May 10, 1994 Price: $9.75

Division of Geological & Geophysical Surveys

PUBLIC-DATA FILE 94-37

THE BIRCH CREEK, MILE 101 STEESE HIGHWAY PLACER MINE RECLAMATION PROJECT: YEAR ONE RESULTS, 1993

Interim report to USEPA Region X

by

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Prepared for
Alaska Department of Environmental Conservation
and
Alaska Department of Natural Resources
Division of Water

May 1994

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Introduction.

The effects of active placer mining operations on downstream water quality have been the subject of continuous monitoring since 1984 (Ray 1992). Active placer mining operations are considered to be primarily point sources of sediment. The sediment originates in either sediment laden discharge or seepage from settling ponds. The post-mining landscape, both reclaimed and unreclaimed, has no identifiable source of sediment and the landscape can be deemed a single, non-point source of sediment. It is generally assumed that sloped areas, lacking surface cover, and containing fine materials, are contributing to the non-point sediment loading streams. The non-point sediment sources associated with the post mining landscape are considerably less understood than the sediment *sources* originating during active placer mining operations.

The Alaska Department of Environmental Conservation (ADEC) received a 3 19 Demonstration Project grant from the United States Environmental Protection Agency in 1992. The purpose of the grant was to reclaim an abandoned placer mine and assess the impacts of reclamation activities and the post mining landscape on downstream water quality. Specific 3 19 project objectives outlined by ADEC are:

- Assess the impacts of the post-mining landscape on downstream water quality, including :
    1. Sediment introduction during channel realignment
    2. Sediment contributions due to slope erosion
    3. Sediment dynamics of the reclaimed flood plain

- Identify the parameters affecting the volunteer recruitment of vegetation, including:
    1. Soil factors, including:
        a. soil moisture
        b. soil tcmpcraturc
    2. Topographic factors, including:
        a. slope
        b. aspect
        c. relief

- Identify the parameters affecting channel stability of reclaimed stream reaches, including:

    1. Channel and flood plain geomorphology
        a. width to depth ratio
        b. discharge
        c. gradient

    2. Sediment transport
        a. suspended sediment transport
        b. bedload transport

    3. Effects of channel realignment on downstream water quality.

The scope of the EPA 3 19 project objectives as outlined, demonstrates the comprehensive nature of the project. To insure that all viewpoints were represented, ADEC determined that the 3 19 Project Work Group should be a partnership between industry, regulatory agencies, and research. Work group membership is shown in Table 1.

Table 1. Composition of the Birch Creek 101 Mile Steese Highway Project Work Group.

Affiliation	Agency or Association
Federal	Environmental Protection Agency Non-point Source Pollution
State	Department of Environmental Conservation Mining Department of Fish and Game Habitat Division Department of Natural Resources Division of Mining Division of Water
Research	University of Alaska Fairbanks School of Mineral Engineering Palmer Experiment Station (SALRM)
Private Industry	Alaska Miners' Association Circle Mining District

The Birch Creek Site

The EPA 3 19 study site shown in Figure 1, an abandoned placer mine on Birch Creek, is located approximately 100 miles northeast of Fairbanks, between mileposts 101 and 102 of the Steese Highway. The legal location of the study site is the flood plain of Birch Creek and Eagle Creek south of the Steese Highway, from milepost 10 1 of the Steese Highway to a claim boundary located 500 feet southwest of the Ptarmigan Creek Bridge, Section 17, Township 7 North, Range 11 East, Fairbanks Meridian. Placer mining permits, obtained from the Alaska Department of Natural Resources, Division of Mining, indicate that three sets of State mining claims were staked in this area. The State mining claims were abandoned by 1986. Land patented under the General Mining Law of 1872 (P.L. Stat. 91), is adjacent to the study site between Ptarmigan Creek and the Steese Highway, downstream of the Steese Highway bridge (U.S. Location Monument No. 5002). The historic operational status of this patent is unknown. The Birch Creek site is assumed to be representative of abandoned placer mines in Interior Alaska.

Methods

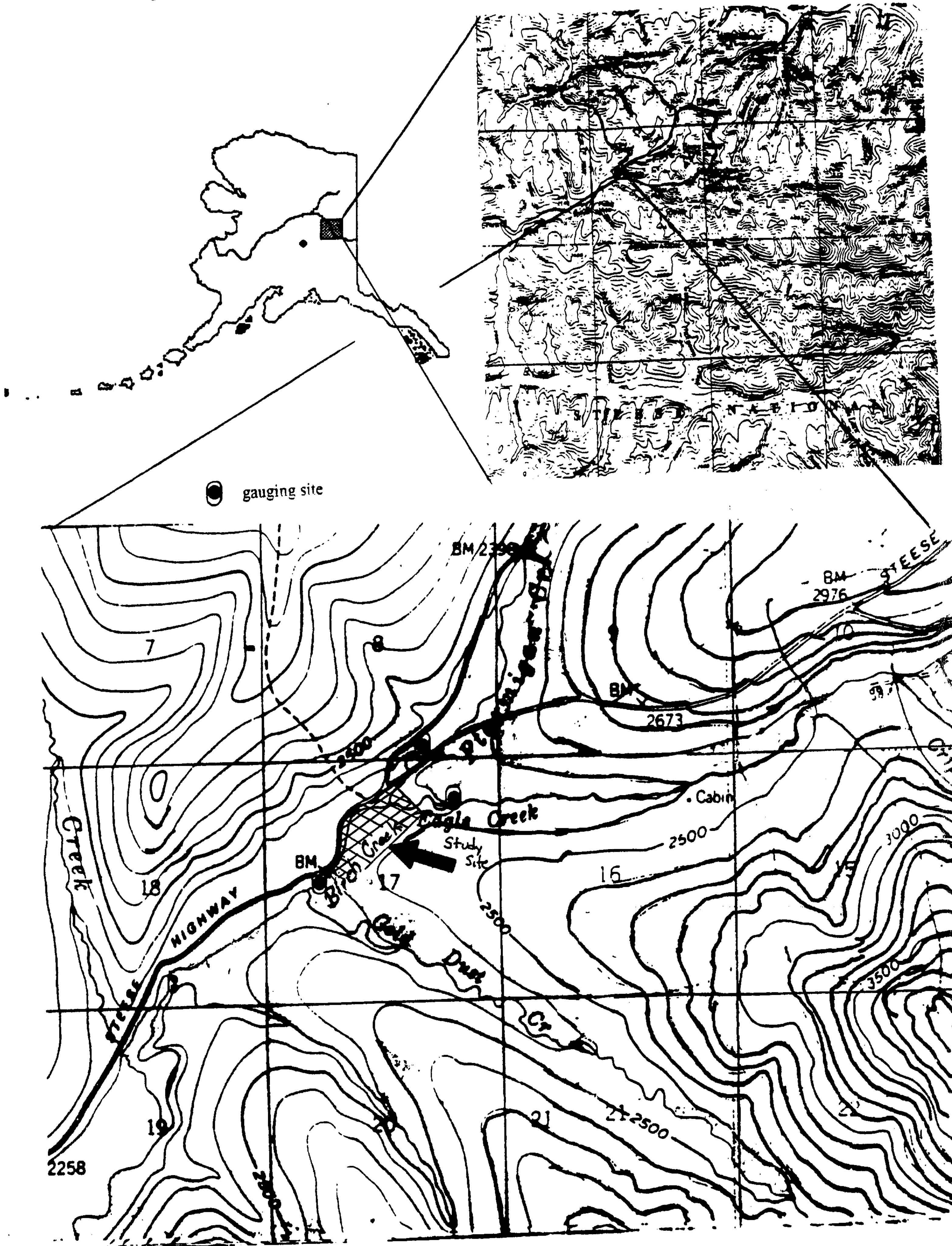
Aerial Photography

Prior to field investigations, aerial photographs of the Birch Creek site were obtained by ADEC. Aerial photographs taken in 1989 for the Alaska Division of Mining, and aerial photographs taken during mapping programs in 195 1 and 1972 were obtained from the Geophysical Institute at the University of Alaska Fairbanks. In conjunction with the Alaska Division of Mining's normal aerial photographing schedule, aerial photographs of the site in August 1993 were obtained. The project work group conducted a visual inspection of the Birch Creek site during breakup in May 1993. During this inspection it was determined that the gauging sites located on Ptarmigan Creek and Eagle Creek, selected by the Alaska Division of Water during the 1992 field season, would also be utilized for the Birch Creek project. A new gauging site (Birch Creek below Reclamation) was added downstream of the Birch Creek Site, near the mouth of the Gold Dust Creek valley. (see Figure 1.)

Hydrology

The three gauging sites were designed to allow discharge, bedload and total suspended solids to be collected at a single site. Point samples for laboratory analysis of daily average values for total

Figure 1. Location of Birch Creek, 101 Mile Steese Highway project and gauging sites.



suspended solids and turbidity. Water was collected four times daily at 6 hour intervals to obtain a daily average sample. Samples were collected using an automated water sampler (ISCO Inc. Lincoln Nebraska). A 5 psi pressure transducer, connected to a data logger (Data pod) was installed to record changes in water surface elevation across the control section. A flow measurement transect, consisting of a staff gage and attachment points for a fiberglass tape, were set-up at each site. Bedload sampling was performed with a Helley Smith bedload sampler along the flow measurement transect. Shortly after installation, the Eagle Creek flow measurement station was moved approximately 1500 feet downstream due to turbulent flow near the gage site. A typical gauging site is shown in Figure 2.

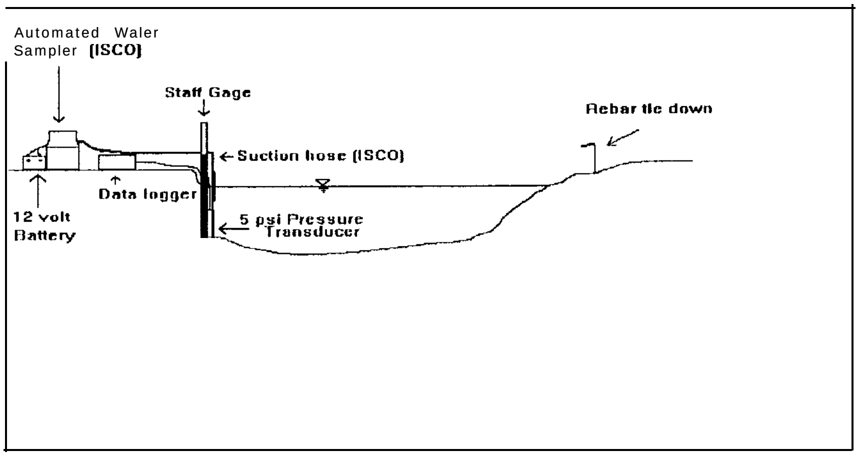


Figure 2. Typical guaging site and equipment used at the Birch Creek Reclamation site.

Stage-discharge rating curves were generated for each gauging site from field measurements. Recorded data pod measurements of water pressure were converted to stage readings by linear regression of field measured data pod readings and stage measurements. Once converted to stage readings, recorded values were used to estimate instantaneous discharge with the calculated stage-discharge relationships generated for each site. Daily average discharge was then calculated. The peak estimated discharge at each site was then checked by plotting the mean velocity versus stage. Mean velocity for the highest recorded stage was then estimated from the plot. Neglecting actual channel geometry, the area added to the channel was assumed to be rectangular above the highest measured stage. Using the estimated mean velocity and the conservative increase in channel area, the accuracy of calculated discharge was judged.

As an additional check, a regression equation for discharge between the upstream gauging sites on Eagle Creek and Ptarmigan Creek and the discharge at the Birch Creek gauging site was used.

Site Surveying

Six cross sections were set up at the Birch Creek Site. The cross sections were placed perpendicular to the existing flood plains and channels. The bench mark for the first cross section is located on the southern downstream corner of the Ptarmigan Creek Bridge. The bridge provides a permanent bench mark elevation free from the effects of frost heaving. Five permanent bench marks, 3/4 inch reinforcing (rebar) bar set in concrete, were installed along the Steese Highway between the Ptarmigan Creek Bridge and milepost 10 1. Elevations of the five bench marks were obtained from a closed loop traverse survey from the Ptarmigan Creek Bridge. The end point of each cross section is a flagged rebar stake, driven into the permafrost above the disturbance along the southern margin of the site. The endpoint of cross section #4 was buried during reclamation activities, and must be relocated during the 1994 field season. Open-end traverse surveys along each cross section, from bench mark to reference mark were performed both prior to and following reclamation work. The gradients of Eagle Creek, Ptarmigan Creek and Birch Creek were surveyed (closed loop traverse) from the confluence of Eagle Creek and Ptarmigan Creek to each gauging site. Intermediate survey points were located at each break in slope along the channel. All survey work will follow the same procedures and will be performed annually and after any large flood events. Continuous monitoring will allow tracking of changes in channel and flood plain geometry.

