material was moved by the river. The July monthly and seasonal average at the Tolovana at campground site was greatly affected by the sample collected July 31. If that value is neglected the seasonal sediment load average at that site is 1.32 tons per day. At the Tolovana at TAPS site where TSS samples were collected four times daily and water levels monitored continuously, the seasonal average is not biased by one sample as at the sites monitored periodically. However, flood events were still responsible for most of the sediment load. If 11 days (out of 74 total days) during the two high flow events are neglected, the sediment load average for the monitoring period is 16.7 tons per day, a decrease of 91 percent. It should be noted that the wide discrepancy between the July and August monthly averages at the two Tolovana sites is because the late July-early August peak was measured and sampled at the upper site on July 31 and did not reach the lower site until August 1.

Table 3. Monthly and Seasonal Sediment Loads at Sampling Sites. Units in tons per day
'm' indicates mining upstream, 'u' indicates unmined.

Location		July	August	September	Season Average
Fortymile Drainage					
Jack Wade Creek	(m)	2.15	0.12	0.46	1.05
Mosquito Fork	(m)	86.6	1.64	1.38	41.7
West Fork	(u)	21.6	1.70	1.67	13.5
Walker Fork	(m)	13.4	8.78	7.91	12.3
South Fork	(m)	158	15.1	7.83	64.3
Tolovana Drainage					
Livengood Creek	(m)	31.1	2.68	0.19	11.5
Tolovana at CG	(u)	428	2.76	0.27	144
Tolovana at TAPS	(m)	14.7	505	2.57	190

D. Water Chemistry. As mentioned above the water chemistry results are in Appendix 3 for the Fortymile drainage sites and Appendix 4 for the Tolovana drainage sites. As a point of reference, the Alaska Department of Environmental Conservation lists primary maximum contaminant concentrations for public drinking water supplies for As (0.05), Ba (1.0), Cd (0.010), Cr (0.05), Pb (0.05), Hg (0.002), and Se (0.01) in milligrams per liter (mg/l). Secondary maximum contaminant concentrations are Cl (250), Cu (1.0), Fe (0.3), Mn (0.05), pH

(6.5-8.5), Na (250), SO_4 (250), TDS (500), and Zn (5) in mg/l with the exception of pH. Primary contaminant concentrations are established for protection of public health. Secondary concentrations represent reasonable goals for drinking water quality and mainly affect the aesthetic qualities of drinking water (DEC 1982).

For the Fortymile drainage primary concentrations were not exceeded in any dissolved samples. For total recoverable samples the chromium concentration was exceeded at Walker Fork above the Fortymile (0.052) and West Fork Dennison (0.060). The mercury concentration was exceeded once with the South Fork sample (0.003). For secondary contaminants, levels were exceeded for pH at Buckskin Creek (6.23), North Fork above South Fork (6.47), South Fork above North Fork (6.31, and West Fork Dennison (8.52 and for iron at Jack Wade Creek (dissolved (D) 0.31), Mosquito Fork (total recoverable (TR) 0.32, D 0.31), Napoleon Creek (TR 1.57), South Fork above North Fork (TR 0.51), South Fork at Bridge (TR 0.35, D 0.39), Uhler Creek (TR 0.74), West Fork Dennison (TR 0.52, D 0.46).

The water chemistry data presented for the Tolovana drainage is less comprehensive than that for the Fortymile. For primary contaminants at Livengood Creek at DOT Bridge the arsenic level was exceeded for both total recoverable (0.13 mg/l) and total (0.12 mg/l) analyses. At the Livengood at DOT Bridge site the cadmium concentration was exceeded with the total analysis (0.023). For secondary contaminants, pH was exceeded at Isabel1 Creek (5.5), Wilber Creek (6.3), Steel Creek (6.1), Duncan Creek (6.0), Upper Lost Creek (5.6), and Lost Creek at TAPS (6.2). Total dissolved solids was exceeded at Olive Creek above Elliott Highway (581).

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APPENDIX 1. Sediment and discharge data for the Fortymile drainage, At Walker Fork and South Fork, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sediment Load (tons/day)	Discharge (cfs)
40Mile b OBrien	071687	1236	29.5	6.4		
40Mile b OBrien	072287	1715	12.8	2.6		
Chicken Cr ab mt	090987	1000	2.9	3.5	0.02	2.49
Hutchinson Cr	081687	1245	10.0	10		
North Fork a Hut	081687	1245	1.6	1.0		
North Fork ab SF	071587	1310	17.0	4.7		
North Fork ab SF	072587	0945	2.3	0.50		
North Fork ab SF	081887	1415	6.4	1.3		
North Fork ab SF	082087	1400	1.2	0.85	4.02	1240
North Fork ab SF	082787	1150	3.4	1.0		
North Fork ab SF	091787	1600	0.4	0.40		
South Fork ab NF	071587	1400	70.4	9.1	1410	7400
South Fork ab NF	072587	0945	1.1	1.3	4.60	1550
South Fork ab NF	081887	2100	5.5	2.4	23.0	1550
South Fork ab NF	082087	1100	5.2	4.8	24.0	1710
South Fork ab NF	082787	1150	0.4	1.3		
South Fork ab NF	091787		0.8	1.4	2.38	1100
Buckskin Creek	081987	1330	0.4	0.60	0.04	33.7
Butte Creek	081987	1710	50.3	1.4	0.55	4.06
Uhler Creek	071587	1500	8.7	1.9	0.69	29.2
Uhler Creek	081987	1510	17.8	4.3	0.91	19.0
Uhler Creek	082687	1935	1.2	2.4		
Uhler Creek	091787	1430	0.8	1.0		
Weaver seepage	071587	1615	30.6	21	0.10	1.26
Weaver seepage	081987	1100	20.1	6.3	0.02	0.28
Weaver seepage	091687	1330	7.0	1.1		
Napoleon Creek	071587	1600			0.00	19.9
Napoleon Creek	081987	1054	23.2	4.1	0.34	5.39
Napoleon Creek	082687	1300	2.1	0.90		
Napoleon Creek	091687		8.4	3.6		
Walker F ab 40m	081987	0930	3.0	2.2		
Walker Fork	071487	1927	36.5	4.6	82.1	833
Walker Fork	071587		94.5	6.5	166	652
Walker Fork	071687		32.9	2.8	39.7	447
Walker Fork	071787		16.4	1.8	13.3	300

