Public Data File 88-5

HYDROLOGIC AND WATER QUALITY INVESTIGATIONS RELATED TO PLACER MINING IN INTERIOR ALASKA, SUMMER 1987

By

Stephen F. Mack, Mary A. Moorman and Linda Harris

Alaska Division of
Geological and Geophysical Surveys

January 1988

THIS DOCUMENT HAS NOT RECEIVED OFFICIAL
DGGS REVIEW AND PUBLICATION STATUS.

794 University Avenue, Suite 200
Fairbanks, Alaska 99709

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Hydrologic and Water Quality Investigations Related to Placer Mining in Interior Alaska, Summer 1987

By Stephen F. Mack, Mary A. Moorman, and Linda Harris

EXECUTIVE SUMMARY

Alaska Division of Geological and Geophysical Surveys (DGGS) investigators, working cooperatively with personnel from the Alaska Department of Fish and Game and Environmental Conservation, and from the U.S. Bureau of Land Management monitored total suspended solids (TSS), turbidity, and discharge at selected sites affected by placer mining in the Tolovana River, Birch Creek and Fortymile River drainages in interior Alaska. At seven sites we had automated equipment for both collecting samples and recording water levels. At five sites we collected grab samples, observed water levels, and measured stream flows when we were in the area. We also collected samples for water chemistry analysis at 12 sites in the Fortymile drainage.

In the drainages we observed, during the 1987 field season runoff ranged from 7.40 inches (Birch Creek above 12mile Creek) to 1.13 inches (Goldstream at Ballaine Road). Median turbidity varied from 230 NTU at Birch Creek above 12mile Creek to 1.0 NTU at Mosquito Fork at the Taylor Highway Bridge. The sites in the Fortymile drainage had the lowest turbidity with average turbidity at all Fortymile sites below 5 NTU. At all sites monitored in both 1986 and 1987 average and median turbidity were lower. At the Birch Creek drainage sites average sediment load was higher in 1987, however. One explanation for this is the large amount of reclamation work done in 1987. Water chemistry results showed Alaska Department of Environmental Conservation primary contaminant concentrations for drinking water exceeded for chromium in samples from Walker Fork above the South Fork and West Fork at the Taylor Highway Bridge, and for mercury in a sample from South Fork at the Taylor Highway Bridge.

INTRODUCTION

During the 1987 summer, Alaska Division of Geological and Geophysical Surveys (DGGS) investigators continued the field-season-long monitoring of interior Alaska streams affected by placer mining begun in 1984. We worked closely with investigators from the Alaska Department of Fish and Game (ADF&G) and the Alaska Department of Environmental Conservation (ADEC) to collect water samples and record water levels at sites as much as 350 road miles apart. Monitoring in 1984-86 concentrated on small streams in the Birch Creek drainage. The results from previous years are reported in "Hydrologic and Water Quality Investigations Related to the Occurrence of Placer Mining in Interior Alaska, Summers 1984-5" and " Hydrologic and Water Quality Investigations Related to the Occurrence of Placer Mining in Interior Alaska, Summer 1986 (Mack and Moorman, 1986; and Mack and Moorman, 1987).

Our initial plan for the 1987 field season was to pool the available automated equipment owned by DGGS, ADF&G, and ADEC to maintain monitoring of turbidity, total suspended solids, and discharge at a few important sites in the Birch Creek drainage (Birch Creek at the Steese Highway Bridge and Birch Creek above Twelvemile Creek), at Faith Creek above the Steese Highway and at Goldstream Creek at Ballaine Road. We started monitoring these sites in late May-early June. From our experience of the previous years we believe that our most useful data comes from sites that have automated water samplers and water level recorders operating throughout the field season. In most cases, manual grab sampling programs are too labor intensive to be done frequently enough to get a good average of the season-long conditions. Also with manual techniques it is difficult to account for possible diurnal variation and to collect samples during infrequent events, such as floods.

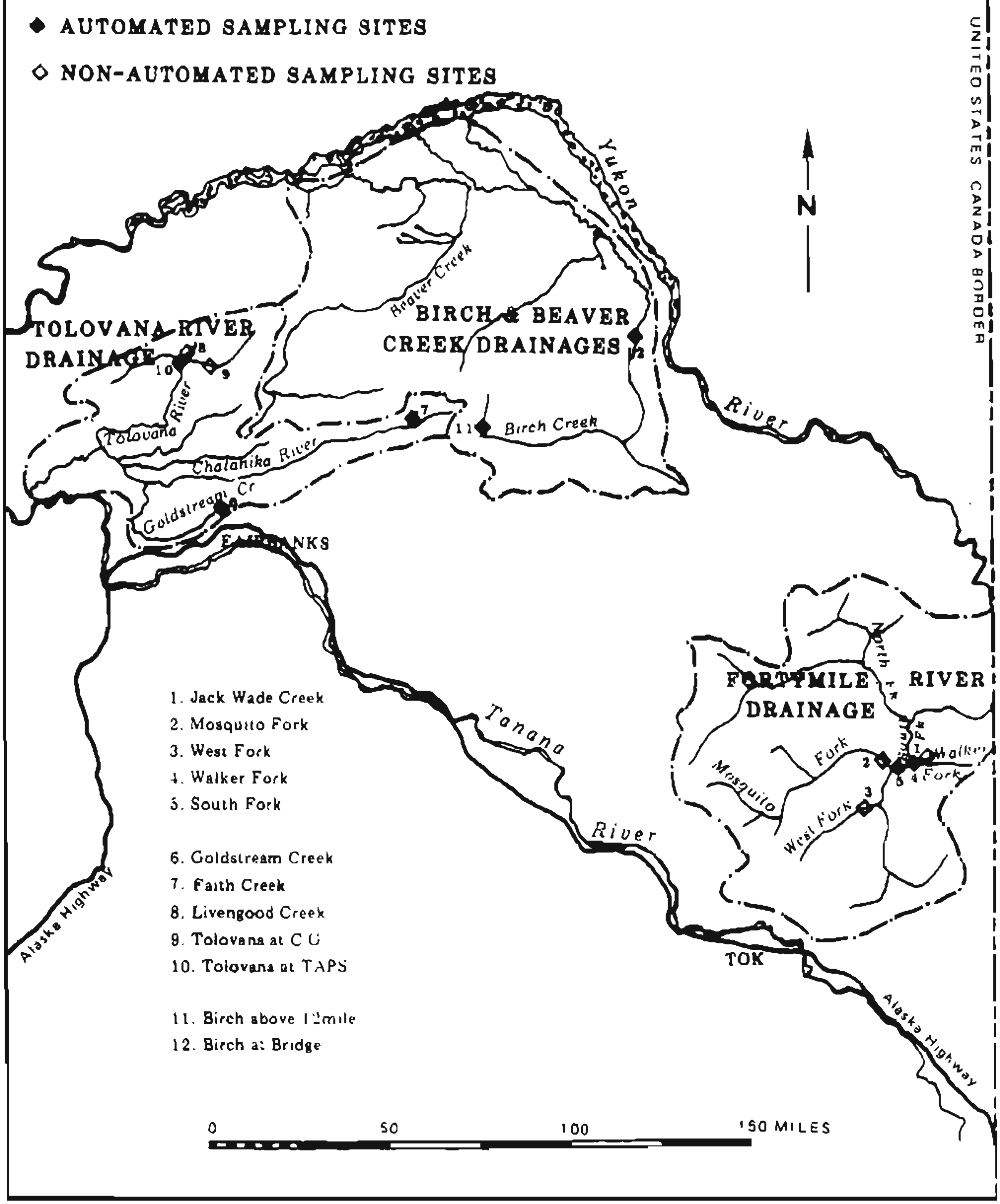
Because of the data needs of court-ordered environmental impact statements, the U.S. Bureau of Land Management (BLM) provided funding for DGGS to collect discharge, turbidity, total suspended solids (TSS), and water chemistry data from streams in the Fortymile drainage and in the upper Tolovana River drainage. We started the discharge, turbidity and TSS monitoring on July 6 in the upper Tolovana drainage at Tolovana at the Trans Alaska Pipeline System (TAPS) crossing (automated, below all mining), Livengood Creek at the Livengood Road (non-automated), and Tolovana at the BLM Campground (non-automated, above mining). We started on July 14 in the Fortymile drainage, regularly monitoring sites at the West Fork Dennison at the Taylor Highway (non-automated, above mining), Mosquito Fork at the Taylor Highway (non-automated), South Fork at Taylor Highway Bridge (automated), Walker Fork at Taylor Highway Bridge (automated), and Jack Wade Creek above the BLM Campground (non-automated). We also collected some samples at on-river sites downstream of the South Fork site when river transport was available. During August 18 through August 22 we collected samples for water chemistry analysis at eleven sites in the Fortymile drainage. We were able to collect numerous samples at the non-automated sites because of the cooperation of the BLM recreation rangers stationed in the Fortymile drainage and by frequent visits to the Tolovana drainage. The results from the monitoring done in the Fortymile and Tolovana drainage have also been reported to the BLM EIS investigation team in a separate document (Mack, Moorman, and Harris, 1987).

The resulting discharge, turbidity, and TSS monitoring network for the 1987 summer included seven automated sites and five non-automated sites in the Birch Creek, Tolovana River and Fortymile River drainages. Samples continued to be collected and water levels recorded at these sites until late September-early October. Figure 1 shows the location of interior Alaska sites regularly monitored this summer.

The data reported here are from analyses done in the DGGS laboratory in the case of water quality results, or from discharge ratings developed by DGGS investigators in the case of discharge estimates. However, it is important to note the field work necessary to collect the samples and record water levels was truly a cooperative effort among DGGS, ADF&G, ADEC, and BLM personnel. Water quality samples from the Goldstream drainage were mostly collected by ADF&G. Samples and water level data from the Tolovana, Faith Creek, and Birch Creek sites were largely collected by Leslie Simmons of ADEC. The work in the Fortymile was greatly assisted by John Bauer of ADEC and by BLM recreation rangers stationed in the area.

Figure 1.

LOCATION OF INTERIOR ALASKA SAMPLING SITES



METHODS

A. Discharge. Velocities used to calculate discharge in most cases were measured with a Marsh McBirney Model 201 Flowmeter. At sites with bridges (Birch Creek at Bridge, 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. 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 Birch Creek at Bridge, Birch Creek above Twelvemile Creek, Faith Creek above Steese Highway, Goldstream Creek at Ballaine Road, 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.

We determined seasonal runoff to have an estimate of the relative amount of water available at the sites we were monitoring. Runoff was calculated by multiplying the seasonal average discharge by 120 days (the assumed length of an operating season), dividing by the drainage area, and converting the units into inches.

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 (TSS) 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 was 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. Sediment yield was calculated by multiplying the seasonal average sediment load by an assumed 120 day field season and dividing by drainage area.

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.

RESULTS AND DISCUSSION

Appendix 1 contains the turbidity, total suspended solids, discharge and sediment load data from the 1987 field season. We have ordered the data chronologically by site and by drainage area. This appendix contains two types of sediment data: 1) samples from automated samplers are composites of four samples which we consider representative of a daily average; and 2) grab samples which are representative of instantaneous conditions. In Appendix 1 the data from automated samplers are matched with daily average discharges. The grab sample data are matched with measured discharges or with instantaneous discharges estimated from observed or recorded water levels. Appendix 2 contains discharge data from each site that had an automated water level recorder. This appendix has daily average discharges in a concise calendar-like format and includes discharges for all days that the recorder was operating, including days for which no TSS or turbidity exists. Appendix 3 contains the Fortymile water chemistry results. Appendix 4 contains graphs of daily turbidity and discharge values at automated sites. These figures vividly show the seasonal variation and relationships of turbidity and discharge at the sites we monitored with automated equipment.

A. Discharge. Table 1 summarizes the monthly average discharges at the sites regularly monitored in 1987. Of the sites also monitored in 1986, Faith Creek averaged less in 1987 while Birch Creek above 12mile and

Birch Creek at the Steese Highway Bridge had higher average flow in 1987. Of note is the disparity in runoff between the sites. The Fortymile sites are similar and relatively low. The Upper Tolovana sites have runoff similar to the Fortymile sites. The Birch Creek sites and Faith Creek have much higher runoff values. The lowest runoff was in Goldstream Creek.