Vegetation sampling was performed in early July. Vegetation polygons were identified in the field and sampled using a point-intersect sampling method. The point intersect method of vegetation sampling allows both density and species diversity estimates for polygons on the disturbed Birch Creek site and in the relatively undisturbed Ptarmigan Creek watershed. Soil samples were collected from each polygon during vegetation sampling. Limited sampling of plant roots and the fruiting bodies of fungi was performed to determine the method and feasibility of future myccorhizal studies, Vegetation data analysis is being performed by Dr. D. Helm at the Plant Materials Research Center. The results of vegetation and soil analysis are not presented in this report.

Results (Prior to Reclamation)

Aerial Photograph Interpretation:

Figures 3 - 6 show available aerial photographs of the Birch Creek site. The aerial photograph taken in 195 1 (Figure 3) shows the upper Birch Creek watershed in a relatively undisturbed condition. The 101 Mile Lodge and the Steese Highway are visible, and the approximate boundaries of the current Birch Creek Site are also shown. The 1972 aerial photograph (Figure 4) was taken during the reconstruction of the Steese Highway, during which, a bridge was constructed over Ptarmigan Creek and a section of road was built across the flood plain of Birch Creek downstream of the 10 1 Mile Lodge. Between 195 1 and 1972, Ptarmigan Creek appears to have migrated laterally towards the lodge. The outlined area shows the vegetation that was stripped during subsequent placer mining operations. The large arrow shows subsequent movement of the confluence of Eagle Creek and Ptarmigan Creek. The confining influences of spoil piles in the Eagle Creek and Birch Creek flood plains are shown in the 1989 aerial photograph (Figure 5). Placer mining operations appear to have been confined to Eagle Creek and the southern limits of the Birch Creek flood plain. The new location of the Eagle Creek channel has caused sediment deposition at the confluence with Ptarmigan Creek (outlined), and lateral migration of Ptarmigan Creek towards the Steese Highway (small arrows). The presence of spoil piles prevents Eagle Creek from migrating laterally away from Ptarmigan Creek. The aerial photographs taken by the Alaska Division of Mining in 1993 (Figure 6) show continued growth of the alluvial fan (outlined), at the confluence of Eagle Creek and Ptarmigan Creek. The lateral migration of Ptarmigan Creek appears to have slowed. However, lateral migration of Eagle Creek (small arrows) has forced the channel into the spoil piles, causing downstream bank erosion. The location of the six cross sections are shown in Figure 6.

Site Cross Sections

Plots of site cross sections prior to reclamation work are shown in Appendix A. Surveyed elevations show that both Eagle Creek and Ptarmigan Creek are actively eroding their banks and that the bed of Eagle Creek is consistently higher than that of Ptarmigan Creek. Cross section #2 (Appendix A,

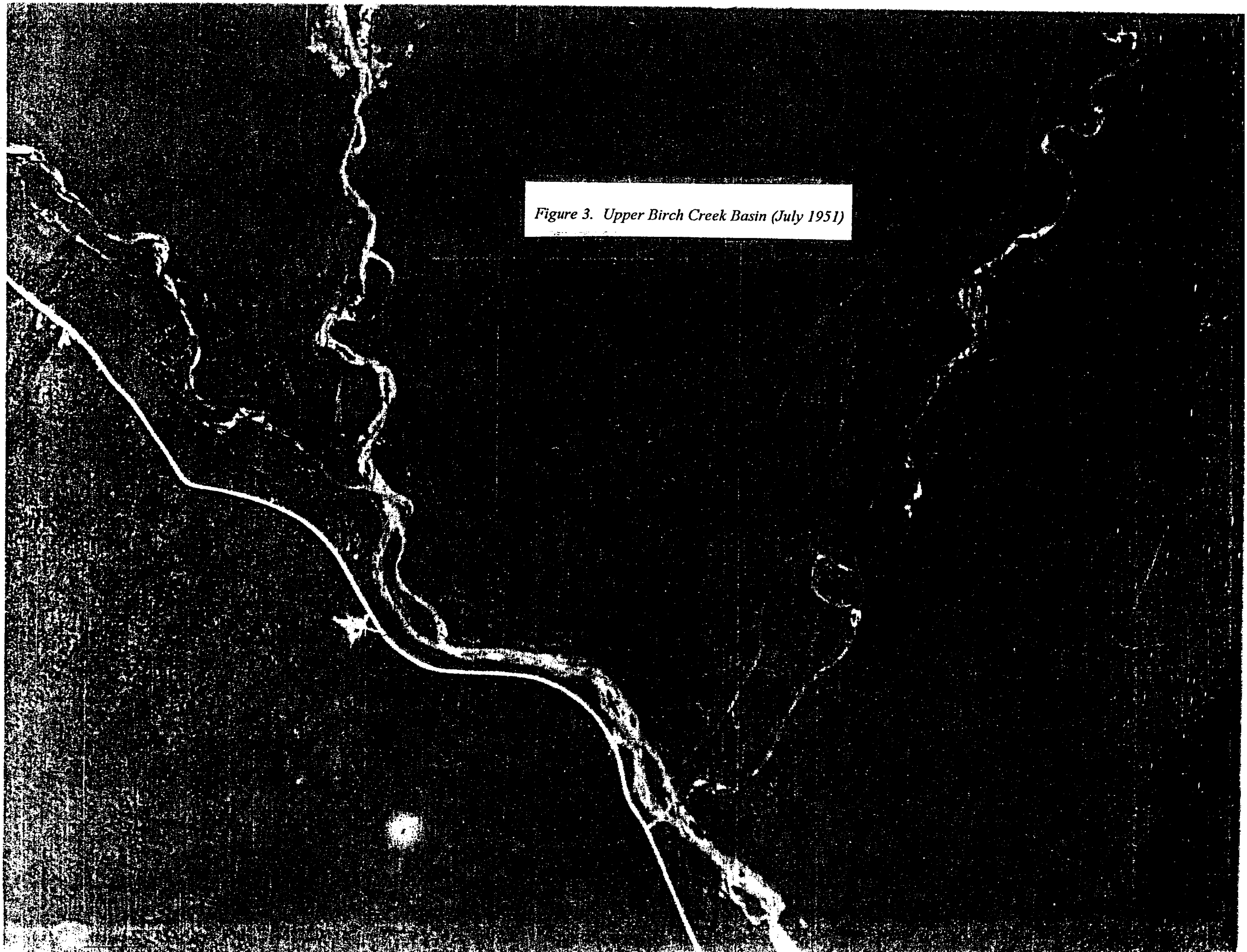


Figure 3. Upper Birch Creek Basin (July 1951)

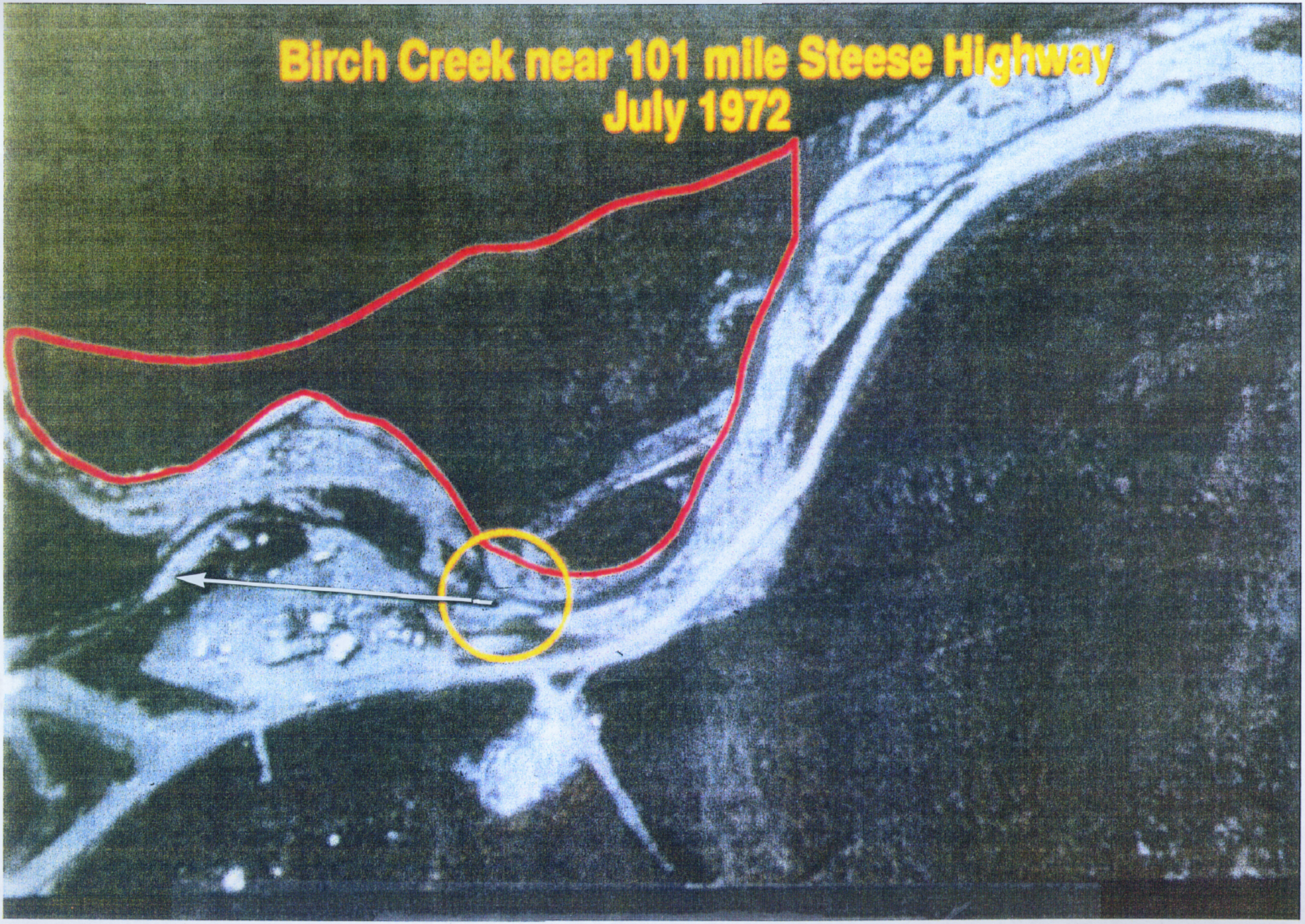


Figure 4. Upper Birch Creek Near 101 Mile Steese Highway (July 1972)