APPENDIX 1. Sediment and discharge data for the Fortymile drainage. At Walker Fork and South Fork, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Walker Fork	071887	1135	21.8	1.4	12.5	213
Walker Fork	071987		4.8	0.70	2.22	171
Walker Fork	071987	1345	1.6	0.80		
Walker Fork	072087		1.9	1.0	0.72	141
Walker Fork	072187		18.5	1.8	9.50	190
Walker Fork	072287	0720	5.4	1.2	2.54	174
Walker Fork	072287		6.7	0.90	3.07	170
Walker Fork	072287	1550	2.8	1.1	1.28	169
Walker Fork	072287	1600	1.6	0.70	0.73	169
Walker Fork	072387		17.6	2.6	11.7	247
Walker Fork	072487		17.6	1.3	12.6	265
Walker Fork	072587		6.4	1.0	4.12	238
Walker Fork	072687		3.7	0.80	1.93	193
Walker Fork	072787		3.9	2.1	1.59	151
Walker Fork	072887	1135	1.2	1.4	0.40	124
Walker Fork	072987	1135	10.3	0.90	3.17	114
Walker Fork	073087		6.1	1.3	2.23	136
Walker Fork	073187		26.9	5.3	22.9	315
Walker Fork	080187		94.7	12	103	403
Walker Fork	080287		76.0	15	99.0	483
Walker Fork	080287	1340	11.6	4.5	15.3	488
Walker Fork	080387		27.7	4.3	32.5	434
Walker Fork	080487		13.9	1.7	12.5	333
Walker Fork	080587		8.3	2.6	5.62	251
Walker Fork	080687		3.7	1.4	1.97	197
Walker Fork	080687	2120	0.8	1.5	0.39	181
Walker Fork	080787		3.2	1.2	1.45	168
Walker Fork	080887		11.5	1.0	4.66	150
Walker Fork	080987		4.0	0.70	1.50	139
Walker Fork	080987	1538	0.8	0.80	0.29	133
Walker Fork	081087		3.0	0.70	1.02	126
Walker Fork	081187		1.5	0.70	0.45	111
Walker Fork	081287		2.9	0.75	0.77	98.2
Walker Fork	081387		3.1	0.55	0.78	92.6
Walker Fork	081487		2.0	0.65	0.80	148
Walker Fork	081587		11.4	1.3	8.56	278
Walker Fork	081687		11.4	1.7	9.70	315
Walker Fork	081787		6.7	1.9	5.93	328
Walker Fork	081887		8.7	3.0	7.99	340
Walker Fork	081987		8.1	3.5	6.54	299
Walker Fork	082087		9.8	2.6	9.50	359
Walker Fork	082187		6.9	4.9	6.33	340
Walker Fork	082287		35.3	3.2	26.5	278
Walker Fork	082287	0940	1.9	2.5	1.48	288

APPENDIX 1. Sediment and discharge data for the Fortymile drainage. At Walker Fork and South Fork, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Walker Fork	082387		5.0	3.1	3.11	230
Walker Fork	082487		10.9	1.9	5.77	196
Walker Fork	082587		5.1	1.2	2.40	174
Walker Fork	082687		6.1	1.3	2.60	158
Walker Fork	082787		4.2	2.8	1.68	148
Walker Fork	082887		4.3	1.1	1.66	143
Walker Fork	082987		7.8	4.4	2.86	136
Walker Fork	083087		6.9	3.1	2.98	160
Walker Fork	083087	2120	0.8	1.7	0.41	192
Walker Fork	083187		30.7	6.8	14.5	175
Walker Fork	090187		77.8	4.1	31.7	151
Walker Fork	090287		9.4	2.4	3.65	144
Walker Fork	090387		4.0	1.6	1.46	135
Walker Fork	090487		1.9	1.2	0.69	135
Walker Fork	090587		3.5	1.0	1.37	145
Walker Fork	090687		0.8	1.2	0.32	146
Walker Fork	090787		2.3	2.1	0.84	136
Walker Fork	090887	1400	2.6	1.6	0.86	123
Walker Fork	091587	1400	3.4	1.2	2.85	311
Walker Fork	091687		10.9	1.9	8.27	281
Walker Fork	091787		9.1	1.8	7.03	286
Walker Fork	091887		26.4	5.9	24.6	345
Walker Fork	091887	0855	5.1	2.0	4.92	358
Walker Fork	091987		22.1	6.1	21.2	356
Walker Fork	092087		11.1	5.0	10.3	344
Walker Fork	092187		5.4	2.1	4.78	328
Walker Fork	092287		2.3	1.4	2.15	347
Walker Fork	100787	1320	24.8	1.6		
Walker Fork abJW	071587	1635	15.7	5.7		
Walker Fork abJW	071687	1040	a.2	3.4		
Walker Fork abJW	081287	1230	3.9	1.1		
Walker Fork abJW	082287	0925	3.1	2.3		
Jack Wade Creek	071487	1815	48.8	8.2	12.5	94.5
Jack Wade Creek	071687	1030	14.5	4.1	2.28	58.3
Jack Wade Creek	071987	1320	1.9	2.1	0.23	44.6
Jack Wade Creek	072287	0730	9.6	2.7	1.03	39.7
Jack Wade Creek	072287	1600	7.4	2.6	0.79	39.7
Jack Wade Creek	072987	0945	3.7	2.4	0.20	20.3
Jack Wade Creek	080287	1345	1.3	4.6	0.26	74.9
Jack Wade Creek	080687	0905	2.1	1.1	0.13	22.5
Jack Wade Creek	080987	1345	0.8	0.75	0.04	18.9
Jack Wade Creek	081287	1230	0.9	1.2	0.03	13.4