Table 1. Summary of Discharge Values
Monthly averages of discharge in cfs
Averages of continuous observations except where noted[1]

Location	Area (mi2)	June (cfs)	July (cfs)	August (cfs)	September (cfs)	Season Average (cfs)	Runoff[2] (in)
Fortymile Drainage							
Jack Wade Creek[1]	48.6		51.5	28.0	22.9	30.7	2.82
Mosquito Fork[1]	1170		1270	368	445	598	2.28
West Fork[1]	579		553	226	191	299	2.30
Walker Fork	394		272	232	243	246	2.78
South Fork	2750		1800	821	677	1010	1.64
Tolovana Drainage							
Goldstream Creek	77.2	24.0	15.7	23.0	15.8	19.6	1.13
Faith Creek 86	61.0	107	80.4	141	149	123	8.99
Faith Creek 87	61.0	113	51.6	134	103	100	7.34
Livengood Creek[1]	20.1		11.1	13.9	6.2	10.9	2.42
Tolovana at CG[1]	140		230	145	36.7	145	4.62
Tolovana at TAPS	249		73.3	293	57.9	158	2.83
Birch Creek Drainage							
Birch 12mile 86	85.4	207	125	71.2	76.5	120	6.26
Birch 12mile 87	85.4	196	147	149	74.8	142	7.40
Birch Bridge[1] 85	2150	4600	1710	1930	3790	3010	6.24
Birch Bridge 86	2150	3730	2370	700[1]	828[1]	1910	3.96
Birch Bridge 87	2150	4120	2570	2380	1010	2520	5.23

[2]Runoff value assumes the season average is the average value for a 120 day summer season.

One should interpret the runoff estimates with caution. These values assume a 120 day season (June through September); however, the data from the Fortymile and Upper Tolovana sites are the result of monitoring that began in mid July. In interior Alaska June flows are higher than the average for the summer season. The high runoff at the Faith Creek and Birch Creek above 12mile sites are indicative of the relatively high altitude, steep slope nature of the drainages above these sites. The low runoff at the Goldstream at Ballaine Road site may indicate that significant amounts of streamflow are being lost to ground water in this drainage.

B. Turbidity. Table 2 shows the monthly and seasonal turbidity averages and seasonal medians at sites regularly monitored in 1987. The median is that value which divides a series so that one half or more of the observations are equal to or greater than it and one half or more of the observations are equal to or less that it (Croxden, Cowden, and Klein, 1967). Because values like turbidity can be no smaller than zero but have no real upper limit, infrequent, extreme events such as floods can produce large turbidity values which distort the mean or average value. The median may better represent the normally observed turbidity value and indicates the extent to which the average is affected by extreme events.

In general, turbidity was lowest in the streams monitored in the Fortymile drainage. In 1987 little difference existed between the streams with mining upstream and the West Fork Dennison which has no mining activity upstream of the sampling site.

The sites in the Tolovana drainage represent three different and hydrologically separate mining areas: Goldstream Valley (Goldstream at Ballaine), Faith Creek (Faith Creek above Steese) and Livengood (Livengood Creek, Tolovana at Campground, and Tolovana at TAPS). The streams from these different areas eventually meet in Minto Flats. Goldstream Creek is a small creek near Fairbanks with a number of mining operations in the drainage. The values reported here were collected by personnel from the Alaska Department of Fish and Game and are discussed in more detail in a separate report (Weber and Robus, 1987). Faith Creek is one of the headwater creeks of the Chatanika River, a popular recreational stream for Fairbanks residents. It has been heavily mined and has received much attention from agency personnel in the past few years (Townsend, 1987). Monitoring indicates that turbidity levels continued to drop in 1987.

The streams with mining upstream in the Livengood area had middle-of-the range average and low median turbidity values when compared to the other mined streams monitored. The data from these streams show the largest difference between the average and median turbidity values. Mining operations in the Livengood area reported little discharge to streams (Peterson, 1987). A large storm passed through the drainage in late July and early August. Runoff from this storm produced turbidity values that greatly affected the averages reported here. This is most pronounced with the data from the the Tolovana at Campground site. While the average is relatively high, the median value is similar to the medians reported from the Fortymile drainage sites. If the value from the July 31 sample is disregarded, the averages from this site correspond to the Fortymile data. High turbidity from this drainage may be more of a nonpoint nature, for example, storm runoff from a disturbed area, than from a point source such as placer mining.

Table 2. Summary of Turbidity Values
Monthly averages in Nephelometric Turbidity Units (NTU)
Averages of data from automated samplers except where noted[1]
[u] indicates site has no mining upstream

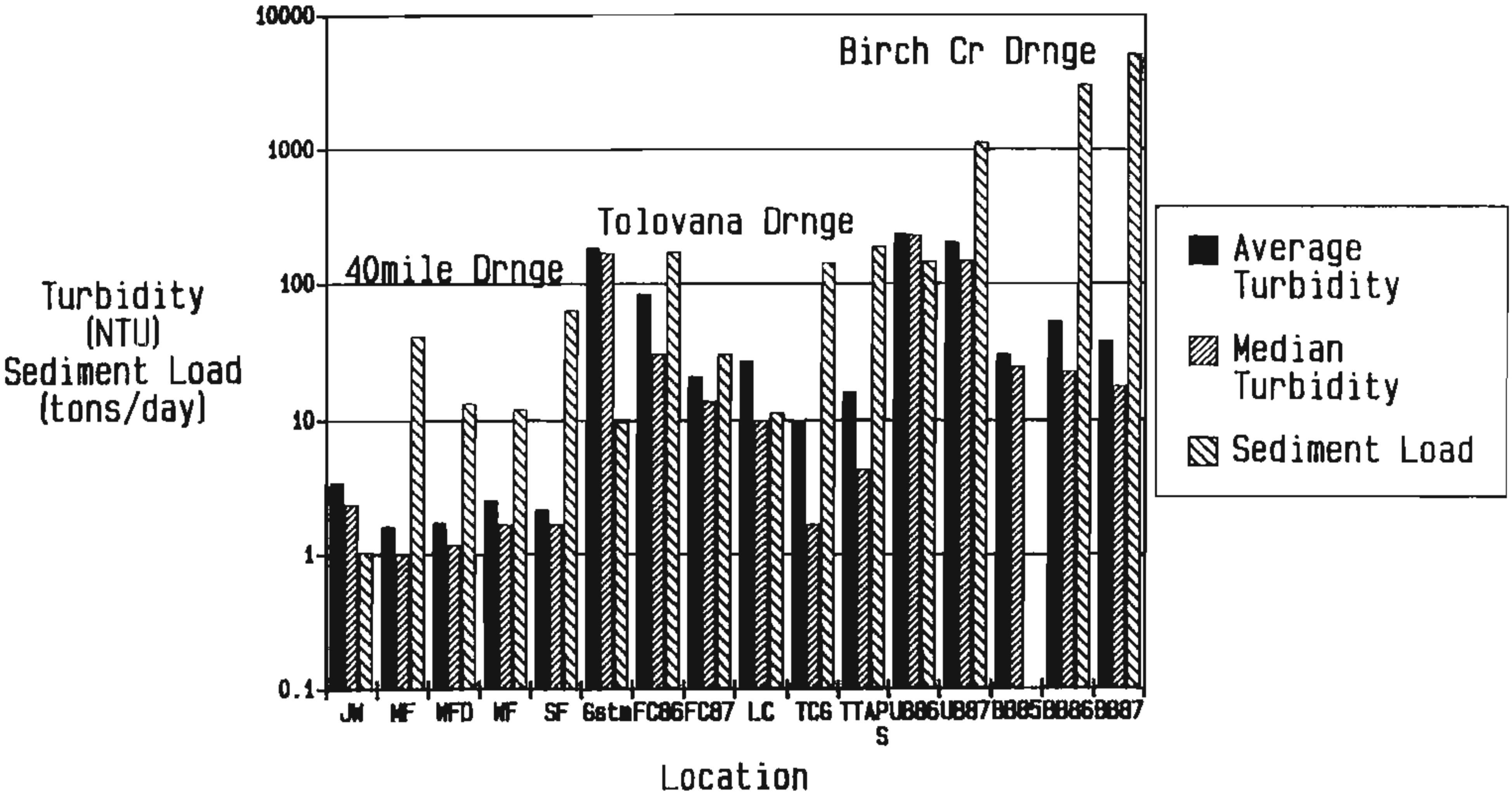
Location	June	July	August	September	Season Average	Season Median
Fortymile Drainage						
Jack Wade Creek[1]		3.9	1.7	5.1	3.5	2.4
Mosquito Fork at Bridge[1]		3.7	1.0	0.9	1.7	1.0
West Fork Dennison[1u]		2.7	1.3	1.5	1.8	1.2
Walker Fork at Bridge		2.1	2.9	2.5	2.6	1.7
South Fork at Bridge		3.7	1.8	1.7	2.2	1.7
Tolovana Drainage						
Goldstream at Ballaine	22	266	205		185	170
Faith Creek 86	46	77	158	17	85	31
Faith Creek 87	31	11	20	24	21	14
Livengood Creek[1]		55	18	7.9	27	10
Tolovana at Campground[1u]		25	3.2	1.1	10	1.7
Tolovana at TAPS		6.7	32	4.9	16	4.4
Birch Creek Drainage						
Birch ab 12mile 86	255	201	237	251	236	230
Birch ab 12mile 87	240	362	148	82	206	150
Birch at Bridge 85[1]	47	23	35	18	31	25
Birch at Bridge 86	79	110	6.3	19	54	23
Birch at Bridge 87	72	31	24	12	38	18

In the Birch Creek drainage, values at Birch Creek above 12mile Creek remained high, relative to other areas, but decreased from the 1987 average and median. The seasonal average and median at the lower site at the Steese Highway Bridge also showed a decrease.

C. Sediment Load. Sediment load represents the amount of material transported by streams and rivers. Table 3 presents the monthly and seasonal sediment load averages and the sediment yield based on the seasonal sediment load divided by drainage area. Figure 2 compares the seasonal turbidity averages and medians to seasonal sediment load at the monitored sites. Two cautions should be noted when interpreting these values. First, monitoring in the Fortymile and Upper Tolovana drainages did not begin until mid July. At most other sites the highest sediment discharges are earlier in the season. Secondly, the averages from the sites that do not have automated equipment can be more greatly affected by extreme events. This is especially true for the data from the Tolovana at Campground site. If the July 31 storm event is disregarded, the monthly average is 0.21 tons/day, the seasonal average becomes 1.32 tons/day and the sediment yield is 1.13 tons/mi^2.

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. The yield values are all in the 2-5

Figure 2. Turbidity and sediment load at monitoring sites.



tons/mi^2 range. Based on the monitoring done this year, it doesn't appear that sediment yield for sites affected by placer mining is much different than natural erosion rates as shown in the yield estimate for the West Fork Dennison site.

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. 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.

As noted above the July and seasonal averages for the Tolovana at Campground site were greatly affected by the July 31 sample value. Because of this the July and seasonal averages in Table 3 are probably high and are not representative of normal values at an unmined site in this drainage. The July 31 sample does demonstrate that, in this drainage, large events have a dramatic effect at sites unaffected by mining. The natural erosion rates or sediment yield for sites unaffected by mining in the upper Tolovana are probably higher than those in the Fortymile drainage.

Goldstream at Ballaine had relatively high turbidity levels yet the sediment load averages and the yield value are both low for the sites monitored in this drainage. This is due to the relatively low runoff at this site (Table 1). Based on 1987 monitoring less streamflow is available for dilution than at other sites.

1987 Faith Creek sediment loads decreased from those measured in 1986. We believe natural erosion rates at this site would be similar to those at Boulder Creek in the Birch Creek drainage (approximately 5 tons/mi^2). Thus, while the sediment load, on average, has decreased it is still much higher than background levels.