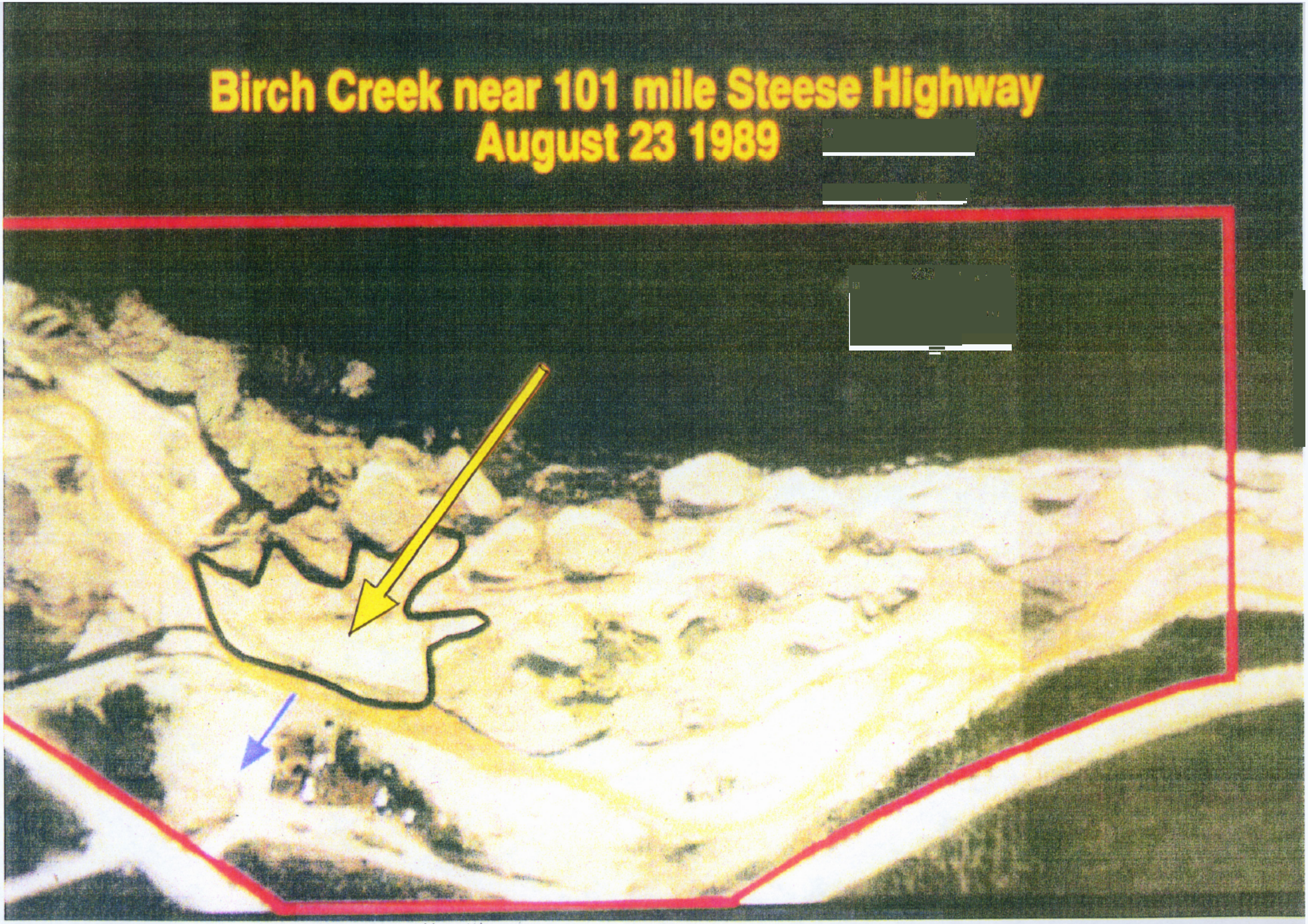


Figure 5. Upper Birch Creek Near 101 Mile Steese Highway (August 1989)

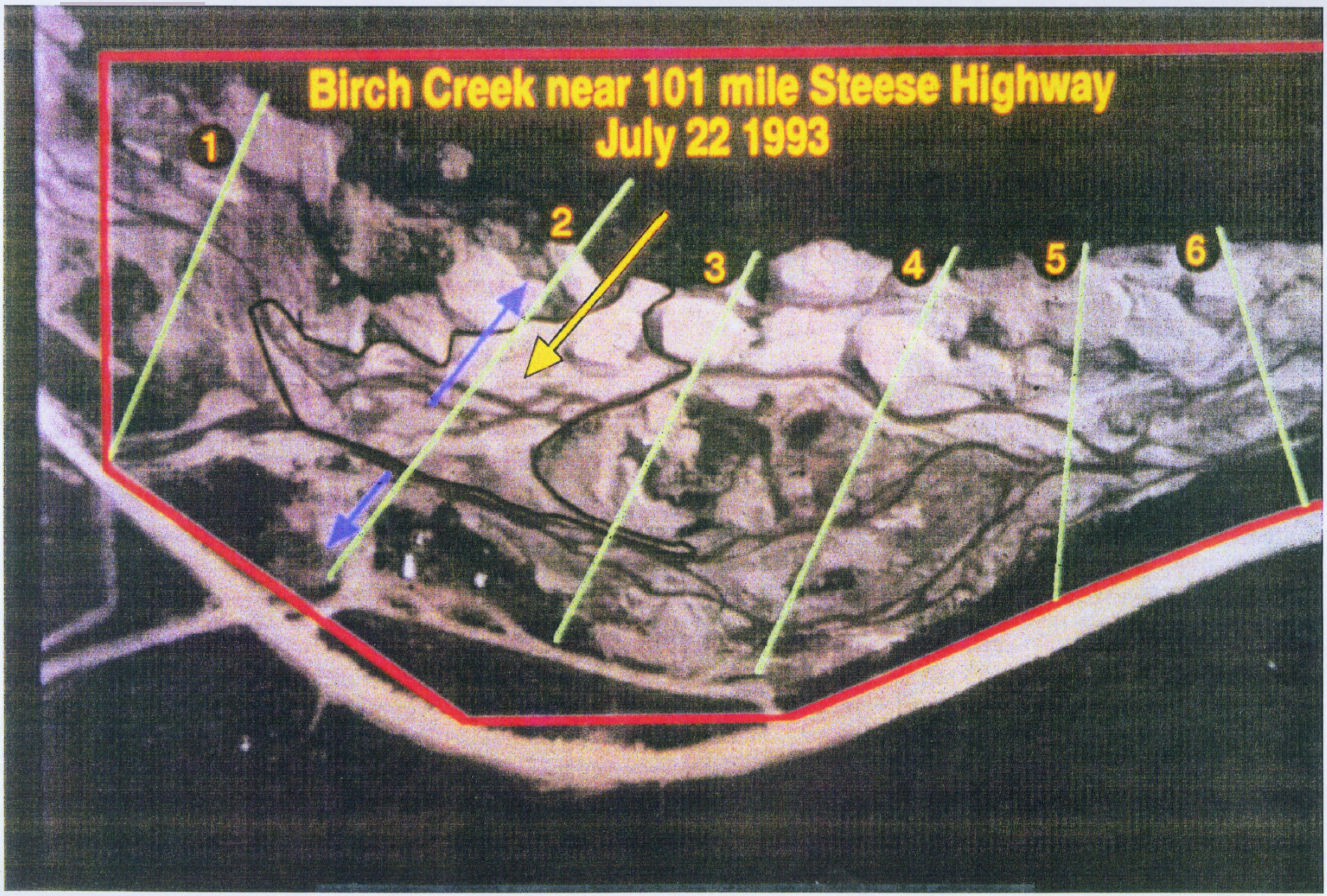


Figure 6. Upper Birch Creek Near 101 Mile Steese Highway (July 1993)

Figure A.2) shows steep cut banks resulting from the lateral migration of Eagle Creek. Cross section #3 (Appendix A, Figure A.3) demonstrates the confining influence of spoil piles on flood plain development.

Water Surface Profiles

The water surface profiles prior to reclamation work are plotted in Figure 7. Eagle Creek has a gradient of 0.018 ft/ft and Ptarmigan Creek has a gradient of 0.012 ft/ft. Birch Creek and Ptarmigan Creek have similar gradients through the Birch Creek site (0.012 ft/ft and 0.014 ft/ft, respectively). Birch Creek changes gradient downstream of the project site from 0.0114 ft/ft to .0167 ft/ft, a gradient closer to that of Eagle Creek. The loss of 0.06 ft/ft gradient between Eagle Creek and Ptarmigan Creek reduces of stream energy at the confluence, causing the deposition of sediment and formation of the alluvial fan seen in Figure 5 and Figure 6.

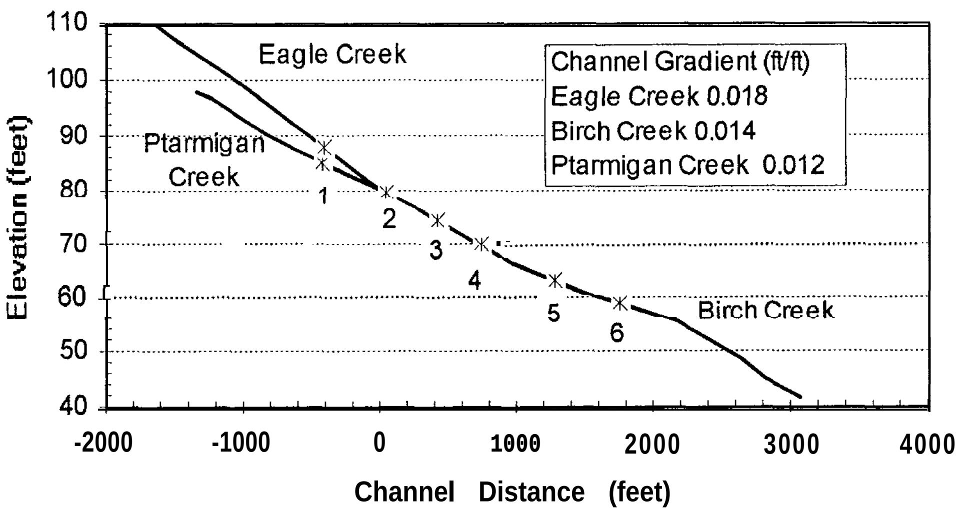


Figure 7. Water Surface Profile Prior to Reclamation of the Birch Creek site.
** Numbers correspond to surveyed cross sections.*

Discharge

Stream flow hydrographs for the gauging sites on Eagle Creek, Ptarmigan Creek, and Birch Creek demonstrate the lack of precipitation in the headwaters of Birch Creek. The recession of the hydrograph from 1 July until late August indicates little precipitation occurred over the upper Birch Creek drainage. The flood event of 2 September was a rain on snow event. Figures 8-10 are the seasonal hydrographs for Ptarmigan Creek, Eagle Creek, and Birch Creek. Daily average discharge values for the three gauging sites are found in Appendix D.

The regression equation between discharge at the Ptarmigan Creek gauge and discharge at the Birch Creek gauge yielded results very close to those calculated by other methods. A regression equation between discharge at the Eagle Creek gauge and discharge at the Birch Creek gauge did not have the predictive value of the Ptarmigan Creek and Birch Creek equation. There appears to be a non-linear relationship between the discharge at the Eagle Creek gauge and the discharge at the Birch Creek gauge. Although measured flow values and actual flow values for small streams can differ by IO-15 % (Gupta 1989) the linear relationship between Ptarmigan Creek and Birch Creek and the non-linear relationship between Eagle Creek and Birch Creek seemingly indicates an interaction between Eagle Creek and ground water (Table 2).

Table 2. Discharge of Eagle Creek, Ptarmigan Creek, and Birch Creek and the difference between the discharge of Birch Creek and the combined discharge of Ptarmigan Creek and Eagle Creek.

Date	Eagle Creek Discharge (Q) (cfs)	Ptarmigan Creek Discharge (Q) (cfs)	Birch Creek Discharge (Q) (cfs)	$Q_{birch} - (Q_{ptarm} + Q_{eagle})$ (cfs)
2 June	29	43	73	+ 1.0
22 June	16	29	41	-4.0
30 June	12	19	30	-1.0
9 July	7.2	13	21	+0.6
15 July	4.3	10	14	-0.3
22 July	4.5	7.2	11	-0.7
12 Aug	4.8	7.5	12	-0.3
23 Aug	5.3	8.3	15	+1.4
2 Sept	24	28	48	-4.0
12 Sept	12	20	30	-2.0
19 Sept	13	21	30	-4.0

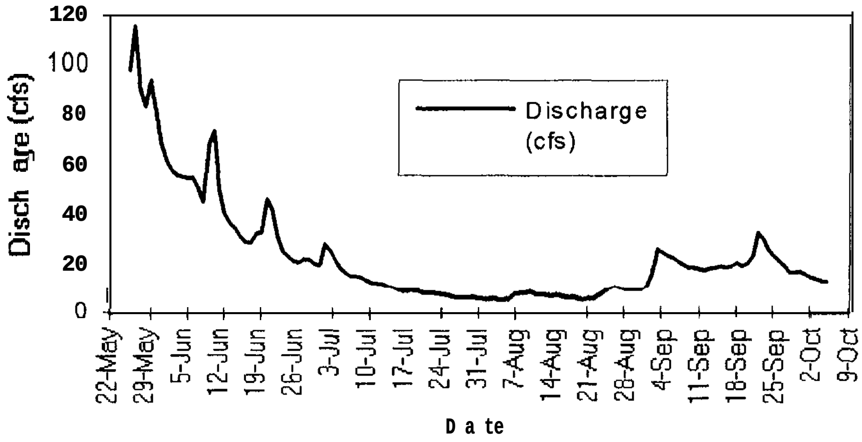


Figure 8. Ptarmigan Creek daily average discharge (1993)

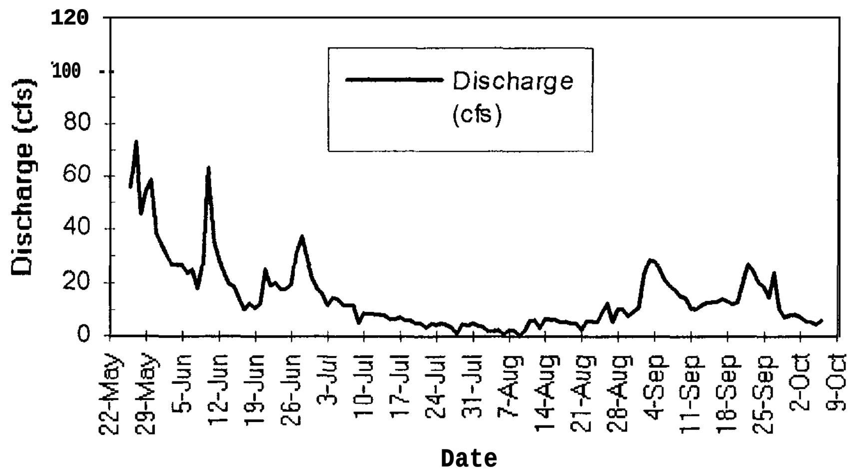


Figure 9. Eagle Creek daily average discharge (1993).