APPENDIX 1. Sediment and discharge data for the Fortymile drainage. At Walker Fork and South Fork, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Jack Wade Creek	082287	0900	2.9	1.6	0.23	29.3
Jack Wade Creek	082587	0915	1.6	1.8	0.09	20.3
Jack Wade Creek	082587	1135	1.4	1.6	0.08	20.3
Jack Wade Creek	082887	1300	1.2	0.95	0.05	16.9
Jack Wade Creek	090287	1455	1.3	2.4	0.05	13.9
Jack Wade Creek	090887	1330	1.3	4.2	0.04	11.4
Jack Wade Creek	090987	0913	10.2	16	0.37	13.4
Jack Wade Creek	091187	0930	6.3	2.1	0.41	24.1
Jack Wade Creek	091587	1700	4.2	2.8	0.31	27.5
Jack Wade Creek	091887	0845	27.3	6.6	3.38	45.8
Jack Wade Creek	092287	1245	1.3	1.4	0.08	24.1
Jack Wade Creek	100787	1310	5.6	2.4	0.60	39.7
South Fork at Br	071587	1821	34.6	7.7	600	6420
South Fork at Br	071687	1450	194	8.6	2700	5170
South Fork at Br	071787		66.7	8.7	625	3470
South Fork at Br	072287		34.1	3.2	62.6	680
South Fork at Br	072287	1430	2.8	1.4	5.14	680
South Fork at Br	072387		26.8	2.7	50.7	700
South Fork at Br	072487		7.3	1.9	13.4	680
South Fork at Br	072587		17.8	1.9	33.6	700
South Fork at Br	072687		8.5	1.8	16.8	730
South Fork at Br	072787		8.2	2.2	16.2	730
South Fork at Br	072887		6.9	3.8	14.3	770
South Fork at Br	072987	1250	10.1	3.1	21.3	780
South Fork at Br	073087		4.8	1.3	9.59	740
South Fork at Br	073187		4.8	1.4		
South Fork at Br	080187		11.3	1.7		
South Fork at Br	080287		10.5	1.3	15.0	530
South Fork at Br	080387		6.8	2.5	10.5	570
South Fork at Br	080487		10.2	4.8	16.8	610
South Fork at Br	080587		5.4	2.5	8.89	610
South Fork at Br	080687		3.6	1.5	5.54	570
South Fork at Br	080787		3.3	1.3	5.08	570
South Fork at Br	080887		12.4	1.2	19.1	570
South Fork at Br	080987		5.8	1.9	10.5	670
South Fork at Br	081087		9.5	0.95	17.2	670
South Fork at Br	081187		10.8	1.6	19.8	680
South Fork at Br	081287		5.3	1.6	10.2	710
South Fork at Br	081387		6.3	1.2	11.9	700
South Fork at Br	081487		8.1	3.0	13.1	600
South Fork at Br	081587		5.7	2.0	11.5	750
South Fork at Br	081687		9.5	2.2	21.0	820
South Fork at Br	081787		8.5	2.7	23.4	1020

APPENDIX 1. Sediment and discharge data for the Fortymile drainage. At Walker Fork and South Fork, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sediment Load -(tons/day)	Discharge (cfs)
South Fork at Br	081887		10.2	2.0	39.7	1440
South Fork at Br	081887	1600	4.0	2.1	15.6	1440
South Fork at Br	081987		11.2	1.9	38.7	1280
South Fork at Br	082087		7.1	3.1	28.2	1470
South Fork at Br	082187		3.3	1.9	13.7	1540
South Fork at Br	082287	1224	5.6	2.0	16.8	1110
South Fork at Br	082387		1.9	1.3		
South Fork at Br	082487		2.7	1.1		
South Fork at Br	082587		3.7	1.2		
South Fork at Br	082587	0945	0.4	1.0	0.83	770
South Fork at Br	082587	1150	1.2	1.5	2.46	760
South Fork at Br	082687		3.1	1.1		
South Fork at Br	082787		4.4	0.90		
South Fork at Br	082887		5.3	1.8		
South Fork at Br	082887	1430	0.4	1.1	0.63	580
South Fork at Br	082987		2.2	1.2		
South Fork at Br	083087		2.1	1.2		
South Fork at Br	083187		14.9	2.2		
South Fork at Br	090187		12.6	1.8		
South Fork at Br	090287		9.7	1.3	12.3	470
South Fork at Br	090387		3.8	1.4		
South Fork at Br	090487		3.7	1.1		
South Fork at Br	090587		2.4	0.95		
South Fork at Br	090687		1.4	1.1		
South Fork at Br	090787		2.8	2.3		
South Fork at Br	090887	1500	3.7	0.95	4.00	400
South Fork at Br	090987		2.9	1.6	3.76	480
South Fork at Br	091087		3.5	1.2	3.97	420
South Fork at Br	091187		3.5	2.3	4.44	470
South Fork at Br	091187	1230	0.8	1.2	1.02	470
South Fork at Br	091287		3.2	2.1	4.75	550
South Fork at Br	091387		1.8	1.6	3.21	660
South Fork at Br	091487		2.0	1.9	3.73	690
South Fork at Br	091587		3.4	1.7	6.61	720
South Fork at Br	091687		10.0	3.8	16.7	620
South Fork at Br	091787		6.8	2.4	12.3	670
South Fork at Br	091887		2.5	1.3	4.66	690
South Fork at Br	091987		2.8	1.5	5.52	730
South Fork at Br	092087		3.4	1.4	7.89	860
South Fork at Br	092187		1.3	1.6	3.86	1100
South Fork at Br	092287		7.1	2.9	24.9	1300
South Fork at Br	092287	1425	16.9	3.3	59.3	1300
South Fork at Br	100787	1340	5.6	2.2	30.2	2000

APPENDIX 1. Sediment and discharge data for the Fortymile drainage. At Walker Fork and South Fork, blank in time column indicates data from automated'sampler