The sites monitored in the Birch Creek drainage show the biggest impact from mining. At the sites affected by mining the sediment loads and yields are the highest of the three drainages monitored by us. At a site unaffected by recent mining monitored in 1986, Boulder Creek at the USGS gage, sediment load and yield values were similar to values found in the Fortymile drainage. The load values for Birch Creek above 12mile Creek showed a dramatic increase in 1987. The high loads at this site were mostly related to high flows and probably represent sediment from non-point sources (disturbed areas) more than point sources (such as mining operations). One explanation for this is the relatively high amount of reclamation work that was being done this summer in the Birch Creek drainage (Peterson, 1987). The increase at the Birch Creek at the Steese Highway Bridge site was not as dramatic but was a significant increase over the previous year and is much higher than natural erosion rates.

Table 3. Monthly and Seasonal Sediment Loads
Monthly and seasonal averages in tons per day
Averages of data from automated samplers except where noted[1]
[u]indicates site has no mining upstream

Location	June	July	August	September	Season Average	Yield[2] ($tons/mi^2$)
Fortymile Drainage						
Jack Wade Creek[1]		2.15	0.12	0.46	1.05	2.59
Mosquito Fork at Bridge[1]		86.6	1.64	1.38	41.7	4.28
West Fork Dennison[1u]		21.6	1.70	1.67	13.5	2.80
Walker Fork at Bridge		13.4	8.78	7.91	12.3	3.75
South Fork at Bridge		158	15.1	7.83	64.3	2.81
Tolovana Drainage						
Goldstream at Ballaine	5.6	11.5	10.9		9.9	15.4
Faith Creek 86	57.2	31.3	548	57.9	174	342
Faith Creek 87	119	8.9	22.1	13.6	30.9	60.8
Livengood Creek[1]		31.1	2.68	0.19	11.5	68.6
Tolovana at Campground[1u]		428	2.76	0.27	144	123
Tolovana at TAPS		14.7	506	2.57	190	91.5
Birch Creek Drainage						
Boulder at Gage 86[u]	2.65	1.89	0.30	0.14	1.25	4.53
Birch ab 12mile 86	420	79.2	40.2	48.3	147	206
Birch ab 12mile 87	4580	1110	426	32.0	1150	1620
Birch at Bridge 86	7270	1450		567[1]	3100	173
Birch at Bridge 87	8660	6580	1100		5260	294

[2]Yield is the seasonal sediment load divided by drainage area. It assumes the season average value represents the average for a 120 day season.

D. Fortymile Drainage Water Chemistry. As mentioned above the water chemistry results for eleven Fortymile drainage sites are in Appendix 3. 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).

CONCLUSIONS

The fourth year of DGGS seasonal monitoring of streams impacted by placer mining was characterized by steady refinement of techniques, broadening of geographical scope, and multiagency cooperation. We concentrated our efforts on maintaining automated equipment throughout the summer at sites important to information users. By enlisting the part-time efforts of personnel from interested agencies we were able to cost-effectively acquire important information about the impacts of placer mining from geographically distant sites.

When measured by sediment levels (turbidity, TSS, or sediment load and yield) the impact of mining in the Birch Creek, Tolovana River, and Fortymile River drainages is not equal at the sites we monitored. The samples from the Birch Creek site had much higher levels than those from the Tolovana drainage sites. The values from the mining-affected Fortymile sites in 1987 were not much different than those of an unmined site in the drainage and were consistently low throughout the summer when compared to the values from mining-affected sites monitored in the other drainages.

Monitoring gave mixed signals as to whether sediment levels were lower than in previous years. If median turbidity is considered, values were lower at every site for which comparative data exists. Sediment load estimates, however, indicated much more material was carried by the monitored streams in the Birch Creek basin in 1987.

Discharge monitoring and runoff estimates indicate that a universal statement that 1987 was a wet year or a dry year cannot be applied to the interior Alaska streams observed by us. Runoff estimates showed a large difference between the sites. The Birch Creek sites and Faith Creek had the most runoff; the Fortymile sites had the lowest as a drainage; and Goldstream at Ballaine had the lowest single site runoff.

ACKNOWLEDGEMENTS

Besides the individuals mentioned in the introduction, the authors would like to acknowledge the valuable contributions of Shirley Liss who collected the samples for water chemistry analysis at the Fortymile drainage sites and who assisted in many ways in the lab and Scott Ray who assisted with the water chemistry analyses.

REFERENCES CITED

Alaska Department of Environmental Conservation, 1982, Drinking water regulations: Title 18, Chapter 80 of the Alaska Administrative Code, Register 83, 1982, Juneau, Alaska, 20 p.

APHA, 1985, Standard methods for the examination of water and wastewater (16th ed.): Washington, D.C., 1268 p.

Croxton, F.E., Cowden, D.J., and Klein, S.K., 1967, Applied general statistics (3rd ed.): Englewood Cliffs, N.J., Prentice-Hall, Inc., 754 p.

Dalrymple, Tate and Benson, M.A., 1984, Measurement of peak discharge by the slope-area method: Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter A2, Washington, D.C., U.S. GPO, 12 p.

Mack, S.F. and Moorman, M.A., 1986, Hydrologic and water quality investigations related to the occurrence of placer mining in interior Alaska, summers 1984-85: Alaska Division of Geological and Geophysical Surveys Public-data File 86-16, unpublished report, 138 p.

Mack, S.F. and Moorman, M.A., 1987, Hydrologic and water quality investigations related to the occurrence of placer mining in interior Alaska, summer 1986: Alaska Division of Geological and Geophysical Surveys Public-data File 87-10, unpublished report, 88 p.

Mack, S.F., Moorman, M.A., and Harris, Linda, 1987, Water quality and discharge data from selected sites in the Fortymile and Tolovana drainages, summer 1987: Alaska Division of Geological and Geophysical Surveys Public-data File 87-32, unpublished report, 39 p.

Peterson, Judd, 1987, Personal communication, October 1987: Alaska Division of Mining, Fairbanks, Alaska.

Skougstad, M.W. et al (eds.), 1979, Methods for determination of inorganic substances in water and fluvial sediments, Techniques of Water Resources Investigations, Book 5, Chapter A1, U.S. Government Printing Office, Washington, D.C., 626 p.

Townsend, A. H., 1987, Placer mining in the upper Chatanika River system, 1980-1986: Technical Report 97-2, Juneau, Alaska, Alaska Department of Fish and Game, Division of Habitat, 29 p.

U.S. Department of the Interior, 1981, Water measurement manual: Denver, Colorado, U.S. Bureau of Reclamation, U.S. Government Printing Office, 327 p.

U.S. Environmental Protection Agency, 1983. Methods for chemical analyses of water and wastes: EPA Publication EPA-600/4-79-020, Cincinnati, Ohio, Environmental Monitoring and Support Laboratory, Office of Research and Development.

Weber, P.K. and Robus, M.H., 1987, Water quality and aquatic habitat assessments of Goldstream Creek drainage: Technical Report 87-3, Juneau Alaska, Alaska Department of Fish and Game, Division of Habitat, 54 p.

APPENDIX 1. 1987 SEDIMENT AND DISCHARGE DATA

APPENDIX 1. 1987 Sediment and Discharge Data

Fortymile Drainage

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

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
Walker Fork	071787		16.4	1.8	13.3	300
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
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

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
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	8.2	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
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

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
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
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		

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
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
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

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
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 1. 1987 Sediment and discharge data.

Tolovana Drainage

Location	date	time	TSS mg/l	Turbidity NTU	Comments
Flume b mine	092487	1250	99.5	190	
Gilmore Creek	061687		35.2	80	
Gilmore Creek	071487	1400	508	850	
Gilmore Creek	073187	1330	1110	2300	
Gilmore b mining	092487	1203	39.0	230	
Goldstream 14mus	061887		33.2	4.4	14 miles upstream
Goldstream 2.5mu	061887		11.7	5.3	2.5 mi upstream
Goldstream Dun T	063087		19.5	9.3	1 Mi. Dunbar Trail
Goldstream a Bal	052287		196	39	
Goldstream a Bal	052387		176	75	
Goldstream a Bal	060487		37.8	40	
Goldstream a Bal	060587		31.8	45	
Goldstream a Bal	060687		33.9	27	
Goldstream a Bal	060787		169	18	
Goldstream a Bal	060887		190	12	
Goldstream a Bal	060987		64.8	16	
Goldstream a Bal	061087		48.4	18	
Goldstream a Bal	061187		35.8	10	
Goldstream a Bal	061287		50.7	24	
Goldstream a Bal	061387		45.5	22	
Goldstream a Bal	061487		37.8	18	
Goldstream a Bal	061587		47.5	14	
Goldstream a Bal	061687		278	17	
Goldstream a Bal	061687		84.9	14	
Goldstream a Bal	071387		348	160	
Goldstream a Bal	071387	1500	110	150	
Goldstream a Bal	071487		233	200	
Goldstream a Bal	071587		169	170	
Goldstream a Bal	071687		145	180	
Goldstream a Bal	071787		226	320	
Goldstream a Bal	071887		218	310	
Goldstream a Bal	071987		152	230	
Goldstream a Bal	072087		129	160	
Goldstream a Bal	072187		168	210	
Goldstream a Bal	072287		143	200	
Goldstream a Bal	072387		188	250	
Goldstream a Bal	072487		331	340	
Goldstream a Bal	072587		252	330	

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Comments
Goldstream a Bal	072687		316	400	
Goldstream a Bal	072787		220	310	
Goldstream a Bal	072887		188	270	
Goldstream a Bal	072987		240	330	
Goldstream a Bal	073087		232	330	
Goldstream a Bal	073187		423	380	
Goldstream a Bal	073187	1400	483	450	
Goldstream a Bal	080187		494	390	
Goldstream a Bal	080287		315	360	
Goldstream a Bal	080387		279	330	
Goldstream a Bal	080487		137	180	
Goldstream a Bal	080587		179	260	
Goldstream a Bal	080687		216	320	
Goldstream a Bal	080787		162	260	
Goldstream a Bal	080887		165	190	
Goldstream a Bal	080987		435	270	
Goldstream a Bal	081087		238	230	
Goldstream a Bal	081187		148	190	
Goldstream a Bal	081287		84.0	170	
Goldstream a Bal	081387		82.6	140	
Goldstream a Bal	081487		60.8	150	
Goldstream a Bal	081587		94.7	150	
Goldstream a Bal	081687		93.4	190	
Goldstream a Bal	081787		156	150	
Goldstream a Bal	081887		74.4	130	
Goldstream a Bal	081987		44.1	120	
Goldstream a Bal	082087		115	140	
Goldstream a Bal	082187		88.4	150	
Goldstream a Bal	082287		63.0	170	
Goldstream a Bal	082387		99.0	180	
Goldstream a Bal	082487		93.7	190	
Goldstream a Bal	082587		93.4	210	
Goldstream a Bal	082687		71.7	190	
Goldstream a Bal	082787		39.5	170	
Goldstream a Bal	082887		79.5	170	
Goldstream a Bal	092287	1020	17.2	60	
Goldstream a Bal	100687	1520	8.8	60	
Goldstream a GSR	071487	1400	198	170	at Goldstream Rd.
Goldstream a GSR	092287	1100	22.4	85	
Goldstream a MS	061787		26.8	16	at Martin Siding
Goldstream a Min	060287		35.3	5.3	
Goldstream a Min	060387		20.4	5.3	
Goldstream a Min	060487		24.2	6.2	
Goldstream a Min	060687		30.9	5.6	
Goldstream a Min	060787		22.0	7.1	
Goldstream a Min	060887		18.0	5.3	