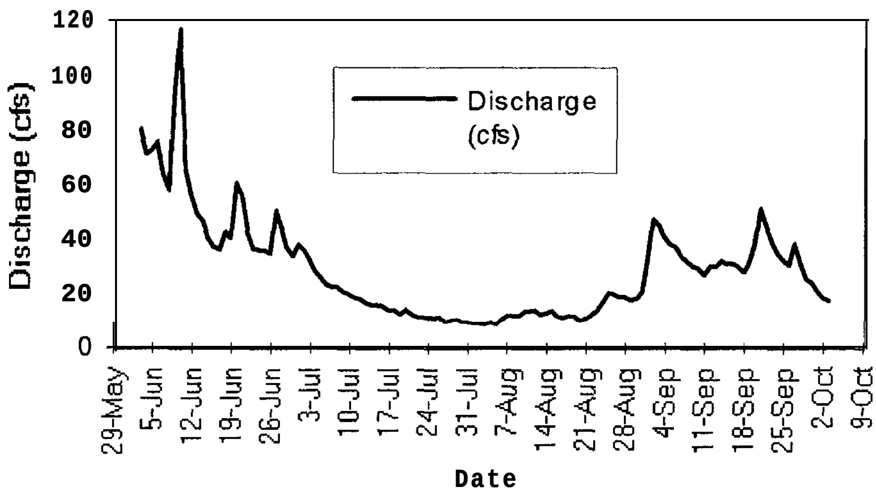


Figure 10. Birch Creek daily average discharge (1993).

Turbidity and Total Suspended Solids:

Seasonal turbidity and total suspended solids data for each gauging site can be found in Appendix B. Due to periodic equipment failure after installation, seasonal values for mean and median turbidity values can not be calculated. However, all automated water sampling equipment functioned properly between 3 June and 11 September 1993. Results from each gauging site are summarized and compared to 1992 results in Table 3. Mean turbidity for Ptarmigan Creek, which is relatively undisturbed, was 0.60 NTU. This value is not appreciably different from results obtained by Ray. (Ray 1993). Mean turbidity for Eagle Creek decreased from 54 NTU in 1992 to 34 NTU in 1993. Eagle Creek median turbidity increased from 3.1 NTU to 8.4 NTU. The increase is due to a high flow event associated with breakup on 9 June and a small flood event on 1 July. The average discharge for the period and suspended sediment load are also presented in Table 3. Daily average total suspended solid transport rates (ton/day) were calculated and are found in Appendix B.

Table 3. Results of automated sampling for the period 3 June to 11 Sept.
**Number of samples refers to the number of samples collected at each site.*

Site	Turbidity (NTU) mean	Turbidity (NTU) median	Average Discharge (cfs)	Total Load (tons)	Number of Samples
Eagle Cr. (1993)	34	8.4	12.72	340	98
Eagle Creek * (1992)	54	3.1	10.8	578	51
Ptarmigan Cr. (1993)	0.62	0.49	19.44	6.61	83
Ptarmigan Cr. * (1993)	0.80	0.60	8.19	0.08	27
Birch Cr. below Reclamation (1993)	9.3	4.6	28.5	274	87

* *From Ray 1993*

Bedload:

Bedload transport by Ptarmigan Creek, Eagle Creek and Birch Creek was measured across the flow measurement transect. The bedload sampler was lowered to the channel bed at regular intervals. Each bedload sample is a composite of the individual measurements across the channel section. Bedload sample particle size analyses and transport rate calculations are found in Appendix C. The calculated rates of bedload transport at each gauging site are presented in Table 4.

Table 4. Bedload Transport Rates for the Birch Creek Site (Summer 1993). (*) values indicate no measurement.

Date	Ptarmigan Creek (ton/day)	Eagle Creek (ton/day)	Birch Creek (ton/day)
22 June	0.09	0.66	0.12
30 June	0.02	0.81	0.09
9 July	*	0.49	0.20
22 July	*	0.06	0.43
12 Aug	*	0.08	0.03
23 Aug	*	0.65	0.03
2 Sept	0.08	3.04	1.91
11 Sept	*	1.82	0.46
19 Sept	*	0.57	0.39

Measurements demonstrate bedload transport in Eagle Creek is significantly greater than bedload transport in Ptarmigan Creek. The bedload transport rates entering the Birch Creek Site appear to be greater than the bedload transport rates exiting the site (Birch Creek). The lack of bedload data at high flows is explained by the absence of significant flood events during the 1993 field season.

Results (During Reclamation)

The decision to realign Eagle Creek was based upon the results of prc-reclamation inventories. The new Eagle Creek channel was designed by Division of Water, ADEC, and Department of Fish and

Game personnel . Discharge measurements at the gauging sites on Eagle Creek and Birch Creek were made prior to the routing of flow into the constructed Eagle Creek Channel.

Turbidity

Results of sediment sampling (10 minute intervals) at a site in the constructed Eagle Creek channel and at Birch Creek are shown in Figures 11 and Figure 12, respectively. Raw turbidity values for both sites can be found in Appendix C.

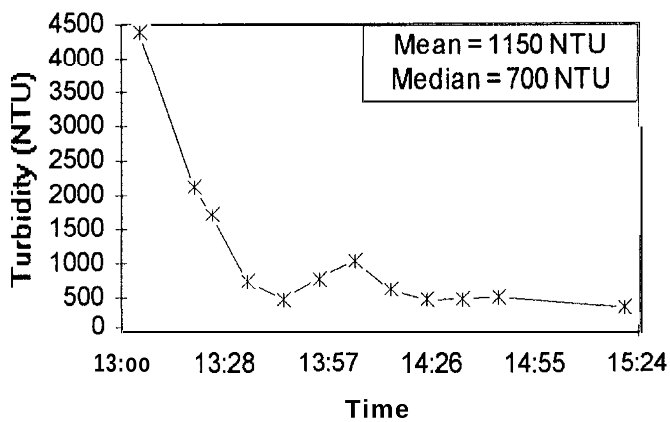


Figure 11. Turbidity at New Eagle Creek Channel Site during Eagle Creek channel realignment. (9 October 1993)

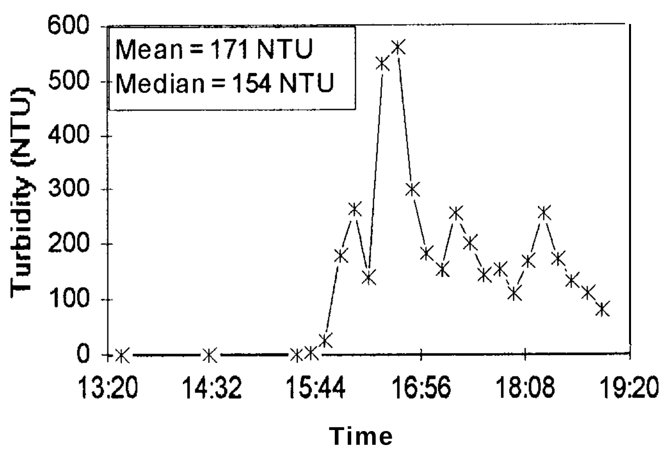


Figure 12. Turbidity at Birch Creek Gauging Site during Eagle Creek channel realignment. (9 October 1993)

Total Suspended Solids:

Sediment loading was calculated for the monitoring period following flow diversion into the constructed Eagle Creek channel from total suspended solids values found in Appendix D. Sediment introduction during the monitoring period at the Birch Creek gauging site was 2.2 tons. Sediment loading during the 2 hour period in the constructed Eagle Creek channel was 2.5 tons. The difference, 0.3 tons, may reflect sampling, analytical error, or deposition between sampling sites.

Results (after Reclamation)

The six cross sections were resurveyed and are presented in Appendix A (Figures A.l-A. 11). Water surface profiles for the site after reclamation were surveyed. The channel length of Eagle Creek was increased by approximately 1000 feet. The gradient of Eagle Creek was reduced from 0.018 ft/ft to 0.017 ft/ft. The gradient change at the confluence of Eagle Creek and Ptarmigan Creek was reduced to 0.001 ft/ft by moving the confluence downstream 2000 feet. The water surface profiles after reclamation are shown in Figure 13. No further monitoring was performed as unexpected delays resulted in the completion of reclamation in early October rather than late August.

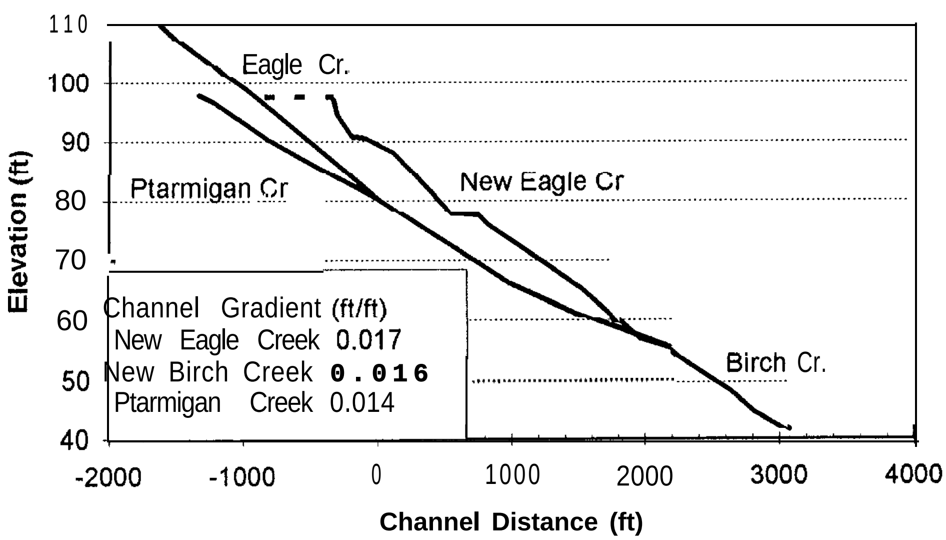


Figure 13. Water surface profile ajier reclamation of the Birch Creek site.

Discussion.

Aerial Photographs

Aerial photographs of the upper Birch Creek basin show the impacts man's activity can have on riparian systems through time. The Ptarmigan Creek bridge, built in 1972 during reconstruction of the Steese Highway, has apparently stopped lateral channel migration of Ptarmigan Creek. The elevated Steese Highway subgrade reduces the area1 extent of the Birch Creek flood plain near milepost 10 1. Hence flood flows are concentrated in the existing channel-flood plain system.

The impact of placer mining operations is also apparent in aerial photographs, It appears that placer mining operations were confined to the flood plain of Eagle Creek and the southern margin of the Birch Creek flood plain. Placer mining operation at the Birch Creek site ceased in 1986. The site characteristics of the abandoned mines near milepost 101 are typical of mining claims abandoned prior to the cnactment of State reclamation performance standards in 1989 (11 A.A.C. 97). Defined stream channels and flood plains are not evident. The piles of excess material in the valley bottom further reduces the area1 cxtant of the flood plain and arc susceptible to mass wasting during periods of high flow. The development of an alluvial fan at the confluence of Eagle Creck and Ptarmigan Creek is clearly shown by comparing Figure 5 to Figure 6. Alluvial fan formation has caused lateral migration of Ptarmigan Creek and Eagle Creek, It is expected without reclamation, the fan would cause inherent channel instability at the confluence of the two creeks, reducing the likelihood of permanent channel establishment.

Site Cross sections (prior to reclamation)

The six cross sections indicate that Eagle Creek and Ptarmigan Creek are eroding the piled overburden. Cross section #2 (Figure A.2) shows steep cut banks resulting from the lateral migration of Eagle Creek. Cross section #3 (Figure A.3) demonstrates the confining influence of spoil piles on Eagle Creek flood plain development. It is not known whether the bank erosion shown in the cross sections exceed the natural rate of bank erosion for either Ptarmigan Creek or Eagle Creek. However, the lateral migration of Eagle Creek into the spoil piles indicates that Eagle Creek is not located in a stable location. Mass wasting of the spoil piles likely results in higher sediment transport rates for Eagle Creek than natural rates.