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Mosquito Fork	071487	1200	61.6	8.0	499	3000
Mosquito Fork	071687	1630	57.5	6.9	345	2220
Mosquito Fork	072287	1346	1.7	1.5	2.05	447
Mosquito Fork	072887	1745	3.4	1.0	3.37	367
Mosquito Fork	072987	1645	2.0	1.1	1.71	317
Mosquito Fork	080287	1107	2.2	1.4	4.79	807
Mosquito Fork	080687	1100	1.6	1.3	1.65	382
Mosquito Fork	080987	0955	1.3	0.70	0.92	263
Mosquito Fork	081287	1050	0.9	0.55	0.48	198
Mosquito Fork	081887	1300	3.5	1.2	3.98	421
Mosquito Fork	082287	1400	1.6	1.1	1.47	339
Mosquito Fork	082587	1225	0.9	0.75	0.69	283
Mosquito Fork	082687	1130	1.2	0.60	0.82	252
Mosquito Fork	090187	1135	1.8	0.80	0.87	179
Mosquito Fork	090887	1140	0.9	0.95	0.38	157
Mosquito Fork	090987	1032	1.2	0.70	0.49	151
Mosquito Fork	091587	1510	0.4	0.95	0.22	205
Mosquito Fork	091587	1625	0.9	0.80	0.50	205
Mosquito Fork	091887	1110	0.8	0.80	0.45	208
Mosquito Fork	092287	1500	1.3	1.2	0.90	256
Mosquito Fork	100787	1426	4.0	1.4	6.51	603
W Fork Dennison	071487	1042	51.6	6.4	187	1340
W Fork Dennison	071687	1652	19.7	4.9	56.4	1060
W Fork Dennison	072187	1345	4.6	1.3	3.77	304
W Fork Dennison	072287	1310	2.3	0.90	1.62	260
W Fork Dennison	072887	1135	4.6	1.3	2.33	188
W Fork Dennison	072887	1655	4.7	1.3	2.39	188
W Fork Dennison	072987	1720	4.0	1.3	1.80	167
W Fork Dennison	080287	1035	3.0	1.0	2.46	304
W Fork Dennison	080687	1020	3.0	1.2	2.46	304
W Fork Dennison	080987	0915	1.2	0.80	0.60	185
W Fork Dennison	081287	1020	2.2	1.2	0.74	125
W Fork Dennison	081887	1035	8.0	2.3	9.68	448
W Fork Dennison	082287	1425	1.6	1.6	1.29	299
W Fork Dennison	082587	1255	2.1	1.2	1.08	191
W Fork Dennison	082687	1300	1.1	1.0	0.52	176
W Fork Dennison	090187	1105	1.4	1.0	0.43	113
W Fork Dennison	090887	1035	1.6	1.1	0.36	84
W Fork Dennison	090987	1055	0.8	1.1	0.18	83
W Fork Dennison	091587	1445	2.9	1.4	1.17	150
W Fork Dennison	091887	1130	1.2	1.0	0.57	176
W Fork Dennison	092287	1230	11.5	3.1	16.8	541
W Fork Dennison	100787	1447	3.6	1.2	3.73	384

APPENDIX 2. Sediment and discharge data for the Tolovana drainage. At Tolovana at TAPS, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turb (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Livengood Cr	070687	1315	12.9	11	0.08	2.17
Livengood Cr	071487	1250	29.1	21	0.15	1.95
Livengood Cr	071787	1620	20.3	10	0.10	1.83
Livengood Cr	072487	1430	28.7	11	0.15	1.88
Livengood Cr	073187	1313	1200	220	155	47.8
Livengood Cr	081087	1700	213	40	1.59	2.77
Livengood Cr	081887	1220	129	38	13.3	38.0
Livengood Cr	082187	1213	8.8	12	0.45	18.9
Livengood Cr	082487	1600	12.7	3.3	0.40	11.7
Livengood Cr	082887	1125	13.1	6.1	0.23	6.59
Livengood Cr	083187	1355	11.5	5.8	0.18	5.74
Livengood Cr	090987	1610	10.5	7.4	0.26	9.06
Livengood Cr	091587	1320	18.9	8.1	0.37	7.16
Livengood Cr	092287	1351	6.4	7.7	0.06	3.26
Livengood Cr	092987	1215	4.5	8.5	0.06	5.30
Ready Bullion Cr	081087	1300	230	32		
Ready Bullion Cr	081887	1252	37.0	5.6		
Tolovana at CG	070687	1230	1.9	1.2	0.05	10.2
Tolovana at CG	071387	1505	25.1	4.3	0.47	6.9
Tolovana at CG	071787	1705	0.76	0.90	0.02	9.5
Tolovana at CG	072487	1530	4.6	0.80	0.31	25.3
Tolovana at CG	073187	1400	721	120	2140	1100
Tolovana at CG	081087	1840	5.4	2.6	2.04	140
Tolovana at CG	081887	1320	11.5	8.4	10.6	342
Tolovana at CG	082187	1200	4.6	1.9	2.77	223
Tolovana at CG	082487	1400	2.6	3.1	0.56	79.8
Tolovana at CG	082887	1100	2.3	1.4	0.26	42.3
Tolovana at CG	083187	1425	2.5	2.0	0.29	42.5
Tolovana at CG	090987	1650	3.85	1.7	0.95	91.2
Tolovana at CG	091587	1456	1.2	1.1	0.08	24.3
Tolovana at CG	092287	1420	0.81	0.90	0.04	18.5
Tolovana at CG	092987	1049	0.64	0.75	0.02	12.6
Tolovana at TAPS	070687	1500	4.3	4.7	0.26	22.7
Tolovana at TAPS	070787		7.2	2.5		
Tolovana at TAPS	070887		8.5	3.6		
Tolovana at TAPS	070987		7.1	2.9		
Tolovana at TAPS	071087		10.7	3.6		
Tolovana at TAPS	071187		7.4	5.4		
Tolovana at TAPS	071287		5.4	3.5		
Tolovana at TAPS	071387		5.7	4.0		
Tolovana at TAPS	071487		8.0	5.2		