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Comments
Goldstream a Min	061087		27.2	5.4	
Goldstream a Min	061187		26.7	5.8	
Goldstream a Min	061287		16.3	5.5	
Goldstream a Min	061387		23.2	5.2	
Goldstream a Min	061487		20.8	5.9	
Goldstream a Min	061587		22.4	5.3	
Goldstream a Min	061687		17.7	4.2	
Goldstream a Min	061787		16.2	4.5	
Goldstream a Min	061887		29.9	8.5	
Goldstream a Min	061887		35.9	3.6	
Goldstream a Min	061987		32.6	9.3	
Goldstream a Min	062087		34.8	8.7	
Goldstream a Min	062187		31.7	7.0	
Goldstream a Min	062287		28.1	5.5	
Goldstream a Min	062387		32.7	11	
Goldstream a Min	062487		35.4	6.8	
Goldstream a Min	062587		29.9	9.0	
Goldstream a Min	062687		24.4	8.8	
Goldstream a Min	062787		18.5	4.1	
Goldstream a Min	062887		15.5	5.4	
Goldstream a Min	062987		16.0	7.5	
Goldstream a Min	063087		12.8	4.3	
Goldstream a Min	070187		16.3	7.1	
Goldstream a Min	070287		18.6	3.9	
Goldstream a Min	070387		21.5	8.4	
Goldstream a Min	070487		16.7	8.0	
Goldstream a Min	070587		24.6	7.0	
Goldstream a Min	070687		30.1	7.4	
Goldstream a Min	070787		21.9	6.1	
Goldstream a Min	070887		58.3	9.6	
Goldstream a Min	070987		16.9	5.9	
Goldstream a Min	071087		18.4	6.8	
Goldstream a Min	071187		17.6	7.9	
Goldstream a Min	071287		16.7	3.9	
Goldstream a Min	071387		14.6	3.3	
Goldstream a Min	071487		16.4	3.6	
Goldstream a Min	071587		17.7	6.9	
Goldstream a Min	072187		33.0	11	
Goldstream a Min	072287		15.9	5.5	
Goldstream a Min	072387		14.5	4.0	
Goldstream a Min	072487		18.4	9.0	
Goldstream a Min	072587		53.3	11	
Goldstream a Min	072687		26.8	8.0	
Goldstream a Min	072787		17.8	13	
Goldstream a Min	072887		18.1	13	
Goldstream a Min	081787		133	190	
Goldstream a SCR	061787		13.1	13	at Sheep Creek Road
Goldstream a SCR	092287	1030	11.7	40	above May

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Comments
Goldstream a mth	082187	1400		24	algae growing in bottle
Goldstream a wrt	081387	1120		70	by Wright's, algae in btle
Goldstream a wrt	082987	1330		110	by Wright's, algae in btle
Goldstream ab St	063087		9.3	8.3	ab Standard Creek
Goldstream abMay	080587		72.8	160	
Goldstream abMay	092287	1005	109	45	ab confl. with May's disch
Goldstream at Br	063087		19.6	9.5	at Bridge Lake
Goldstream b May	080587		919	1300	
Goldstream b May	092287	1000	181	210	
Goldstream b OCC	062087		56.4	10	b old channel of Chatanika
Goldstream b Ped	092487	1210	30.4	110	b confl Pedro and Gilmore
Outlet Minto Lak	062087		5.86	4.7	
Outlet Minto Lak	062087		4.81	3.9	1.5 meter
Pedro Creek	061687		11.0		no turb reported
Pedro Creek	071487	1400	224	110	
Pedro Creek	073187	1330	57.3	65	
Pedro ab Gilmore	092487	1202	15.1	45	
Pedro b 2mines	092487	1318	104	110	
Steamboat Cr	092487	1255	14.7	9.8	
Tom Creek	092487	1230	0.81	0.45	Upper Gilmore trib
Twin Creek abmin	092487	1307	1.04	0.40	ab mining

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (ton/d)
Faith at Steese	052987		557	55	313	471
Faith at Steese	053087		351	39		
Faith at Steese	053187		380	50		
Faith at Steese	060187		209	27		
Faith at Steese	060287		223	38		
Faith at Steese	060387		154	20		
Faith at Steese	060487		133	22		
Faith at Steese	060587		180	21		
Faith at Steese	060687		117	14		
Faith at Steese	060787		142	21		
Faith at Steese	060887		42.1	8.5		
Faith at Steese	060987		221	30		
Faith at Steese	061087		87.3	37		
Faith at Steese	061187		79.3	55		
Faith at Steese	061287		220	90		
Faith at Steese	061387		1480	120		
Faith at Steese	061487		274	35		
Faith at Steese	061587		83.5	17		
Faith at Steese	061587	1335	32.9	9.2		
Faith at Steese	061587	1340	26.1	9.1	98.1	6.9
Faith at Steese	061687		149	15	153	61.5
Faith at Steese	061787		42.1	5.0	137	15.5
Faith at Steese	061887		20.8	4.4	83.3	4.7
Faith at Steese	061987		15.5	3.4	74.9	3.1
Faith at Steese	062087		22.5	13	64.7	3.9
Faith at Steese	062187		23.8	10	58.7	3.8
Faith at Steese	062287		14.1	8.8	58.7	2.2
Faith at Steese	062387		17.0	13	48.2	2.2
Faith at Steese	062487		13.0	8.5	41.3	1.5
Faith at Steese	062587		1380	210	348	1300
Faith at Steese	062687		494	47	310	414
Faith at Steese	062787		143	20	135	52.1
Faith at Steese	062887		76.8	15	83.2	17.3
Faith at Steese	062987		50.7	17	63.6	8.7
Faith at Steese	063087		47.5	20	52.0	6.7
Faith at Steese	070187		48.2	19	47.8	6.2
Faith at Steese	070287		34.5	19	43.3	4.0
Faith at Steese	070387		32.8	13	38.7	3.4
Faith at Steese	070587		20.0	4.8	34.5	1.9
Faith at Steese	070687		12.5	3.6	32.5	1.1
Faith at Steese	070787		12.6	3.1	29.7	1.0
Faith at Steese	070887		12.6	6.2	27.9	0.9
Faith at Steese	070987		20.5	11	28.0	1.5
Faith at Steese	071087	0917	5.5	14	30.3	0.4
Faith at Steese	071187		24.3	13	28.7	1.9
Faith at Steese	071287		24.3	14	27.1	1.8
Faith at Steese	071387		17.4	14	26.8	1.3

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Faith at Steese	071487		11.6	13	36.8	1.2
Faith at Steese	071587		9.5	8.0	38.7	1.0
Faith at Steese	071687		9.9	4.8	33.5	0.9
Faith at Steese	071787		12.0	6.6	29.4	1.0
Faith at Steese	071887		6.5	6.7	26.8	0.5
Faith at Steese	071987		8.3	5.6	24.7	0.6
Faith at Steese	072087		10.7	4.5	27.4	0.8
Faith at Steese	072087		2.7	2.7	25.5	0.2
Faith at Steese	072187		14.1	4.9	25.7	1.0
Faith at Steese	072287		10.9	4.3	24.8	0.7
Faith at Steese	072387		11.2	7.2	27.2	0.8
Faith at Steese	072487		334	38	236	212
Faith at Steese	072587		57.0	23	103	15.8
Faith at Steese	072687		25.2	24	59.3	4.0
Faith at Steese	072787		13.0	17	46.1	1.6
Faith at Steese	072887		11.3	14	39.8	1.2
Faith at Steese	072987		8.8	8.4	37.0	0.9
Faith at Steese	073087		12.5	7.2	67.0	2.3
Faith at Steese	073087	1615	14.7	9.0	67.0	2.7
Faith at Steese	080487		54.6	55	84.6	12.5
Faith at Steese	080487	1108	115	48	84.6	26.2
Faith at Steese	080487	1120	70.8	75	84.6	16.2
Faith at Steese	080587		38.0	50	73.3	7.5
Faith at Steese	080687		15.8	17	65.2	2.8
Faith at Steese	080787		18.6	12	79.8	4.0
Faith at Steese	080887		43.5	25	149	17.5
Faith at Steese	080987		31.6	23	139	11.8
Faith at Steese	081087		15.3	14	102	4.2
Faith at Steese	081187		7.9	5.3	85.3	1.8
Faith at Steese	081287		10.8	4.2	72.9	2.1
Faith at Steese	081387		5.8	2.9	71.2	1.1
Faith at Steese	081487		187	19	229	115.7
Faith at Steese	081587		111	9.6	248	74.5
Faith at Steese	081687		41.9	12	218	24.7
Faith at Steese	081787		33.4	13	174	15.7
Faith at Steese	081887		30.3	12	156	12.8
Faith at Steese	081987		180	20	284	138
Faith at Steese	082087		105	13	236	66.9
Faith at Steese	082187		43.4	11	186	21.8
Faith at Steese	082187	1655	10.5	11	186	5.3
Faith at Steese	082287		65.9	15	155	27.6
Faith at Steese	082387		28.6	11	140	10.8
Faith at Steese	082487		24.5	14	122	8.0
Faith at Steese	082587		26.5	15	108	7.8
Faith at Steese	082687		31.1	24	102	8.6
Faith at Steese	082787		26.8	21	99.3	7.2
Faith at Steese	082887		15.5	16	88.2	3.7
Faith at Steese	082987		15.8	14	87.2	3.7
Faith at Steese	083087		36.7	16	90.0	8.9

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Faith at Steese	083187		26.1	6.8	83.5	5.9
Faith at Steese	090187		38.5	7.2	83.1	8.6
Faith at Steese	090287		52.9	6.6	141	20.2
Faith at Steese	090387		45.0	8.1	147	17.8
Faith at Steese	090487		65.6	11	172	30.4
Faith at Steese	090587		96.7	9.0	201	52.4
Faith at Steese	090687		50.6	8.1	166	22.6
Faith at Steese	090787		28.8	5.5	153	11.9
Faith at Steese	090887		26.5	5.5	151	10.8
Faith at Steese	090987		21.5	8.3	136	7.9
Faith at Steese	091087		42.3	50	124	14.2
Faith at Steese	091087	1535	44.2	75	124	14.8
Faith at Steese	091187		115	110	115	35.9
Faith at Steese	091187	1655	79.6	65	115	24.8
Faith at Steese	091287		72.5	20	105	20.6
Faith at Steese	091387		28.9	27	93.1	7.3
Faith at Steese	091587		61.8	16	84.5	14.1
Faith at Steese	091687		16.0	6.9	79.8	3.4
Faith at Steese	091787		16.3	13	74.9	3.3
Faith at Steese	091887		26.7	26	71.1	5.1
Faith at Steese	091987		29.7	26	66.2	5.3
Faith at Steese	092087		28.5	40	63.0	4.8
Faith at Steese	092187		25.7	35	60.2	4.2
Faith at Steese	092287		33.6	50	56.4	5.1
Faith at Steese	092387		30.8	34	53.6	4.5
Faith at Steese	092487		16.7	21	51.3	2.3
Faith at Steese	092587		17.7	15	49.4	2.4
Faith at Steese	092687		20.8	13		
Faith at Steese	092787		8.9	8.4		
Faith at Steese	092887		8.4	6.7		
Faith at Steese	092987		6.8	5.5		
Faith at Steese	093087		22.5	5.6		
Faith at Steese	100287	1648	2.6	3.6		

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed 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		
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

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
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
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

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Sed load (tons/day)	Discharge (cfs)
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	1336	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 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Birch Creek Drainage						
Birch at Bridge	052887	1545			1870	
Birch at Bridge	052987		254	30	4110	2820
Birch at Bridge	053087		573	95	4530	7010
Birch at Bridge	053187		181	35	4120	2010
Birch at Bridge	060187		231	40	4340	2710
Birch at Bridge	060287		238	60	3900	2510
Birch at Bridge	060387		288	50	4880	3800
Birch at Bridge	060487		1180	120	9180	29200
Birch at Bridge	060587		1640	190	7070	31300
Birch at Bridge	060687		4110	360	4140	45900
Birch at Bridge	060787		2310	200	2690	16800
Birch at Bridge	060887		170	25	1990	911
Birch at Bridge	060987		74.6	18	1740	350
Birch at Bridge	061087		935	130	7860	19800
Birch at Bridge	061187		1060	170	4530	13000
Birch at Bridge	061287		201	45	2830	1530
Birch at Bridge	061387		107	23	2450	710
Birch at Bridge	061487		356	40	6330	6080
Birch at Bridge	061587		1440	170	6290	24500
Birch at Bridge	061687		375	65	4850	4910
Birch at Bridge	061787		496	34	5950	7970
Birch at Bridge	061887		215	22	4870	2830
Birch at Bridge	061987		113	18	3080	936
Birch at Bridge	062087		76.3	15	2280	470
Birch at Bridge	062187		71.8	15	1800	349
Birch at Bridge	062287		48.9	16	1510	199
Birch at Bridge	062387		39.3	16	1320	140
Birch at Bridge	062487		23.8	10	1180	75.8
Birch at Bridge	062587		43.1	13	1100	128
Birch at Bridge	062687		962	120	9480	24600
Birch at Bridge	062787		703	120	7960	15100
Birch at Bridge	062887		164	29	3850	1700
Birch at Bridge	062987		123	15	2440	810
Birch at Bridge	063087		101	13	1790	490
Birch at Bridge	070187		102	11	1510	415
Birch at Bridge	070287		123	12	2000	665
Birch at Bridge	070387		243	22	2510	1650
Birch at Bridge	070487		186	27	1910	960
Birch at Bridge	070587		155	19	1480	618
Birch at Bridge	070687		88.3	15	1240	296
Birch at Bridge	070787		50.0	13	1090	147
Birch at Bridge	070887	1822	8.5	9.1	980	22.5
Birch at Bridge	070987	0700	13	7.7	918	32.2
Birch at Bridge	070987		49.7	7.3	918	123
Birch at Bridge	071087		21.4	8.2	931	53.8
Birch at Bridge	071187		30	16	1040	84.2
Birch at Bridge	071287		20.9	12	1050	59.3