Channel Gradients (prior to reclamation)

Surveyed channel gradients at the Birch Creek site indicate the presence of 0.06 ft/ft loss in gradient between Eagle Creek and Ptarmigan Creek. Sediment deposition and alluvial fan formation (Figure 5 and Figure 6) indicate a reduction of stream energy at the confluence of Eagle Creek and Ptarmigan Creek.

Discharge

Daily average discharge for Ptarmigan Creek varied between 115 cfs (27 May) and 6.0 cfs (5 August). The Ptarmigan Creek hydrograph (Figure 8) indicates the absence of runoff generating storms in the Ptarmigan Creek basin from 3 July until 2 September.

Daily average discharge for Eagle Creek varied between 73 cfs (27 May) and 0.44 cfs (9 August). As with Ptarmigan Creek, the Eagle Creek stream flow hydrograph indicates the absence of runoff generating storms between 3 July and 2 September. Impacts of active placer mining operations on Eagle Creek can be seen in the stream flow hydrograph for Eagle Creek (Figure 9). Contrasted to the smooth recession curve evident in the stream flow hydrograph for Ptarmigan Creek, the recession curve for Eagle Creek is irregular. Water demand for active placer operations coupled with low precipitation, necessitated surface water withdrawal into recycle ponds. The withdrawals, commonly lasting less than two hours, account for the irregularities in the Eagle Creek hydrograph.

Daily average discharge for Birch Creek below the reclamation site varied from 116 cfs (10 June) and 8.6 cfs (3 August), Assuming no losses between gauging sites, discharge at the Birch Creek gauge should be equal to the combined discharge at the Eagle Creek and Ptarmigan Creek gages. Figure 14 shows the discharge at the Birch Creek gage plotted as a function of the combined discharge of Eagle Creek and Ptarmigan Creek gages.

The discharge relationship between the discharge entering the site (Ptarmigan Creek and Eagle Creek) and the discharge leaving the site (Birch Creek) should theoretically be 1 to 1, assuming no losses. A regression line between the combined discharge of Ptarmigan Creek and Eagle Creek and the discharge at the Birch Creek gauge was calculated. For the above assumption to be true, namely no losses, the confidence interval of the regression line must include the theoretical line. The regression results and data are plotted in Figure 14. Since the confidence intervals do not include the theoretical line, the slope of the regression line shown in Figure 14 is statistically different than 1 (95% confidence). The magnitude of the losses indicated in Figure 14 indicates a surface water- ground water connection.

Calculated discharge values are based upon discharge measurements, which may be in error as much as 15%. To determine whether the relationship shown is real or an artifact of measurement error, the precision and accuracy of flow measurements will be tested during the 1994 field season.

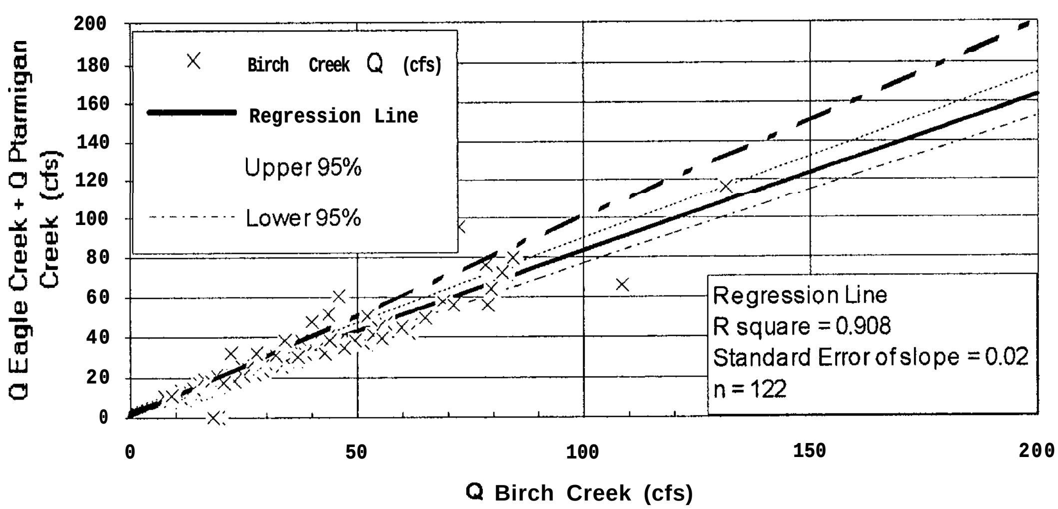


Figure 14. Discharge of Birch Creek as a function of the combined discharge of Ptarmigan Creek and Eagle Creek.
**Bold dashed line represents theoretical (Qin =Qout)*

If the connection is found to be real, it would be a reversal of the conclusions drawn by other researchers working in the upper Birch Creek basin (Cooper and Van Heveren, 1992), and would allow hydrologic recovery rates to be estimated from flow data collected at the 12 Mile Creek gage and hydrologic data collected in 1983-1984 (Berjerklie and LaPerrier, 1984).

Turbidity and Total Suspended Solids (prior to reclamation)

Seasonal turbidity for Ptarmigan Creek ranged from a peak of 2.2 NTU (26 May) to a low of 0.25 NTU (8 September). Mean turbidity of Ptarmigan Creek was 0.62 NTU and median turbidity was 0.49 NTU. The suspended load of Ptarmigan Creek does not appear to vary significantly with discharge (Figure 15).

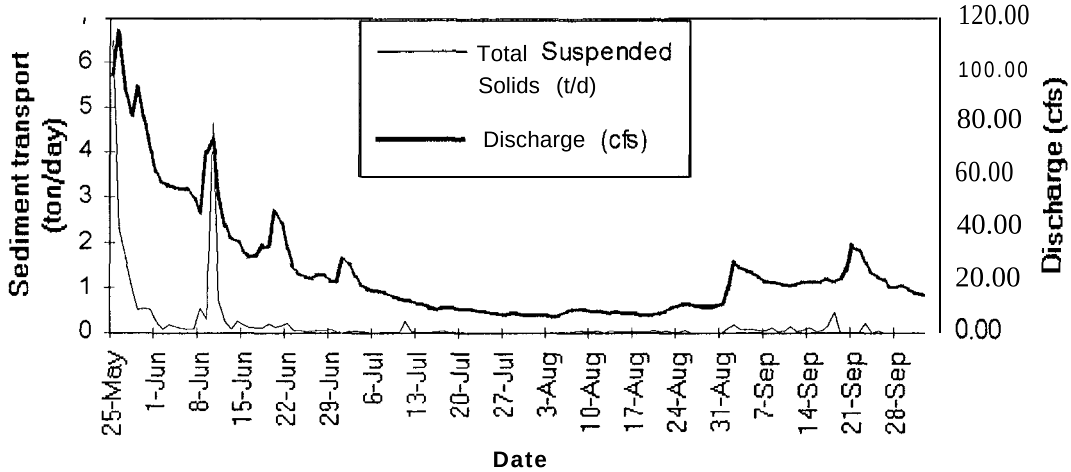


Figure 1.5. Ptarmigan Creek Discharge and Sediment Transport.

Seasonal turbidity for Eagle Creek ranged from 400 NTU (2 September) to 0.85 NTU (29 July). Mean turbidity of Eagle Creek was 33 NTU. Although higher than the 5 NTU standard, mean turbidity of Eagle Creek has declined from a 1992 value of 54 NTU (Ray 1993). Median turbidity, however, increased from 3.1 NTU in 1992 (Ray 1993) to 8.4 NTU. The rise in median values is probably due to the longer period of recording, which was 98 days in 1993 compared to 51 days in 1992. Included in the 98 days are turbidity values associated with spring breakup, not included in the 1992 data.

Suspended sediment transport in Eagle Creek is far more sensitive to changes in discharge. Figure 16 shows both Eagle Creek discharge and suspended sediment transport during the 1993 field season. The relationship between discharge and sediment loading is almost directly proportional. This is consistent with results reported by others (Peterson et al., 1985). Eagle Creek has been mined from its confluence with Ptarmigan Creek to its ephemeral reaches on Mastodon Fork. The increased sensitivity observed is likely due to the presence of unbedded material in the flood plain of Eagle Creek.

Seasonal turbidity values for Birch Creek varied from a peak of 90 NTU (27 August) to 0.90 NTU (5 July). Mean turbidity of Birch Creek at the Birch Creek below Reclamation gauge was 9.3 NTU, slightly above the 5 NTU standard. Median turbidity was 4.6 NTU and below the 5 NTU standard . This is the first year of data collection at the Birch Creek below Reclamation gage.

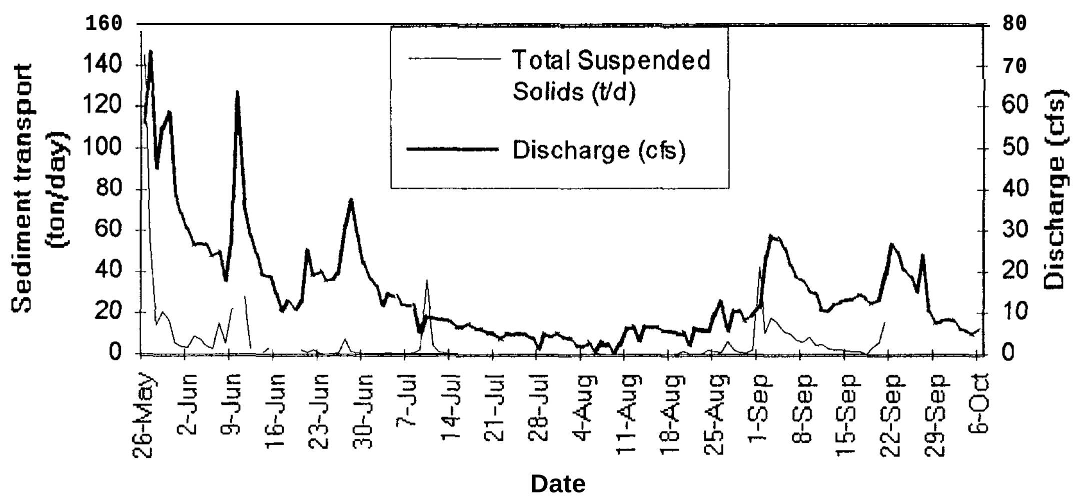


Figure 16. Eagle Creek Discharge and Sediment Transport.

Suspended sediment transport at the Birch Creek below Reclamation gage displayed sensitivity to discharge comparable to that of Eagle Creek. Suspended sediment transport by Birch Creek showed that for average flow conditions the sediment loads of Eagle Creek and Ptarmigan Creek were transported through the Birch Creek Site. At high flows, suspended sediment loads at the Birch Creek gage were higher than those of Eagle Creek and Ptarmigan Creek combined. Figure 17 shows the relationship between sediment transport and discharge for the Birch Creek gage.

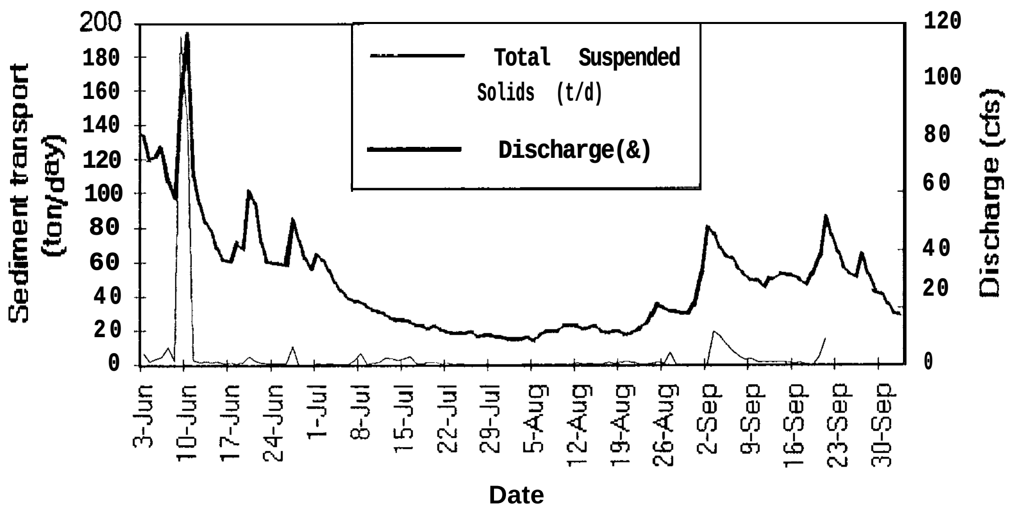


Figure 17. Birch Creek Discharge and Sediment Transport.