APPENDIX 2. Sediment and discharge data for the Tolovana drainage. At **Tolovana at** TAPS, blank in time column indicates data from automated sampler

Location	Date	Time	TSS (mg/l)	Turb (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Tolovana at TAPS	071487	1310	2.1	5.4	0.09	15.4
Tolovana at TAPS	071587		4.6	3.8		
Tolovana at TAPS	071687		6.8	4.8		
Tolovana at TAPS	071787		3.3	4.5	0.19	21.3
Tolovana at TAPS	071787	1524	0.77	3.6	0.04	21.1
Tolovana at TAPS	071887		8.6	4.3	0.51	22.0
Tolovana at TAPS	071987		8.1	3.3	0.53	24.3
Tolovana at TAPS	072087		10.0	2.7	0.76	28.0
Tolovana at TAPS	072187		8.1	2.8	0.63	29.0
Tolovana at TAPS	072287		8.6	2.5	0.68	29.3
Tolovana at TAPS	072387		11.5	2.6	1.01	32.7
Tolovana at TAPS	072487		13.6	4.0	1.93	52.7
Tolovana at TAPS	072487	1355	10.3	3.2	1.26	45.2
Tolovana at TAPS	072587		69.1	21	18.2	97.6
Tolovana at TAPS	072687		79.9	15	23.9	111
Tolovana at TAPS	072787		25.5	4.2	5.01	72.7
Tolovana at TAPS	072887		18.4	3.7	2.73	55.0
Tolovana at TAPS	072987		14.5	5.3	1.78	45.5
Tolovana at TAPS	073087		30.1	10	5.13	63.1
Tolovana at TAPS	073187		226	45	319	523
Tolovana at TAPS	073187	1232	918	150	1250	506
Tolovana at TAPS	080187		2240	170	6710	1110
Tolovana at TAPS	080287		616	65	919	552
Tolovana at TAPS	080387		238	35	224	348
Tolovana at TAPS	080487		229	20	141	229
Tolovana at TAPS	080587		65.7	8.3	30.5	172
Tolovana at TAPS	080687		50.3	5.0	18.7	138
Tolovana at TAPS	080787		58.9	9.1	22.1	139
Tolovana at TAPS	080887		72.9	11	40.2	204
Tolovana at TAPS	080987		210	24	173	305
Tolovana at TAPS	081087		121	14	86.8	266
Tolovana at TAPS	081087	1520	27.4	7.7	17.3	234
Tolovana at TAPS	081187		63.8	7.6	58.9	342
Tolovana at TAPS	081287		34.5	6.2	11.2	120
Tolovana at TAPS	081387		39.9	5.7	9.73	90.3
Tolovana at TAPS	081487		426	50	143	124
Tolovana at TAPS	081587		2020	220	3330	610
Tolovana at TAPS	081687		758	100	1380	677
Tolovana at TAPS	081787		369	70	616	618
Tolovana at TAPS	081887		244	18	301	457
Tolovana at TAPS	081887	1140	82.5	15	101	455
Tolovana at TAPS	081987		364	35	496	505
Tolovana at TAPS	082087		285	27	378	491
Tolovana at TAPS	082187		385	45	363	349

APPENDIX 2. **Sediment and discharge data** for the Tolovana drainage. **At Tolovana at TAPS,** blank in time column indicates **data** from automated sampler

Location	Date	Time	TSS (mg/l)	Turb (NTU)	Sediment Load (tons/day)	Discharge (cfs)
Tolovana at TAPS	082187	1235	411	130	389	350
Tolovana at TAPS	082287		172	16	118	255
Tolovana at TAPS	082387		78.1	8.1	40.9	194
Tolovana at TAPS	082487		55.1	4.8	24.4	164
Tolovana at TAPS	082487	1430	16.3	3.3	5.41	123
Tolovana at TAPS	082587		36.8	4.1	12.6	127
Tolovana at TAPS	082687		31.2	5.7	8.85	105
Tolovana at TAPS	082787		22.5	4.4	5.50	90.5
Tolovana at TAPS	082887		24.9	3.9	5.34	79.4
Tolovana at TAPS	082887	1210	6.8	2.5	1.52	82.8
Tolovana at TAPS	082987		13.1	3.0	2.53	71.5
Tolovana at TAPS	083087		37.4	4.9	6.79	67.2
Tolovana at TAPS	083187	1315	4.7	1.7	0.90	70.8
Tolovana at TAPS	090187		36.7	3.1	6.11	61.7
Tolovana at TAPS	090987		19.9	3.5	4.98	92.6
Tolovana at TAPS	090987	1430	7.59	3.0	1.86	91.0
Tolovana at TAPS	091087		83.2	21	24.7	110
Tolovana at TAPS	091187		61.5	17	15.6	94.0
Tolovana at TAPS	091287		10.3	2.7	2.23	80.3
Tolovana at TAPS	091387		11.3	2.3	2.14	70.0
Tolovana at TAPS	091487		13.7	2.8	2.37	64.0
Tolovana at TAPS	091587	1245	9.7	2.1	1.47	56.2
Tolovana at TAPS	091687		12.7	4.4	1.69	49.3
Tolovana at TAPS	091787		6.5	2.5	0.89	50.7
Tolovana at TAPS	091887		4.6	2.0	0.61	49.1
Tolovana at TAPS	091987		3.5	2.8	0.44	46.9
Tolovana at TAPS	092087		3.5	2.1	0.43	45.9
Tolovana at TAPS	092187		3.0	1.9	0.36	45.0
Tolovana at TAPS	092287		13.8	4.9	1.62	43.4
Tolovana at TAPS	092287	1.336	5.2	3.1	0.67	47.5
Tolovana at TAPS	092387		28.8	9.7	3.34	42.9
Tolovana at TAPS	092487		17.8	6.2	1.94	40.4
Tolovana at TAPS	092587		8.7	3.3	0.93	39.4
Tolovana at TAPS	092687		7.4	2.6	0.76	37.9
Tolovana at TAPS	092787		3.8	3.0	0.37	35.8
Tolovana at TAPS	092887		9.1	2.9	0.88	35.8
Tolovana at TAPS	092987		5.4	4.1	0.52	35.4
Tolovana at TAPS	092987	1510	1.9	2.7	0.17	32.9
West Fk Tolovana	082187	1300	8.8	2.0		