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Birch at Bridge	071387		124	20	1770	591
Birch at Bridge	071487		583	36	4430	6980
Birch at Bridge	071587		446	35	4540	5470
Birch at Bridge	071687		101	17	2890	788
Birch at Bridge	071787		41.2	9.6	1970	219
Birch at Bridge	071887		27.0	9.6	1500	109
Birch at Bridge	071987		25.4	9.3	1270	87.1
Birch at Bridge	072087		27.0	11	1150	83.8
Birch at Bridge	072187		16.1	8.2	1070	46.5
Birch at Bridge	072287		19.9	4.9	1010	54.3
Birch at Bridge	072387		66.8	10	1060	191
Birch at Bridge	072487		630	45	1720	2920
Birch at Bridge	072587		1840	210	10500	52200
Birch at Bridge	072687		3320	190	10500	94100
Birch at Bridge	072787		1320	120	5300	18900
Birch at Bridge	072887		557	40	3380	5090
Birch at Bridge	072987		547	23	3000	4430
Birch at Bridge	073087		375	22	3080	3120
Birch at Bridge	073087	1054	42.3	15	3080	352
Birch at Bridge	073187		428	26	2960	3420
Birch at Bridge	080187		606	85	3890	6370
Birch at Bridge	080287		484	55	3490	45560
Birch at Bridge	080387		312	36	3620	3050
Birch at Bridge	080487		263	31	2700	1910
Birch at Bridge	080587		214	22	2260	1310
Birch at Bridge	080687		175	23	1940	918
Birch at Bridge	080787		166	22	1700	762
Birch at Bridge	080887		165	25	1550	691
Birch at Bridge	080987		188	29	1500	759
Birch at Bridge	081087		140	24	1480	557
Birch at Bridge	081187		119	22	1390	447
Birch at Bridge	081287		99.7	19	1280	345
Birch at Bridge	081387		111	18	1200	358
Birch at Bridge	081387		17.3	11	1200	56
Birch at Bridge	081487		249	30	1220	819
Birch at Bridge	081587		273	41	2580	1900
Birch at Bridge	081687		330	60	4760	4200
Birch at Bridge	081787		102	29	3720	1020
Birch at Bridge	081887		56.6	12	3120	477
Birch at Bridge	081987		47.2	14	2640	336
Birch at Bridge	082087		47.0	13	2500	317
Birch at Bridge	082187		98.4	20	4180	1110
Birch at Bridge	082187	1205	74.5	18	4180	841
Birch at Bridge	082287		62.9	18	3740	635
Birch at Bridge	082387		36.1	13	2950	288
Birch at Bridge	082487		25.3	11	2420	165
Birch at Bridge	082587		26.0	11	2050	144
Birch at Bridge	082687		16.3	9.4	1820	80.1
Birch at Bridge	082787		17.7	11	1660	79.3

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Birch at Bridge	082887		17.1	12	1610	74.3
Birch at Bridge	082987		42.0	13	1550	176
Birch at Bridge	083087		16.5	13	1500	66.8
Birch at Bridge	083187		28.2	15	1730	132
Birch at Bridge	090187		25.4	16	1690	116
Birch at Bridge	090287		17.6	12	1600	76.0
Birch at Bridge	090287	1130	7.5	8.4	1600	32.4
Birch at Bridge	090387		35.4	11		
Birch at Bridge	090487		25.8	9.1		
Birch at Bridge	090587		20.2	11		
Birch at Bridge	090687		23.2	10		
Birch at Bridge	090787		24.8	17		
Birch at Bridge	090887		19.5	12		
Birch at Bridge	090987		15.9	13		
Birch at Bridge	091187	1011	8.77	10		
Birch at Bridge	100287	1035	5.3	14	698	10.0
Birch ab 12mile	061587	1740	172	92	226	105
Birch ab 12mile	061587	1750	562	88	226	343
Birch ab 12mile	061687		6330	273	285	4870
Birch ab 12mile	061787		17100	240	278	12800
Birch ab 12mile	061887		2590	150	178	1250
Birch ab 12mile	061987		1110	151	145	435
Birch ab 12mile	062087		588	223	125	198
Birch ab 12mile	062187		790	273	113	240
Birch ab 12mile	062287		406	260	102	112
Birch ab 12mile	062387		415	235	88.5	99
Birch ab 12mile	062487		272	193	78.0	57
Birch ab 12mile	062587		16220	703	407	17800
Birch ab 12mile	062687		14400	450	450	17500
Birch ab 12mile	062787		1490	266	243	979
Birch ab 12mile	062887		1030	228	168	468
Birch ab 12mile	062987		5300	103	133	1900
Birch ab 12mile	063087		3720	150	119	1200
Birch ab 12mile	070187		2430	200	137	899
Birch ab 12mile	070287		1760	220	144	684
Birch ab 12mile	070387		1290	370	123	430
Birch ab 12mile	070487		1190	360	105	338
Birch ab 12mile	070587		1340	230	89.2	323
Birch ab 12mile	070687		1040	300	80.4	226
Birch ab 12mile	070787		1010	360	75.9	207
Birch ab 12mile	070887		386	130	70.9	73.8
Birch ab 12mile	070987		452	120	85.0	104
Birch ab 12mile	071087	0740	279	340	96.7	72.7
Birch ab 12mile	071087	0740	308	340	96.7	80.4
Birch ab 12mile	071087		410	400	96.7	107
Birch ab 12mile	071187		585	550	99.1	157
Birch ab 12mile	071287		634	550	106.1	182
Birch ab 12mile	071387		1190	500	124.7	401

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Birch ab 12mile	071487		2170	550	182.3	1070
Birch ab 12mile	071587		720	380	144.3	281
Birch ab 12mile	071687		339	290	119.7	109
Birch ab 12mile	071787		371	370	100.2	100
Birch ab 12mile	071887		316	360	91.1	77.8
Birch ab 12mile	071987		263	270	87.1	61.8
Birch ab 12mile	072087		253	270	82.6	56.5
Birch ab 12mile	072187		205	200	80.4	44.5
Birch ab 12mile	072287		264	220	76.7	54.6
Birch ab 12mile	072387		401	250	80.8	87.4
Birch ab 12mile	072487		7770	1500	560	11700
Birch ab 12mile	072587		4750	450	449	5760
Birch ab 12mile	072687		1840	300	222	1100
Birch ab 12mile	072787		904	180	155	379
Birch ab 12mile	072887		343	210	128	119
Birch ab 12mile	072987		369	280	131	130
Birch ab 12mile	073087		1270	320	197	677
Birch ab 12mile	073087	1420	367	230	197	195
Birch ab 12mile	073187		9360	700	330	8340
Birch ab 12mile	080187		2130	190	227	1310
Birch ab 12mile	080287		573	170	170	263
Birch ab 12mile	080387		285	160	141	108
Birch ab 12mile	080487		273	170	139	102
Birch ab 12mile	080587		245	220	125	82.6
Birch ab 12mile	080687		268	260	112	81.4
Birch ab 12mile	080787		271	300	106	77.5
Birch ab 12mile	080887		250	230	108	72.8
Birch ab 12mile	080987		156	120	110	46.2
Birch ab 12mile	081087		268	75	104	75.1
Birch ab 12mile	081187		113	30	96.5	29.4
Birch ab 12mile	081287		80.8	85	92.3	20.1
Birch ab 12mile	081387		102	100	88.6	24.4
Birch ab 12mile	081387	1310	42.8	34	88.6	10.2
Birch ab 12mile	081487		5900	650	219	3490
Birch ab 12mile	081587		3520	360	263	2500
Birch ab 12mile	081687		930	90	212	532
Birch ab 12mile	081787		1130	140	216	658
Birch ab 12mile	081887		492	150	179	239
Birch ab 12mile	081987		1230	190	221	734
Birch ab 12mile	082087		2510	180	243	1650
Birch ab 12mile	082187		618	110	206	343
Birch ab 12mile	082287		309	80	173	144
Birch ab 12mile	082387		301	80	151	123
Birch ab 12mile	082487		171	55	137	63.4
Birch ab 12mile	082587		132	27	124	44.1
Birch ab 12mile	082687		117	65	117	37.1
Birch ab 12mile	082787		73.2	40	116	22.8
Birch ab 12mile	082887		84.7	70	108	24.8
Birch ab 12mile	082987		102	100	105	28.8

Appendix 1. 1987 sediment and discharge data.

Location	Date	Time	TSS (mg/l)	Turbidity (NTU)	Discharge (cfs)	Sed Load (tons/day)
Birch ab 12mile	083087		150	70	98.6	39.9
Birch ab 12mile	083187		162	55	98.5	43.0
Birch ab 12mile	090187		206	37	96.5	53.7
Birch ab 12mile	090187	1720	29.1	34	96.5	7.6
Birch ab 12mile	090287		531	110	97.0	139
Birch ab 12mile	090387		96.0	50	99.8	25.9
Birch ab 12mile	090487		63.3	40	95.3	16.3
Birch ab 12mile	090587		81.2	75	88.3	19.4
Birch ab 12mile	090687		97.7	95	88.0	23.2
Birch ab 12mile	090787		100	95	89.8	24.2
Birch ab 12mile	090887		130	140	88.1	31.0
Birch ab 12mile	090987		140	130	84.4	32.0
Birch ab 12mile	091087		96.7	95	83.6	21.8
Birch ab 12mile	091187		173	210	81.9	38.3
Birch ab 12mile	091187	1252	36.7	70	81.9	8.1
Birch ab 12mile	091287		197	150	78.9	41.9
Birch ab 12mile	091387		192	90	75.6	39.2
Birch ab 12mile	091487		343	150	82.2	76.1
Birch ab 12mile	091587		286	100	95.3	73.6
Birch ab 12mile	091687		255	80	72.8	50.1
Birch ab 12mile	091787		104	90	70.4	19.7
Birch ab 12mile	091887		143	95	68.1	26.3
Birch ab 12mile	091987		165	40	65.2	29.1
Birch ab 12mile	092087		61.6	50	64.4	10.7
Birch ab 12mile	092187		69.1	75	62.8	11.7
Birch ab 12mile	092287		101	30	60.9	16.5
Birch ab 12mile	092387		133	65	59.4	21.4
Birch ab 12mile	092487		118	110	58.5	18.6
Birch ab 12mile	092587		126	90	58.0	19.7
Birch ab 12mile	092687		63.0	35	56.7	9.6
Birch ab 12mile	092787		17.3	14	55.8	2.6
Birch ab 12mile	092887		37.4	8.7	53.8	5.4
Birch ab 12mile	100287	1356	8.2	6.0	52.3	1.2

APPENDIX 2. 1987 DISCHARGES AT AUTOMATED SITES

APPENDIX 2. 1987 Discharges at automated sites.

Walker Fork at the Taylor Highway Bridge
Discharge in cubic feet per second

Max	893
Min	88.9
Avg	246

Day	June	July	August	September
1			403	151
2			483	144
3			434	135
4			333	135
5			251	145
6			197	146
7			168	136
8			150	128
9			139	129
10			126	169
11			111	270
12			98	343
13			93	353
14		833	148	364
15		652	278	311
16		447	315	281
17		300	328	286
18		213	340	345
19		171	299	356
20		141	359	344
21		190	340	328
22		170	278	347
23		247	230	
24		265	196	
25		238	174	
26		193	158	
27		151	148	
28		124	143	
29		114	136	
30		136	160	
31		315	175	
Mon Avg		198	232	243

Appendix 2. 1987 discharges at automated sites.