<u>Bedload</u>

The results of bedload sampling indicate that Eagle Creek has a significantly higher bedload transport rate than Ptarmigan Creek. Although pre-disturbance bcdload transport rates for Eagle Creek are unknown, particle size analysis indicates that a much higher percentage of large material is transported by Eagle Creek than Ptarmigan Creek. Low bedload transport rates are indicative of a relatively stable channel armor layer. Conversely, the high bedload transport rates of Eagle Creek and Birch Creek indicate the armor layer of these streams is not stable the range of discharges over which bedload was sampled (Klingman and Emmett, 1982).

The seasonal particle size distribution of Ptarmigan Creek bedload samples (Figure B. 1) indicates most (D_{60}) of the transported material is less than 5 mm in diameter. The seasonal particle size distribution for Eagle Creek bedload samples (Figure B.2) indicates most of the material transported is between 2.0 mm and 12 mm in diameter. The majority of the material transported past the Birch Creek gauge is between 1.0 mm and 10.5 mm in diameter (Figure B.3) The absence of the 12 mm size class from bedload samples at the Birch Creek gauge indicates that deposition of the largest bedload material occurs between the Eagle Creek and Ptarmigan Creek gauges. Stream power increases during high flows. So, the absence of bedload measurements at high flows probably decreases the D_{60} values for the three streams.

Most bedload models are based on stream power and particle fall velocity. Stream power is a function of discharge, channel slope and the specific weight of the fluid. The fall velocity is a function of particle density, fluid density, and fluid viscosity. Unfortunately, fluid viscosity is a function of fluid temperature, which was not measured during the 1993 field season. During the 1994 field season water temperature will be recorded at each gauge site and the bedload transport during the high flows associated with breakup will be measured.

Turbiditv and Total Suspended Solids (during reclamation)

The peak turbidity in the new Eagle Creek channel was 4500 NTU. Turbidity decreased linearly to 500 NTU 45 minutes after the initiation of flow at the gauge in the new Eagle Creek channel. The rise to 1000 NTU after 65 minutes probably indicates the arrival of the full Eagle Creek discharge at the sampling station. Turbidity appears to gradually decrease, presumably to near baseline levels (see Figure 11).

The initial turbidity peak (275 NTU) at the Birch Creek gauge is due to construction of the new Eagle Creek channel. Although gravel was not moved near Eagle Creek and heavy equipment did not travel through Eagle Creek, sediment was introduced into Eagle Creek by reclamation activity. It was observed that as the heavy equipment traveled near Eagle Creek, sediment laden water would seep from the banks into Eagle Creek. The second peak of 550 NTU is the arrival of the 4500 NTU Eagle Creek peak. The two subsequent peaks at 250 NTU are poorly understood. (see Figure 12)

Suspended Sediment introduced into Birch Creek during the monitoring period following channel realignment was 2.2 tons. The loss of 0.3 tons between gauging sites likely represents procedural error or deposition of material between sampling locations.

Channel Gradient (after reclamation)

The overall length of Eagle Creek was reduced by 500 feet above the existing Ptarmigan Creek and Eagle Creek confluence during channel realignment. Channel gradient differences were minimized by locating the confluence of Eagle Creek 2000 ft downstream of its original location. The flattened area of the water surface profile shown (Figure 13) is a pond that formed over a depression. Eliminating the rapid gradient change at the confluence of Ptarmigan Creek and Eagle Creek should allow both discharge and sediment to be transported through the Birch Creek site without deposition or scour. Gradient adjustment will allow bedload to be transported through the site. Although increased bedload transport downstream of the Birch Creek site will not impair water quality, the effects of changing bedload dynamics on the benthic community are not known. The channel will be continuously monitored for changes in gradient, bank erosion and bar formation.

Summary. (1993 field work)

During the summer of 1993, baseline environmental studies were conducted at the Birch Creek site. Current site processes and characteristics were investigated. In addition to providing a reference for future change, investigations conducted at the Birch Creek site during 1993 indicate that there are significant hydrologic differences between Eagle Creek and Ptarmigan Creek. Pertinent results are presented for each project objective.

Goal: Assessment of the impact of the post-mining landscape on downstream water quality.

1. Sediment introduction during channel realignment.

Sediment introduction during channel realignment was minimal. Despite extraordinarily high turbidity values at the Eagle Creek sampling site (4500 NTU), actual sediment introduction was only 2.5 tons. Turbidity values dropped rapidly with the addition of flow from Ptarmigan Creek (600 NTU). Total sediment introduced downstream was 2.2 tons.

2. Sediment contributions due to slope erosion.

1993 field work indicates that most erosion of slopes is by fluvial action. Bank erosion is shown in survey data. Increased downstream sediment transport is taken as an indication of fluvial erosion during high flow events.

Slope erosion measurements will begin during the 1994 field season. Erosion test plots will be established for surface run-off. Wind erosion will also be measured. Soil infiltration capacity, moisture retention and temperature will be measured in the plant rooting zone (<1m).

3. Sediment dynamics of the Reclaimed flood plain.

Investigations will begin in 1994. However, data collected during the 1993 field season indicate the Eagle Creek flood plain and the Birch Creek flood plain contribute larger amounts of suspended sediment in response to changes in discharge, than does the Ptarmigan Creek flood plain. This is principally due to the instability of channels over time, which prevents the formation of stable channel beds and flood plain vegetation. By stabilizing and realigning Eagle Creek during the 1993 field season, a decrease in the sensitivity of suspended sediment to discharge should occur.

Goal: Identification of parameters affecting the volunteer recruitment of vegetation

Studies of the hydrologic and thermal regimes of recontoured spoil piles and overburden will enable management practices to be evaluated and, if necessary, developed. Thermal and hydrologic monitoring will begin during the 1994 field season, The field investigations and results pertaining to this goal are summarized in a separate report.

Goal: Identification of parameters affecting the stability of reclaimed stream reaches.

1. Channel and flood plain geomorphology.

Field investigations during the 1993 season indicate that the presence of piled material in the flood plain of Birch Creek and Eagle Creek exerts a confining influence on flood plain development. Lateral migration of Eagle Creek and Ptarmigan Creek has been caused by sediment deposition at the confluence of Ptarmigan Creek and Eagle Creek. Lateral migration of both Ptarmigan Creek and Eagle Creek undercut the piled material, causing mass wasting of the undercut slope.

2. Discharge

Discharge through the Birch Creek Site shows some indication of groundwater interaction. The precision and accuracy of flow measurements will be tested during the 1994 field season to insure the connection is real and not a measurement artifact.

3. Sediment transport.

Suspended sediment measurements indicate little deposition occurs on the Birch Creek Site. The Birch Creek Site in its unreclaimed state actually contributed sediment to Birch Creek. Data collection will continue during the 1994 field season.

4. Bedload

Bedload transport in Eagle Creek is significantly higher than that of Ptarmigan Creek. Hence, alluvial fan formation at the confluence of Eagle Creek and Ptarmigan Creek can be attributed to sediment transported by Eagle Creek. The large gradient difference between Eagle Creek and Ptarmigan Creek results in decreased available stream energy for sediment transport. Resulting deposition of bedload at the confluence forces both Eagle Creek and Ptarmigan Creek to migrate laterally away form each other. Using aerial photographs and survey data, channel stability would be best attained by separating Eagle Creek from Ptarmigan Creek. By minimizing gradient changes at the confluence of Eagle Creek and Ptarmigan Creek, both total sediment load and discharge should be transported through the site.

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Appendix A

Site Cross Sections Prior to Reclamation of the Birch Creek Site

All elevations are relative to Bench mark # 1 (elevation =100 ft). Vertical scale is exaggerated to show relief.

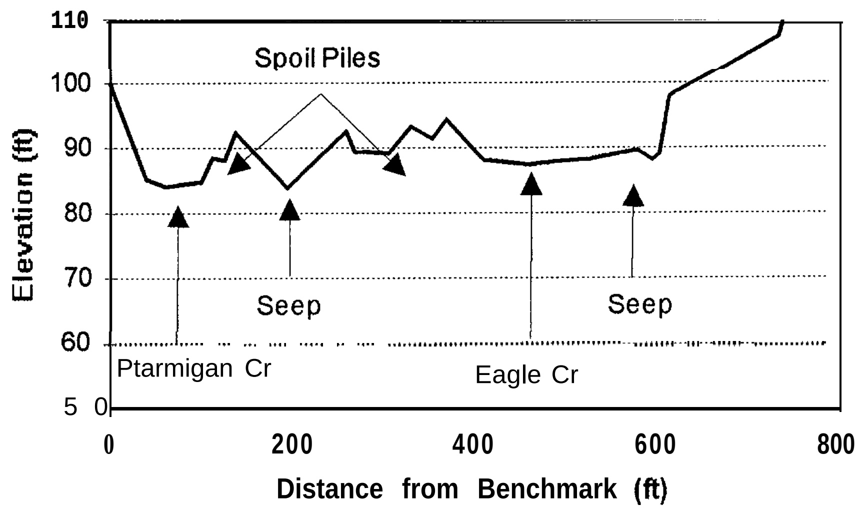

Figure A. 1 Cross section #1 (22 June 1993)

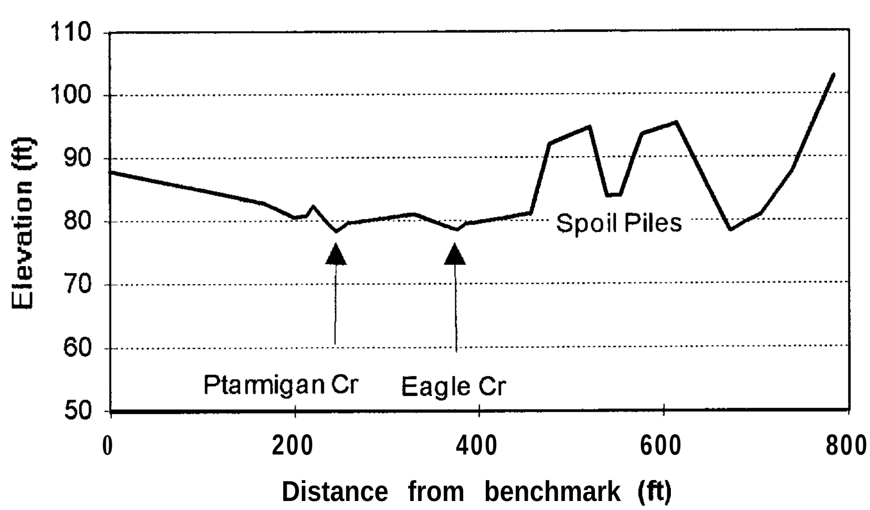

Figure A.2 Cross section #2 (22 June 1993)

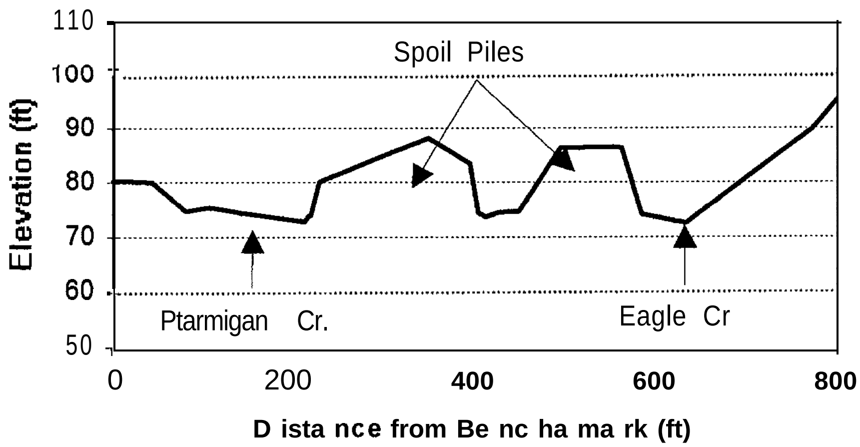

Figure A.3 Cross section #3 (22 June 1993)