APPENDIX 3. **Fortymile** drainage **water** chemistry
With trace metals, **'T'** represents total recoverable, **'D'** represents dissolved

Stream Reach	Date	TIME	TSS mg/l	SL t/d	TURB NTU	TDS mg/l	DISCHARGE cfs	PH	ALK as CaC03	HARDNS as CaC03	NO3 mg/l	CL mg/l
Buckskin Creek	8-19-87	1400	0.4	0.04	0.60	43	33.7	6.23	70.9	94.8	<0.01	0.16
Jack Wade Creek	8-22-87	900	2.9	0.23	1.6	24.8	29.3	6.84	40.7	48.7	0.27	0.08
Mosquito Fork	8-18-87	1300	3.5	3.98	1.2	27.2	421	8.12	44.5	49.0	0.06	0.44
Napoleon Creek	8-19-87	1100	23.2	0.34	4.1	33.0	5.39	6.81	54.0	57.6	0.21	0.35
North Fork ab SF	8-20-87	1100	1.2	4.02	0.85	43.4	1240	6.47	71.0	78.1	0.02	0.72
South Fork ab NF	8-20-87	1300	5.2	24.0	4.8	22.9	1710	6.31	37.7	40.9	0.02	0.15
South Fork at Bridge	8-18-87	1600	4.0	15.6	2.1	22.6	1440	7.79	37.4	36.4	0.04	0.14
Uhler Creek	8-19-87	1530	17.8	0.91	4.3	17.6	19.0	7.90	29.0	33.5	0.22	0.01
Walker Fork at Bridge	8-22-87	1030	1.9	1.48	2.5	35.4	288	6.55	58.8	46.6	<0.01	0.09
Walker Fork at 40m	8-19-87	930	3.0		2.2	26.7		7.83	44.0	48.6	0.06	0.16
West Fork Dennison	8-18-87	1100	8.0	9.68	2.3	14.7	448	8.52	23.4	29.5	<0.01	0.63

Trace metals are reported in mg/l

Stream Reach	SO4 mg/l	Na mg/l	K mg/l	F mg/l	Mg mg/l	Ca mg/l	Sr mg/l	Ba mg/l	As T	As D	Al T	Al D
Buckskin Creek	27.6	3.09	1.08	<0.001	5.07	29.6	co.01	0.031	<0.002	(0.002	0.090	0.067
Jack Wade Creek	12.4	2.04	1.34	<0.001	3.21	14.2	<0.01	0.048	<0.002	<0.002	0.298	0.239
Mosquito Fork	8.09	4.02	0.62	<0.001	3.55	13.7	0.1	0.007	co.002	x0.002	0.107	0.085
Napoleon Creek	3.88	2.64	0.88	<0.001	4.10	16.2	0.2	0.024	<0.002	<0.002	0.935	0.171
North Fork ab SF	20.4	3.79	0.72	<0.001	5.67	21.9	to.01	0.010	<0.002	<0.002	0.193	0.054
South Fork ab NF	7.26	3.58	0.60	<0.001	3.39	10.8	<0.01	0.009	<0.002	<0.002	0.320	0.121
South Fork at Bridge	6.12	3.55	0.52	<0.001	2.96	9.7	<0.01	0.007	<0.002	<0.002	0.216	0.147
Uhler Creek	3.30	1.64	0.72	<0.001	1.97	10.1	0.17	0.013	<0.002	co.002	0.697	0.28
Walker Fork at Bridge	11.0	3.45	0.92	<0.001	4.51	11.2	<0.01	0.032	<0.002	<0.002	0.179	0.143
Walker Fork at 40m	11.6	3.59	0.93	<0.001	4.95	11.3	<0.01	0.034	<0.002	<0.002	0.204	0.128

APPENDIX 3. Fortymile drainage water chemistry
With trace metals, 'T' represents total recoverable, 'D' represents dissolved
Trace metals are reported in mg/l

Stream Reach	B	B	Be	Be	Cd	Cd	Cr	Cr	cu	cu	Fe	Fe
	T	D	T	D	T	D	T	D	T	D	T	D
Buckskin Creek	0.022	co.01	co.02	<0.02	<0.01	<0.01	0.005	so.002	0.040	0.026	0.05	0.10
Jack Wade Creek	<0.01	<0.01	<0.02	<0.02	<0.01	so.01	0.006	<0.002	<0.005	0.019	0.30	0.31
Mosquito Fork	<0.01	so.01	<0.02	<0.02	co.01	<0.01	0.013	co.002	0.019	0.019	0.32	0.31
Napoleon Creek	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.021	<0.002	<0.005	0.007	1.57	0.19
North Fork ab SF	<0.01	<0.01	go.02	<0.02	<0.01	<0.01	0.039	<0.002	co.005	0.011	0.04	0.09
South Fork ab NF	<0.01	<0.01	co.02	<0.02	co.01	<0.01	0.035	co.002	<0.005	0.037	0.51	0.26
South Fork at Bridge	<0.01	<0.01	<0.02	<0.02	<0.01	so.01	0.004	to.002	<0.005	0.015	0.35	0.39
Uhler Creek	<0.01	<0.01	<0.02	so.02	<0.01	<0.01	0.035	co.002	0.005	0.007	0.74	0.29
Walker Fork at Bridge	<0.01	so.01	<0.02	<0.02	<0.01	<0.01	0.049	go.002	<0.005	0.016	0.22	0.20
Walker Fork at 40m	0.021	<0.01	so.02	co.02	<0.01	co.01	0.052	<0.002	co.005	0.018	0.26	0.20
West Fork Dennison	<0.01	0.010	<0.02	<0.02	co.01	co.01	0.060	so.002	0.014	0.02	0.52	0.46