Goldstream Creek at Ballaine Road, 1987
Discharge in cubic feet per second

Max	54.3
Min	8.1
Avg	20.2

Stage affected by beaver dams in late August-early September

Day	May	June	July	August	September	October
1		41.1	13.7	41.5	27.8	12.1
2		43.3	12.5	31.0	31.8	11.2
3		35.0	12.4	22.7	31.2	11.1
4		32.4	12.4	20.2	31.5	11.1
5		28.9	10.5	18.0	17.0	10.6
6		25.6	9.8	15.8	12.2	12.0
7		23.0	9.6	18.6	11.9	
8		21.8	10.1	36.0	17.1	
9		21.8	10.2	43.2	9.4	
10		22.4	11.0	33.7	10.4	
11		20.9	10.6	25.8	11.6	
12		20.0	10.2	21.0	13.1	
13		27.1	15.4	18.3	14.4	
14		36.4	19.9	18.1	14.6	
15		32.6	21.9	18.0	13.1	
16		27.6	20.1	17.3	12.6	
17		24.8	15.8	16.6	13.7	
18		21.3	13.9	16.2	14.5	
19		19.4	12.9	20.8	14.9	
20		18.2	15.5	25.0	15.3	
21		17.8	16.7	23.5	14.5	
22	32.4	15.8	16.4	21.8	15.5	
23	31.9	14.6	15.8	19.0	15.0	
24	29.9	14.3	22.5	17.8	15.2	
25	27.4	16.5	27.8	16.5	15.5	
26	25.4	24.3	22.0	16.1	13.8	
27	24.9	22.9	18.1	16.2	12.0	
28	23.8	19.4	16.2	17.5	11.2	
29	23.5	16.7	15.6	25.5	11.4	
30	24.5	14.9	16.6	32.8	11.8	
31	24.7		31.3	28.5		
Mon Avg	26.8	24.0	15.7	23.0	15.8	11.4

Appendix 2. 1987 discharges at automated sites.

Faith Creek at Steese Highway
Discharge in cubic feet per second

Max	650
Min	21.9
Avg	98.4

Day	June	July	August	September
1		47.8	177	83.1
2		43.3	134	141
3		38.7	98.5	147
4		34.5	84.6	172
5		32.5	73.3	201
6		29.7	65.2	166
7		27.9	79.8	153
8		28.0	149	151
9		30.3	139	136
10		28.7	102	124
11		27.1	85.3	115
12		26.8	72.9	105
13		36.8	71.2	93.1
14		38.7	229	87.7
15	98.1	33.5	248	84.5
16	153	29.4	218	79.8
17	137	26.8	174	74.9
18	83.3	24.7	156	71.1
19	74.9	27.4	284	66.2
20	64.7	25.5	236	63.0
21	58.7	25.7	186	60.2
22	58.7	24.8	155	56.4
23	48.2	27.2	140	53.6
24	41.3	236	122	51.3
25	348	103	108	49.4
26	310	59.3	102	
27	135	46.1	99.3	
28	83.2	39.8	88.2	
29	63.6	37.0	87.2	
30	52.0	67.0	90.0	
31		297	83.5	
Mon Avg	113	51.6	134	103

Appendix 2. 1987 discharges at automated sites.

Tolovana River at TAPS crossing
Discharge in cubic feet per second

Max	1390
Min	21.1
Avg	145

Day	June	July	August	September
1			1108	61.7
2			552	58.2
3			348	56.3
4			229	56.0
5			172	56.6
6		22.7	138	69.3
7			139	79.3
8			204	75.2
9			305	92.6
10			266	110
11			171	94.0
12			120	80.3
13			90.3	70.0
14			124	64.0
15			610	56.2
16			677	49.3
17		21.3	618	50.7
18		22.0	457	49.1
19		24.3	505	46.9
20		28.0	491	45.9
21		29.0	349	45.0
22		29.3	255	43.4
23		32.7	194	42.9
24		52.7	154	40.4
25		97.6	127	39.4
26		111	105	37.9
27		72.7	90.5	35.8
28		55.0	79.4	35.8
29		45.5	71.5	35.4
30		63.1	67.2	
31		523	65.2	
Mon Avg		80.5	287	57.9

Appendix 2. 1987 discharges at automated sites.

Birch Creek above 12Mile Creek
Discharge in cubic feet per second

Max	1010
Min	47.6
Avg	133

Day	June	July	August	September	October
1		137	227	96.5	79.8
2		144	170	97.0	52.3
3		123	141	99.8	
4		105	139	95.3	
5		89.2	125	88.3	
6		80.4	112	88.0	
7		75.9	106	89.8	
8		70.9	108	88.1	
9		85.0	110	84.4	
10		96.7	104	83.6	
11		99.1	96.5	81.9	
12		106.1	92.3	78.9	
13		124.7	88.6	75.6	
14		182.3	219	82.2	
15	226	144.3	263	95.3	
16	285	119.7	212	72.8	
17	278	100.2	216	70.4	
18	178	91.1	179	68.1	
19	145	87.1	221	65.2	
20	125	82.6	243	64.4	
21	113	80.4	206	62.8	
22	102	76.7	173	60.9	
23	88.5	80.8	151	59.4	
24	78.0	560	137	58.5	
25	407	449	124	58.0	
26	450	222	117	56.7	
27	243	155	116	55.8	
28	168	128	108	53.8	
29	133	131	105	51.9	
30	119	197	98.6	60.3	
31		330	98.5		
Mon Avg	196	147	149	74.8	66.0

Appendix 2. 1987 discharges at automated sites.

Birch Creek at Steese Highway Bridge
Discharge in cubic feet per second

Max	15500
Min	698
Avg	2661

Day	May	June	July	August	September
1		4340	1510	3890	1690
2		3900	2000	3490	1600
3		4880	2510	3620	
4		9180	1910	2700	
5		7070	1480	2260	
6		4140	1240	1940	
7		2690	1090	1700	
8		1990	980	1550	
9		1740	918	1500	
10		7860	931	1480	
11		4530	1040	1390	1310
12		2830	1050	1280	1270
13		2450	1770	1200	1220
14		6330	4430	1220	1150
15		6290	4540	2580	1070
16		4850	2890	4760	1000
17		5950	1970	3720	969
18		4870	1500	3120	962
19		3080	1270	2640	936
20		2280	1150	2500	912
21		1800	1070	4180	888
22		1510	1010	3740	874
23		1320	1060	2950	858
24		1180	1720	2420	839
25		1100	10500	2050	822
26		9480	10500	1820	797
27		7960	5300	1660	781
28	1870	3850	3380	1610	768
29	4110	2440	3000	1550	758
30	4530	1790	3080	1500	737
31	4120		2960	1730	
Mon Avg	3658	4123	2573	2379	1010

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 CaCO3	HARDNS as CaCO3	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	<0.01	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	<0.002	<0.002	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	<0.01	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	<0.002	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

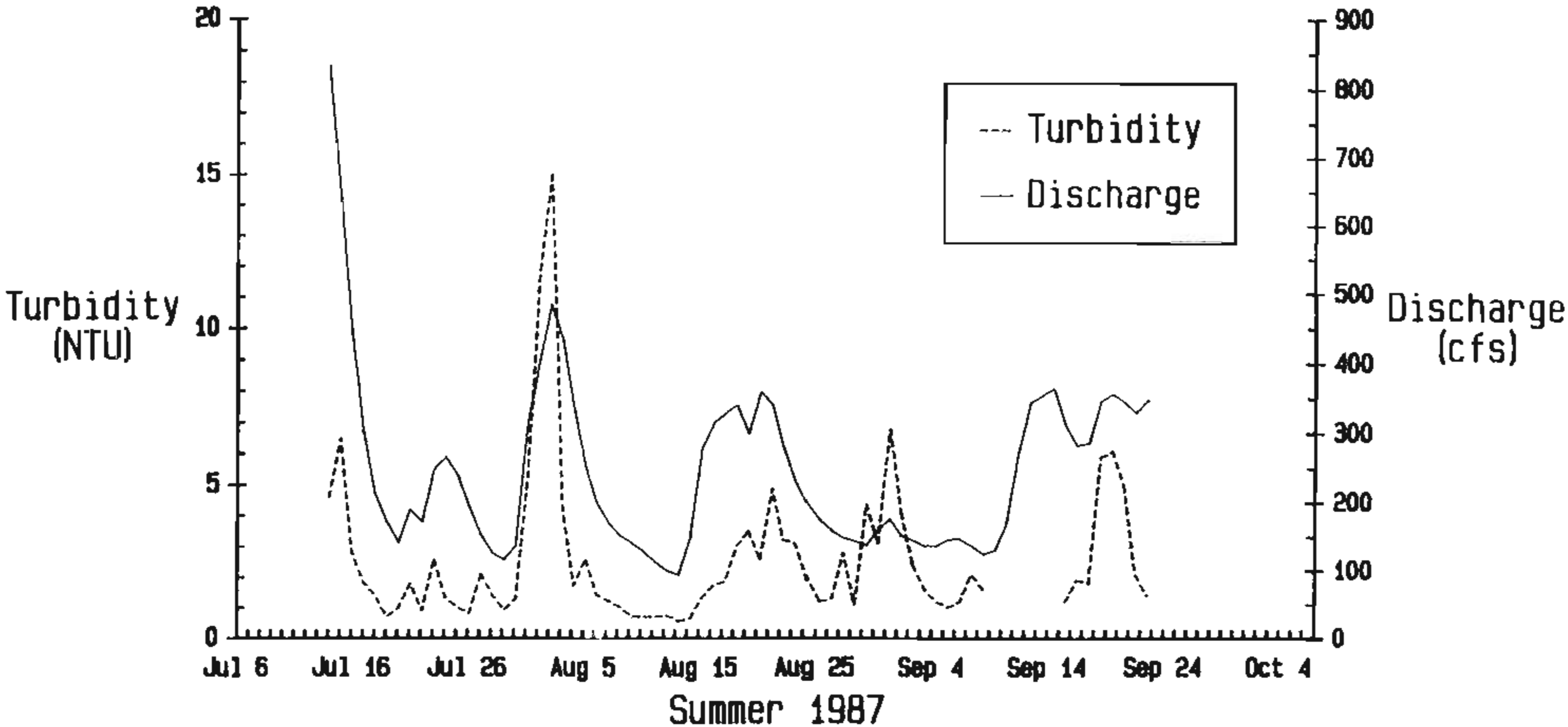
Trace metals are reported in mg/l

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	<0.01	<0.02	<0.02	<0.01	<0.01	0.005	<0.002	0.040	0.026	0.05	0.10
Jack Wade Creek	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.006	<0.002	<0.005	0.019	0.30	0.31
Mosquito Fork	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.013	<0.002	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	<0.02	<0.02	<0.01	<0.01	0.039	<0.002	<0.005	0.011	0.04	0.09
South Fork ab NF	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.035	<0.002	<0.005	0.037	0.51	0.26
South Fork at Bridge	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.004	<0.002	<0.005	0.015	0.35	0.39
Uhler Creek	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.035	<0.002	0.005	0.007	0.74	0.29
Walker Fork at Bridge	<0.01	<0.01	<0.02	<0.02	<0.01	<0.01	0.049	<0.002	<0.005	0.016	0.22	0.20
Walker Fork at 40m	0.021	<0.01	<0.02	<0.02	<0.01	<0.01	0.052	<0.002	<0.005	0.018	0.26	0.20
West Fork Dennison	<0.01	0.010	<0.02	<0.02	<0.01	<0.01	0.060	<0.002	0.014	0.02	0.52	0.46