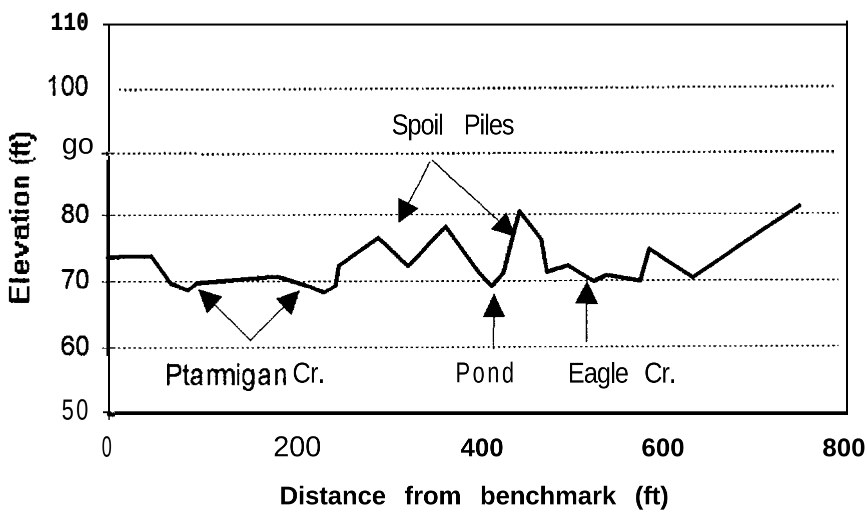

Figure A.4 Cross section #4 (22 June 1993)

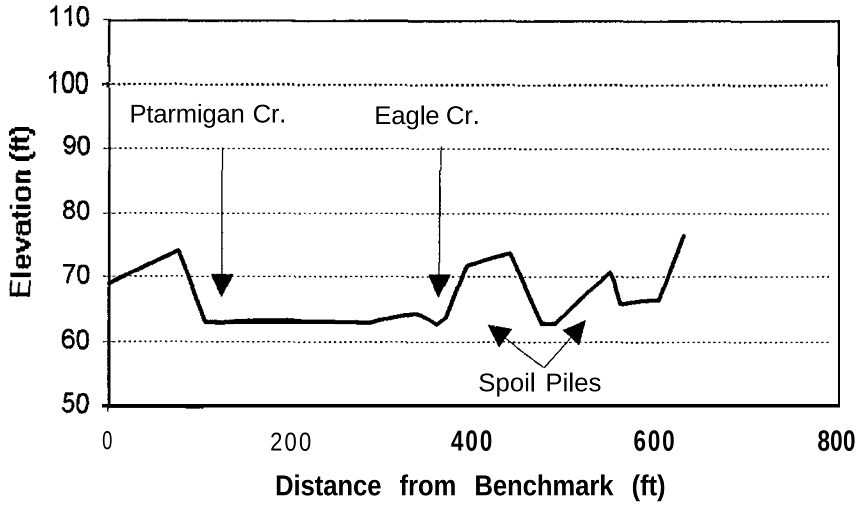

Figure A.5 Cross section #5 (22 June 1993)

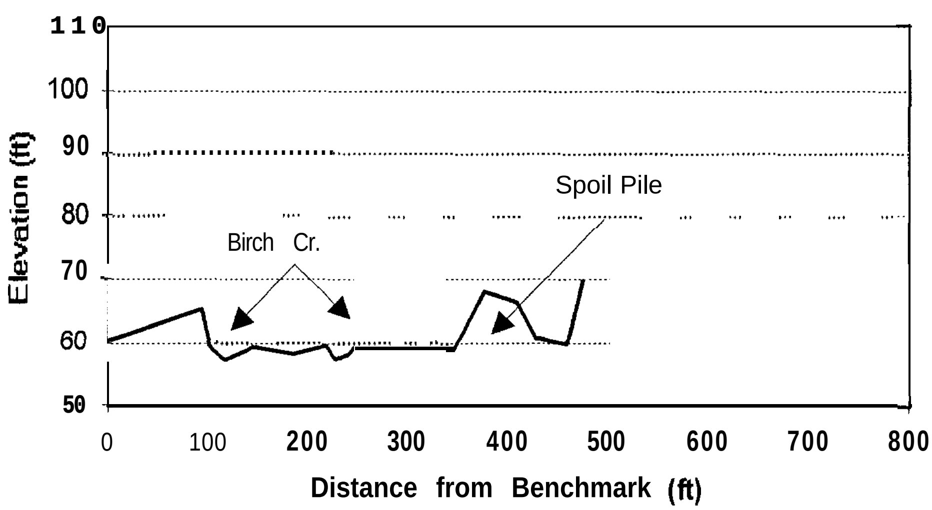

Figure A.6 Cross section #6 (22 June 1993)

Site Cross Sections after Reclamation

All elevations are relative to Bench mark # 1 (elevation =100 ft). Vertical scale is exaggerated to show relief.

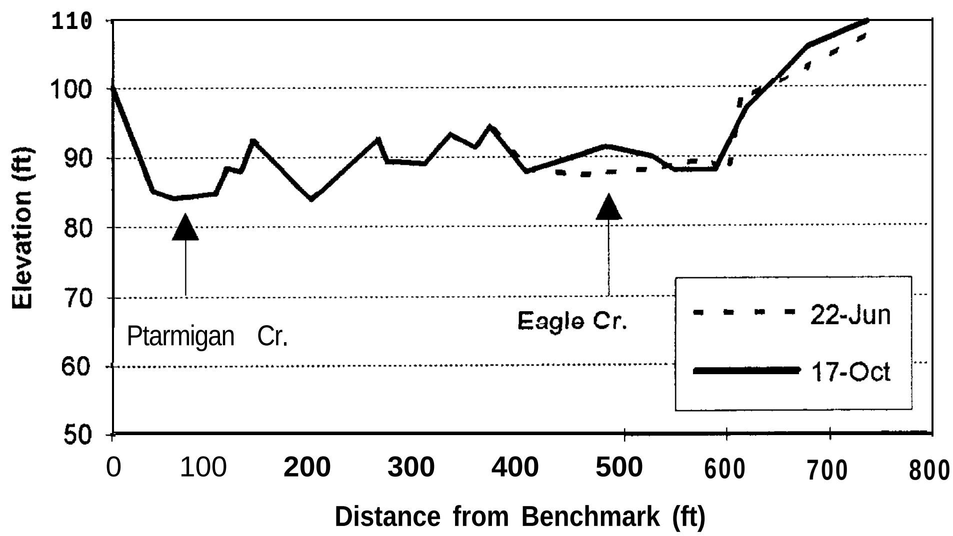

Figure A. 7 Cross section # 7 (17 October 1993)

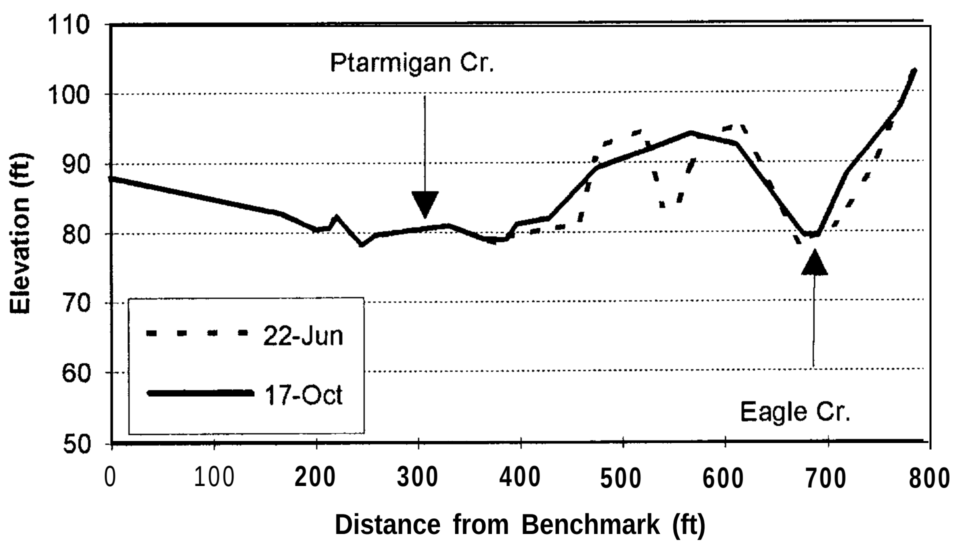

Figure A.8 Cross section #2 (17 October 1993)

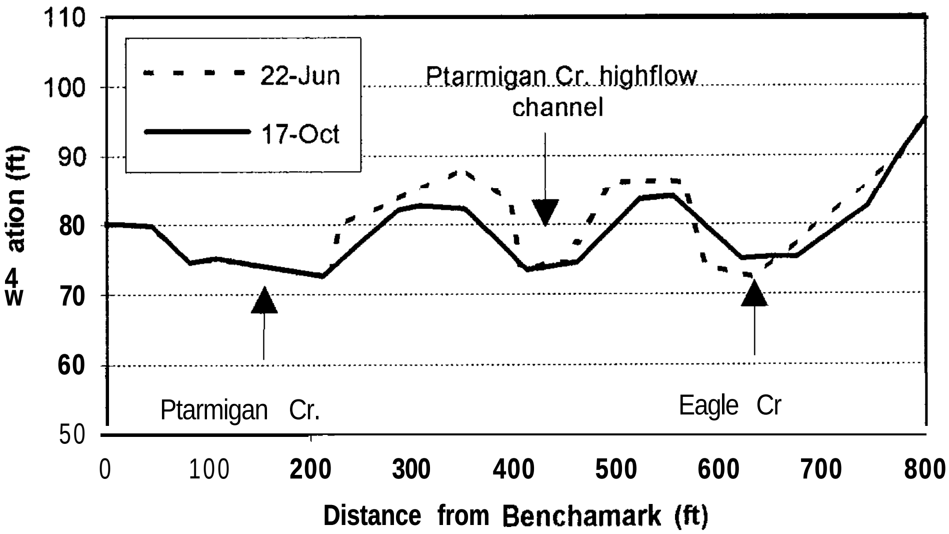

Figure A.8 Cross section #3 (I 7 October 1993)

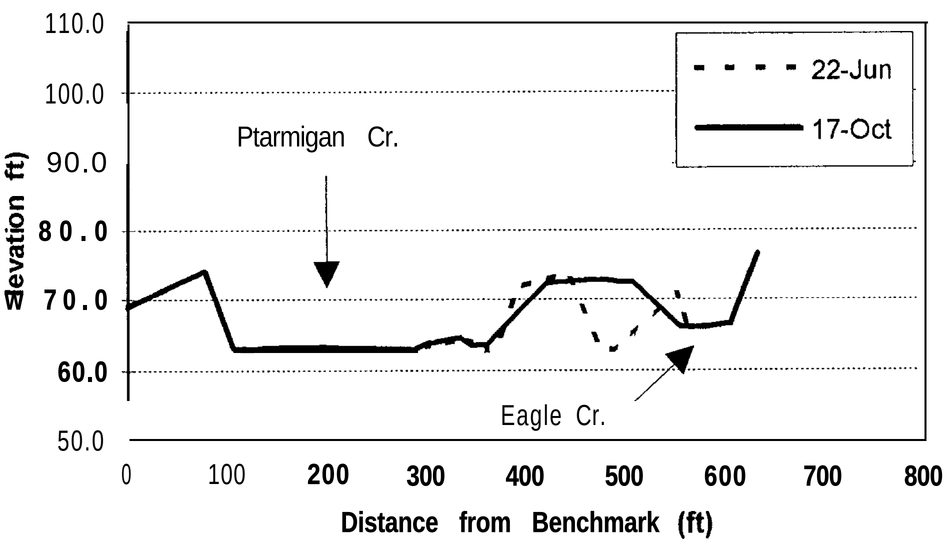

Figure A. 9 Cross section #5 (17 October I993)

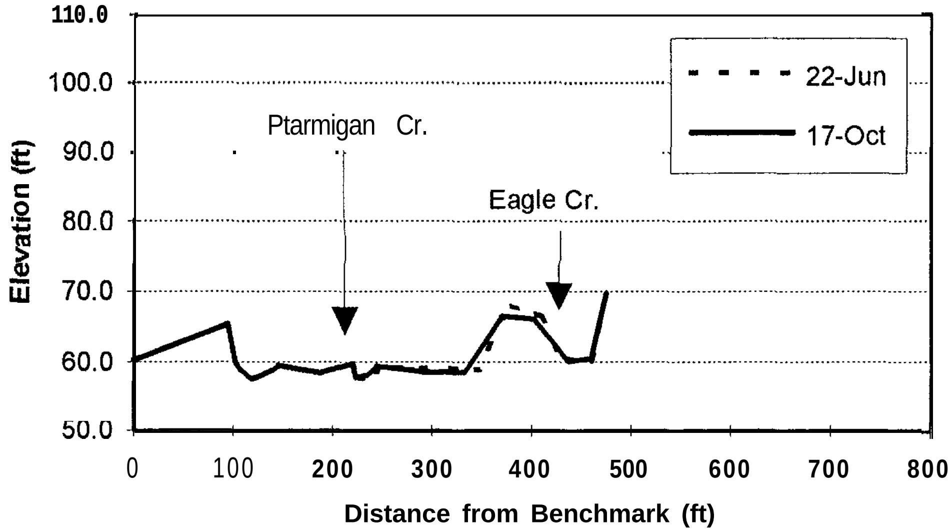

Figure A. 10 Cross section #6 (17)October 1993)

Appendix B.