Stream Reach	Pb	Pb	Mn	Mn	Hg	Hg	Se	Se	Si	Si	Zn	Zn
	T	D	T	D	T	D	T	D	T	D	T	D
Buckskin Creek	-0.03	<0.03	0.007	<0.005	0.002	<0.001	(0.02	(0.02	1.92	3.92	(0.02	<0.02
Jack Wade Creek	so.03	<0.03	0.043	0.037	<0.001	<0.001	<0.02	<0.02	2.16	4.19	co.02	<0.02
Mosquito Fork	<0.03	<0.03	0.012	0.007	<0.001	<0.001	<0.02	<0.02	2.02	3.73	<0.02	0.03
Napoleon Creek	<0.03	<0.03	0.033	0.007	<0.001	<0.001	<0.02	<0.02	3.57	4.45	0.02	<0.02
North Fork ab SF	<0.03	<0.03	0.008	<0.005	<0.001	~0.001	<0.02	<0.02	2.05	3.12	co.02	<0.02
South Fork ab NF	<0.03	<0.03	0.018	0.008	<0.001	<0.001	<0.02	<0.02	3.37	4.21	<0.02	0.02
South Fork at Bridge	<0.03	<0.03	0.018	0.012	0.003	<0.001	<0.02	<0.02	4.50	3.83	so.02	<0.02
Uhler Creek	<0.03	<0.03	0.031	0.014	<0.001	<0.001	co.02	co.02	4.98	3.60	<0.02	<0.02
Walker Fork at Bridge	<0.03	<0.03	0.019	0.011	<0.001	<0.001	<0.02	<0.02	4.00	3.83	<0.02	co.02
Walker Fork at 40m	<0.03	<0.03	0.017	0.009	<0.001	<0.001	co.02	co.02	4.09	2.67	co.02	co.02

APPENDIX 4. Tolovana drainage water chemistry.
DEC Use Attainability Analysis data

Stream Reach	Date	TSS mg/	SL t/d	ss ml/l	TURB NTU	TDS mg/l	DISCHARGE	DO w/l	PH	ALK mg/l as CaC03	HARDNS mg/l as CaC03	As TR ug/l	As Total ug/1	Cd TR mg/l	Cd Total mg/l
Livengood ab Amy	8/01/86	152	6.57	0.2	50	110	16	13.5	6.5	68	85	6.0	<5.0	<0.003	<0.003
Livengood at DOT grdg	8/11/86	447	1.21	<0.2	1300	420	1.0	9.5	7.6	239	308	130	120	<0.003	0.023
Livengood at mouth	8/04/86	195	a.95	<0.2	330	187	17	10.8	7.5	171	205	21	30	<0.003	co.003
Heine Creek	8/07/86	2.8	0.0030	<0.2	2.2	83	0.4	11.8	6.6	51	51	<5.0	<5.0	<0.003	<0.004
Wonder Creek	8/09/86	0.2	0.0001	<0.2	0.35	150	0.1	9.8	7.0	154	137	<5.0	<5.0	<0.003	<0.003
Franklin Cr ab Rd	7/31/86	0.4		<0.2	1.3	127		11.2	7.2	120	103	<5.0	<5.0	<0.003	<0.003
Upper Franklin Cr	8/09/86	0.8		<0.2	0.35	184		10.1	8.0	171	222	<5.0	<5.0	(0.003	co.003
Isabel1 Cr	7/31/86	2560		6.5	400	121		12.1	5.5	103	103	17	10	0.003	<0.003
Amy Cr	8/05/86	4.4	0.013	<0.2	6.1	146	1.1	11.7	7.2	120	137	5.0	<5.0	<0.003	co.004
Upper Amy	8/11/86	9.8	0.011	<0.2	5.7	176	0.4	11.7	7.2	86	154	<5.0	<5.0	co.003	co.003
Lucille Cr	8/07/86	0.2	0.0001	<0.2	1.5	212	0.2	13.2	8.0	171	171	<5.0	<5.0	<0.003	<0.004
Gertrude Cr	8/07/86	8.7	0.028	<0.2	7.5	163	1.2	12	7.6	154	154	<5.0	6	~0.003	<0.004
Upper Gertrude	8/08/86	27	0.015	<0.2	1.2	139	0.2	12	7.2	137	154	<5.0	<5.0	co.003	(0.003
Ruth Cr	8/11/86	0.6		<0.2	1.2	151		11.7	7.7	103	137	11	10	<0.003	co.003
Ready Bullion Cr	8/05/86	13	0.018	<0.2	7.5	321	0.5	12	7.8	205	257	4.0	<5.0	co.003	<0.003
Tolovana at TAPS	7/30/86	26		<0.2	29	121	>340	11.2	7.2	120	103	<5.0	<5.0	<0.003	co.003
Lower Tolovana	8/11/86	3.5		<0.2	7.4	154		a.7	6.8	103	120	<5.0	<5.0	co.003	so.003
Wilber Cr	8/04/86	11	0.128	<0.2	11	157	4.3	12.1	6.3	51	68	<5.0	<5.0	<0.003	<0.003
Steel Cr	8/04/86	9.4	0.038	<0.2	2.4	95	1.5	11.8	6.1	34	51	<5.0	<5.0	<0.003	co.003
Cleary ab Elliott	8/06/86	0.4	0.0010	<0.2	0.3	165	0.9	9.5	6.9	120	120	<5.0	<5.0	<0.003	co.003
Upper Cleary Cr	8/12/86	0.2	0.0002	<0.2	0.7	157	0.4	8.8	6.8	86	120	<5.0	<5.0	<0.003	<0.003
Esther Ab Elliott	8/06/86	7.2	0.0039	go.2	4	206	0.2	10.5	7.7	222	222	<5.0	<5.0	<0.003	<0.003
Olive ab Elliott	8/06/86			<0.2	1.2	581		12	7.6	257	496	<5.0	<5.0	(0.003	<0.003
Duncan Cr	8/08/86	4.6	0.137	<0.2	7	73	11	11.6	6.0	34	34	<5.0	<5.0	<0.003	<0.003
Upper Lost Cr	8/05/86	26	1.26	<0.2	9	133	18	10.1	5.6	34	51	<5.0	<5.0	co.003	co.003
Lost Cr at TAPS	7/30/86	1.8	0.011	<0.2	4.6	130	2.2	9.4	6.2	51	68	6.0	<5.0	<0.003	<0.003