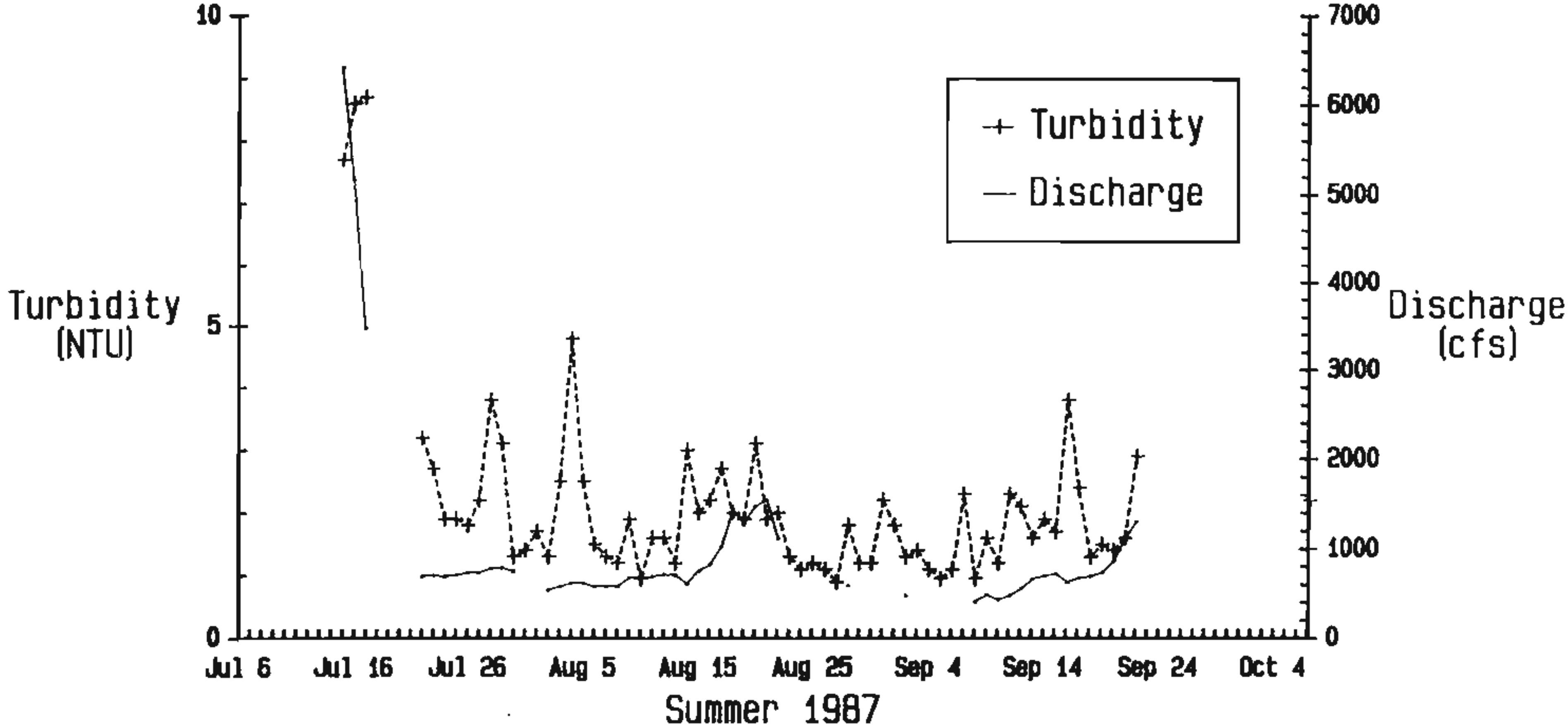
Stream Reach	Pb	Pb	Mn	Mn	Hg	Hg	Se	Se	Si	Si	Zn	Zn
	T	D	T	D	T	D	T	D	T	D	T	D
Buckskin Creek	0.03	<0.03	0.007	<0.005	0.002	<0.001	<0.02	<0.02	1.92	3.92	<0.02	<0.02
Jack Wade Creek	<0.03	<0.03	0.043	0.037	<0.001	<0.001	<0.02	<0.02	2.16	4.19	<0.02	<0.02
Mosquito Fork	<0.03	<0.03	0.012	0.007	<0.001	<0.001	<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	<0.02	<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	<0.02	<0.02
Uhler Creek	<0.03	<0.03	0.031	0.014	<0.001	<0.001	<0.02	<0.02	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	<0.02
Walker Fork at 40m	<0.03	<0.03	0.017	0.009	<0.001	<0.001	<0.02	<0.02	4.09	2.67	<0.02	<0.02

APPENDIX 4. SEASONAL TURBIDITY AND DISCHARGE FIGURES

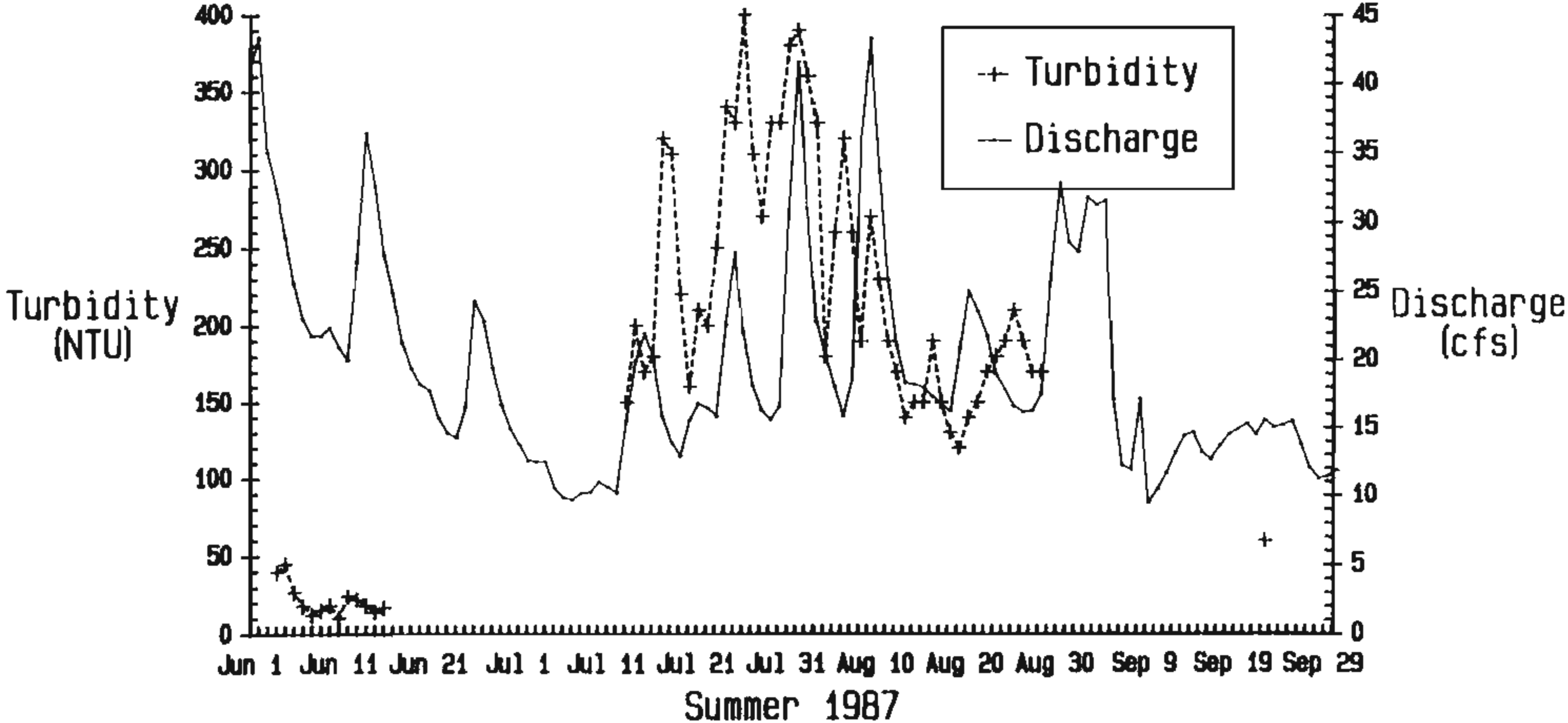
Appendix 4. Figure 1. Turbidity and discharge
Walker Fork below Taylor Hwy Bridge



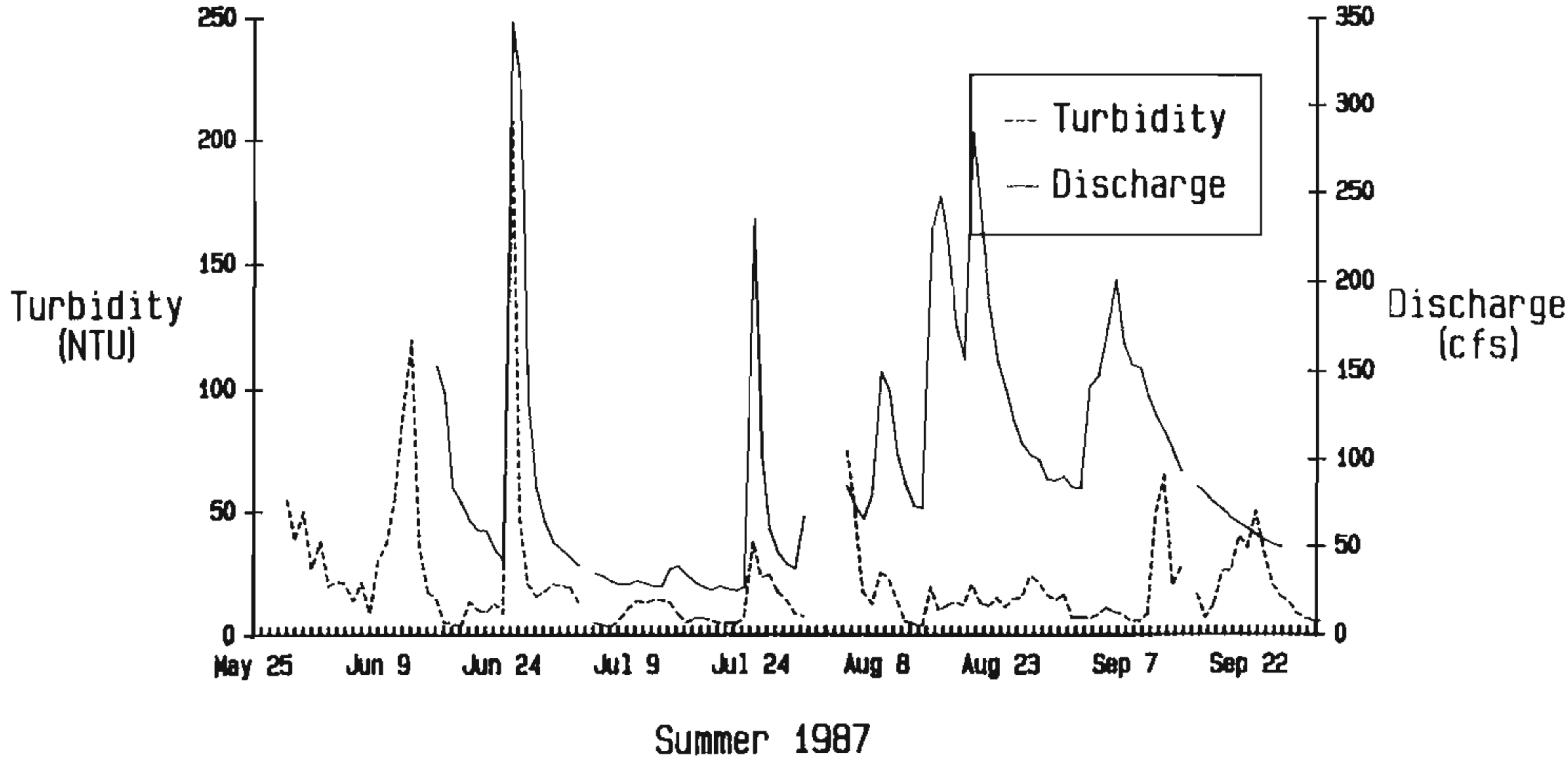
Appendix 4. Figure 2. Turbidity and discharge
South Fork at Taylor Hwy Bridge



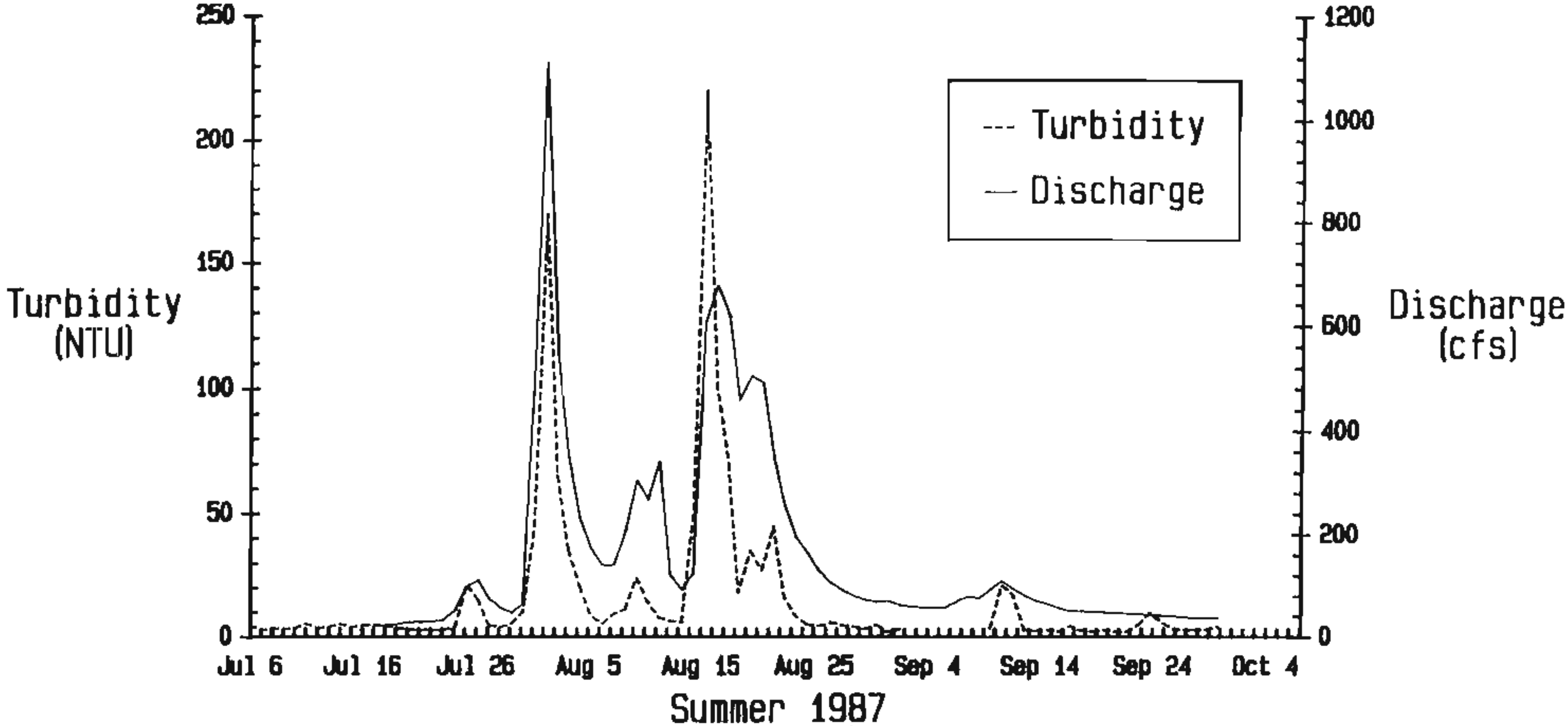
Appendix 4. Figure 3. Turbidity and discharge
Goldstream Creek at Ballaine Road



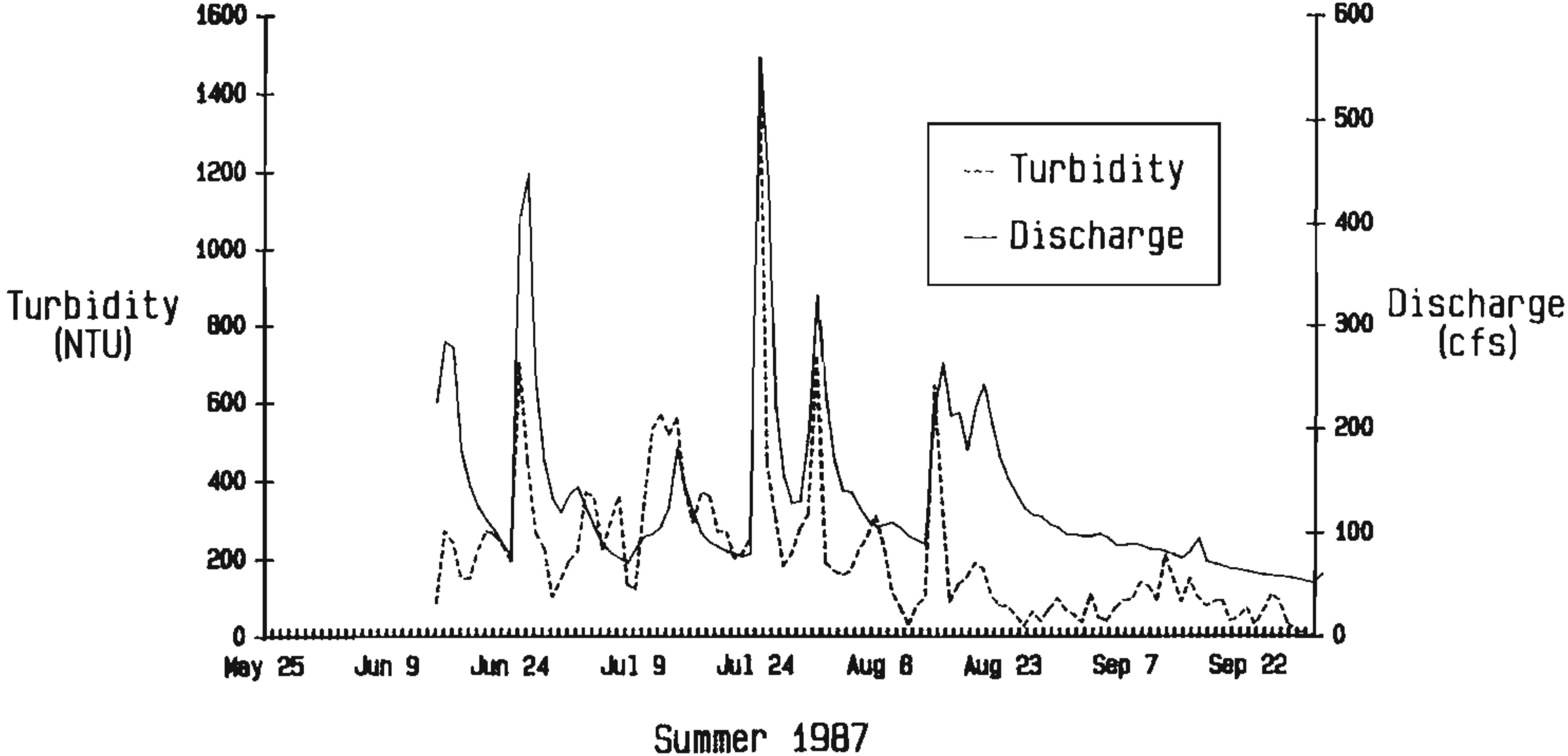
Appendix 4. Figure 4. Turbidity and discharge
Faith Creek at Steese Highway



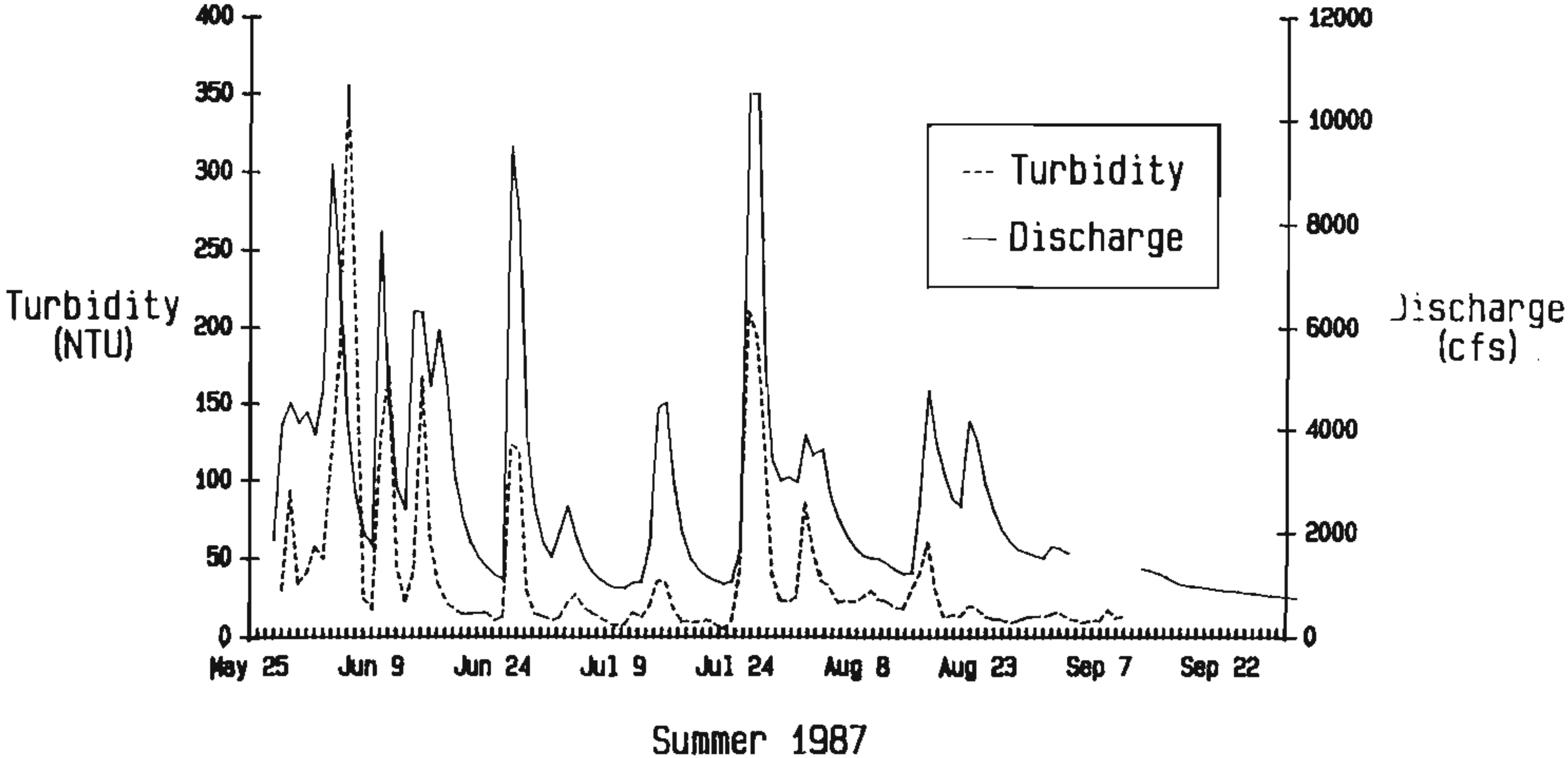
Appendix 4. Figure 5. Turbidity and discharge
Tolovana River at TAPS Crossing



Appendix 4. Figure 6. Turbidity and discharge
Birch Creek above 12mile Creek



Appendix 4. Figure 7. Turbidity and discharge
Birch Creek at Bridge



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 Fortymile 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 Highway 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 confluence with South Fork in SE¼, NE¼, Sec 34, T8S, R30E, FM
Napoleon Creek	Napoleon Creek at the South Fork	200 feet upstream of confluence with South Fork in SW¼, 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 confluence 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		
Goldstream at Ballaine	Goldstream Creek at the Ballaine Road Bridge	upstream of bridge in the NW¼, SW¼, Sec 18, T1N, R1W, FM
Faith at Steese	Faith Creek at Steese Highway	above bridge in SE¼, NE¼, sec 6, T5N, R7E, FM
Livengood at Bridge	Livengood Creek at the Livengood Road Bridge	downstream of bridge in the NE¼, 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
Birch Creek Drainage		
Birch ab 12mile	Birch Creek above Twelvemile Creek	1/4 mile above confluence in SW¼, NW¼, sec 33, T7N, R10E, FM
Birch at Bridge	Birch Creek at Steese Highway Bridge	200 ft. above bridge on left bank in SE¼, NE¼, sec 1, T10N, R16E, FM