APPENDIX 4. Tolovana drainage water chemistry.
DEC Use Attainability Analysis data

Stream Reach	Cu TR	Cu Total	Pb TR	Pb Total	Hg Total	Ni TR	Ni -Total	MINED ?
	mg/l	mg/l	ug/l	ug/l	ug/l	mg/l	mg/l	
Livengood ab Army	0.008	0.006	<5.0	<5.0	<1.0	<0.013	<0.013	n
Livengood at DOT grdg	0.109	0.110	39	48	<1.0	0.08	0.071	Y
Livengood at mouth	0.023	0.023	8.D	14	<1.0	0.017	0.017	Y
Heine Creek	<0.003	<0.004	<5.0	<5.0	<1.0	<0.013	<.017	n
Wonder Creek	co.003	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Franklin Cr ab Rd	so.003	so.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Upper Franklin Cr	so.003	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Isabel1 Cr	0.090	0.073	21	13	<1.0	0.071	0.058	Y
Amy Cr	0.006	<0.004	<5.0	<5.0	<1.0	<0.013	<.017	Y
Upper Amy	0.007	(0.003	<5.0	<5.0	<1.0	0.014	<.013	n
Lucille Cr	<0.003	<0.004	<5.0	<5.0	<1.0	<0.013	<.017	n
Gertrude Cr	0.004	so.004	<5.0	<5.0	<1.0	<0.013	<.017	Y
Upper Gertrude	0.006	<0.003	<5.0	<5.0	<1.0	0.023	0.017	n
Ruth Cr	0.007	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	Y
Ready Bullion Cr	<0.003	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Tolovana at TAPS	0.006	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	?
Lower Tolovana	co.003	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	?
Wilber Cr	0.006	<0.003	<5.0	<5.0	<1.0	co.013	<.013	n
Steel Cr	0.005	10.003	<5.0	<5.0	<1.0	co.013	<.013	n
Cleary ab Elliott	<0.003	(0.003	<5.0	<5.0	<1.0	co.013	<.013	n
Upper Cleary Cr	<0.003	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Esther Ab Elliott	<0.003	so.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Olive ab Elliott	<0.003	(0.003	<5.0	<5.0	<1.0	0.025	0.020	Y
Duncan Cr	0.005	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	n
Upper Lost Cr	go.003	<0.003	<5.0	<5.0	<1.0	<0.013	<.013	?
Lost Cr at TAPS	0.004	<0.003	<5.0	<5.0	<1.0	<0.013	0.026	n

APPENDIX 5. Specific Locations of Sampling Sites.

Site Name	Full Name	MTRS Description
Fortymile drainage		
Jack Wade Creek	Jack Wade Creek at BLM campground	upstream of campground in SW¼, NE¼, Sec 35, T27N, R19E, CRM
Walker Fork	Walker Fork below Taylor Highway Bridge	downstream of bridge in NE¼, SW¼, Sec 35, T27N, R19E, CRM
South Fork at Bridge	South Fork of the Forty-mile River at the Taylor Highway Bridge	at the bridge in the SE¼, SW¼, Sec 6, T26N, R19E, CRM
Mosquito Fork	Mosquito Fork of the Fortymile River above Taylor Highway Bridge	50 above the bridge in the NW¼, NW¼, Sec 1, T26N, R17E, CRM
West Fork	West Fork of the Dennison Fork at the Taylor High-way Bridge	100 feet above the bridge in the SW¼, NW¼, Sec 1, T25N, R16E, CRM
Buckskin Creek	Buckskin Creek at the South Fork	100 feet upstream of con-fluence with South Fork in SE¼, NE¼, Sec 34, T8S, R30E, FM
Napoleon Creek	Napoleon Creek at the South Fork	200 feet upstream of con-fluence with South Fork in SW+, NW¼, Sec 20, T27N, R19E, CRM
North Fork ab SF	North Fork Fortymile above confluence with South Fork Fortymile	1/4 mile upstream of confluence in NE¼, NE¼, Sec 10, T8S, R30E, FM
South Fork ab NF	South Fork Fortymile above confluence with North Fork Fortymile	1/4 mile upstream of confluence in NE¼, NE¼, Sec 10, T8S, R30E, FM
Uhler Creek	Uhler Creek at the South Fork	200 feet above the con-fluence with the South Fork in the NW¼, SW¼, Sec 23, T8S, R30E, FM

Appendix 5. Specific Locations of Sampling Sites.

Site Name	Full Name	MTRS Description
Walker Fork ab SF	Walker Fork above South Fork	300 feet above the confluence with the South' Fork in the SE¼, SW¼, Sec 19, T27N, R19E, CRM
Tolovana Drainage		
Livengood at Bridge	Livengood creek at the Livengood Road Bridge	downstream of bridge in the NE+, NE¼, sec 21, T8N, R5W, FM
Ready Bullion Creek	Ready Bullion Creek at the Livengood Road Bridge	at the bridge in the NE¼, NW¼, sec 21, T8N, R5W, FM
Tolovana at TAPS	Tolovana River at the Trans Alaska Pipeline crossing	upstream of the bridge in the SW¼, NE¼, Sec 5, T7N, R5W, FM
Tolovana at CG	Tolovana River at the BLM campground	beside campground in the SE¼, SE¼, Sec 36, T8N, R4W, FM