Ptarmigan Creek Bedload 1993.

PTARMIGAN CREEK BEDLOAD (SUMMER 1993)							
	DATE 22-Jun-93	30-Jun-93	2-Sep-93				
MESH	MASS (grams)			retained (g)	accumulated (g)	Percent retained	Percent Passing
25500	0	0	0	0	0	0.00	100.00
18850	0	0	0	0	0	0.00	100.00
12250	0	0	0	0	0	0.00	100.00
6700	0	3.2	4.2	7.4	7.4	33.64	66.36
2000	3.1	1.8	2.1	7	14.4	65.45	34.55
1180	0.6	0.5	1.6	2.7	17.1	77.73	22.27
850	0.4	0.4	1	1.8	18.9	85.91	14.09
600	0.2	0.2	0.8	1.2	20.1	91.36	8.64
425	0.1	0.2	0.8	1.1	21.2	96.36	3.64
300	0	0	0.4	0.4	21.6	98.18	1.82
150	0.1	0	0.2	0.3	21.9	99.55	0.45
pan	0	0	0.1	0.1	22	100.00	0.00
Initial mass (g)	4.5	6.3	11.4	22.2		Standard Error (%)	0.90
final mass (g)	4.5	6.3	11.2	22			
Transport (g/min)	9	12.6	22.8				
Discharge (cfs)							

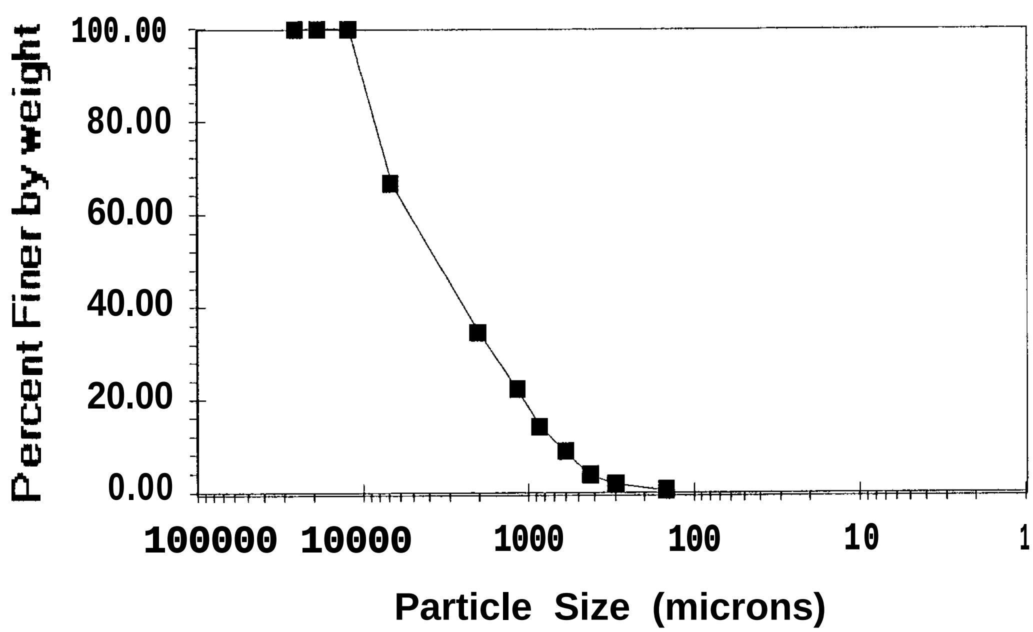

Figure B. 1 Cumulative Particle Size Distribution of Ptarmigan Creek Bedload. (1993)

Eagle Creek Bedload 1993

EAGLE CREEK BEDLOAD (SUMMER 1993)														
	DATE	22-Jun-93	30-Jun-93	9-Jun-93	22-Jul-93	12-Aug-93	23-Aug-93	2-Sep-93	12-Sep-93	19-Sep-93				
MESH		MASS (grams)									retained (g)	accumulated (g)	Percent retained	Percent Passing
25500		0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
18850		17.7	16.6	0	0	0	0	29.3	0	0	63.6	63.6	4.86	95.14
12250		0	15.2	4.5	0	0	0	32.4	20.1	14.4	86.6	150.2	11.47	88.53
6700		7.4	13.3	4.3	0	1.8	8.3	40.5	14.3	11.9	101.8	252	19.25	80.75
2000		29.8	33.7	20.6	3	4.2	29.8	104.3	96.9	24.5	346.8	598.8	45.74	54.26
1180		17.4	17	16.4	3.1	2.5	28.1	61.9	52.7	13.6	212.7	811.5	61.99	38.01
850		11.1	10.2	10	1.5	1.7	16.1	51.2	35.1	8.5	145.4	956.9	73.10	26.90
600		9	9.8	9.9	1	1.3	11.3	51.8	28.8	8	130.9	1087.8	83.10	16.90
425		6.9	7.1	6.8	0.5	0.8	6.2	50.4	22.6	5.2	106.5	1194.3	91.24	8.76
300		3.7	3.4	2.9	0.1	0.4	2.1	36.2	11.6	2.2	62.6	1256.9	96.02	3.98
150		1	1.1	0.9	0.1	0.2	0.6	19.1	26.7	0.7	50.4	1307.3	99.87	0.13
pan		0.1	0	0	0	0.2	0.1	1.2	0.1	0	1.7	1309	100.00	0.00
Initial mass (g)		104.3	127.7	76.9	9.5	13.1	103.2	479.3	286.6	89.3	1289.9		Standard Error (%)	1.46
final mass (g)		104.1	127.4	76.3	9.3	13.1	102.6	478.3	308.9	89	1309			
Transport (g/min)		417.2	510.8	307.6	38	52.4	412.8	1917.2	1146.4	357.2				
Discharge (cfs)														

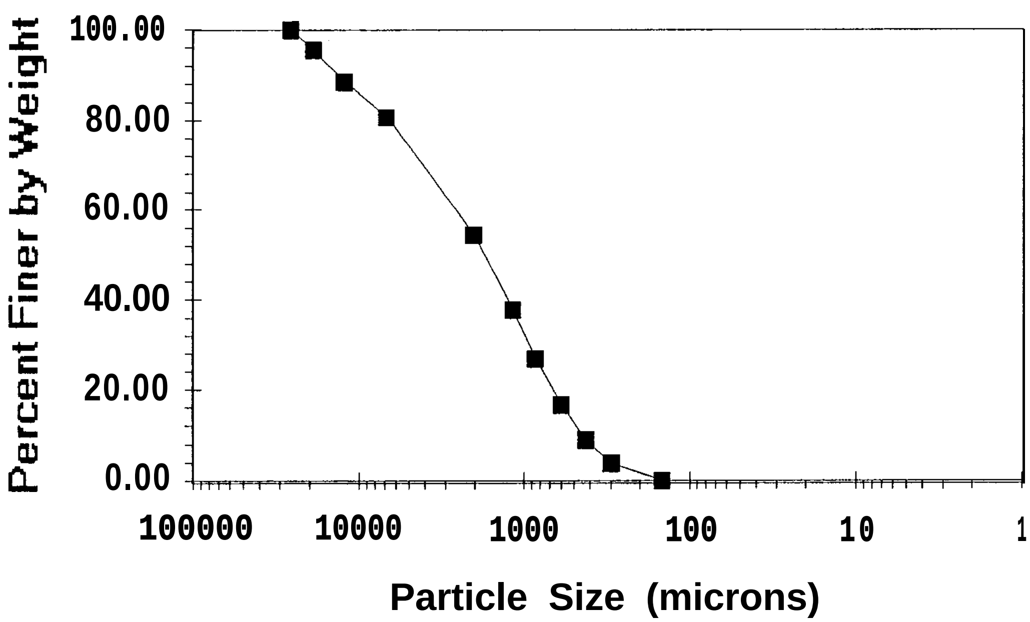

Figure B. 2 Cumulative Particle Size Distribution of Eagle Creek Bedload. (1993)

Birch Creek below Reclamation Bedload 1993.

BIRCH CREEK BELOW RECLAMATION BEDLOAD (SUMMER 1993)													
DATE	22-Jun-93	30-Jun-93	9-Jun-93	22-Jul-93	12-Aug-93	23-Aug-93	2-Sep-93	12-Sep-93	19-Sep-93				
MESH	MASS (grams)									retained (g)	accumulated (g)	Percent retained	Percent Passing
25500	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
18850	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
12250	0	0	0	0	0	0	15.6	0	0	15.6	15.6	2.21	97.79
6700	1.8	2.6	1.6	10.1	0	0	33.1	1.1	7.1	57.4	73	10.33	89.67
2000	11.1	7.7	20.6	26.3	1.3	0.1	81	13.9	46.9	208.9	281.9	39.91	60.09
1180	6.7	5.1	16.8	9.5	1.8	0.6	40.1	14.3	30.2	125.1	407	57.62	42.38
850	4.8	3.2	9.4	5.7	1.3	0.9	29.9	10.7	12.3	78.2	485.2	68.69	31.31
600	4.7	3.7	7.6	6.1	1.2	1.2	30.8	12	11.3	78.6	563.8	79.81	20.19
425	4.2	3.2	4.6	5.4	1	1.8	32.4	10.6	7.8	71	634.8	89.86	10.14
300	2.7	2.2	2.1	3	1	1.9	24.3	7	4.1	48.3	683.1	96.70	3.30
150	0.8	0.8	0.7	1.1	0.5	0.9	12.5	3	1.5	21.8	704.9	99.79	0.21
pan	0	0	0	0	0.4	0.1	0.9	0.1	0	1.5	706.4	100.00	0.00
Initial mass (g)	37.1	28.7	63.5	67.4	8.4	7.9	300.5	72.5	121.7	707.7		Standard Error (%)	-0.18
final mass (g)	36.8	28.5	63.4	67.2	8.5	7.5	300.6	72.7	121.2	706.4			
Transport (g/min)	74.2	57.4	127	269.6	16.8	15.8	1202	290	243.4				
Discharge (cfs)													

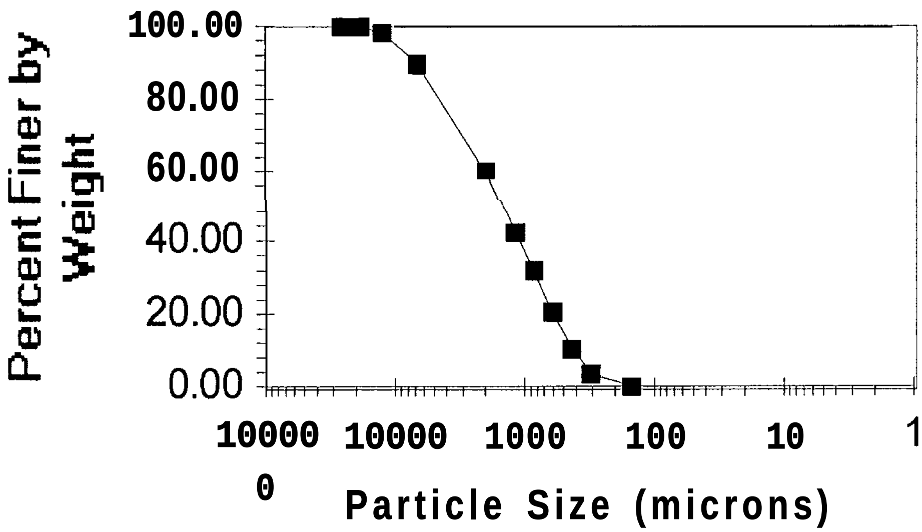

Figure B.3 Cumulative Particle Size Distribution of Birch Creek Bedload. (1993)

Appendix C.

Raw Sediment Data resulting from Eagle Creek Realignment (9 October 1993).

Site	Date	Time	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Eagle Diversion	9-Oct-93	1305	4400	6910	5.2	97
Eagle Diversion	9-Oct-93	1320	2150	3321	5.2	47
Eagle Diversion	9-Oct-93	1325	1700	2796	5.2	39
Eagle Diversion	9-Oct-93	1335	750	1371	5.2	19
Eagle Diversion	9-Oct-93	1345	500	893	5.2	13
Eagle Diversion	9-Oct-93	1355	800	1776	5.2	25
Eagle Diversion	9-Oct-93	1405	1050	2275	5.2	32
Eagle Diversion	9-Oct-93	1415	600	1325	5.2	19
Eagle Diversion	9-Oct-93	1425	450	1142	5.2	16
Eagle Diversion	9-Oct-93	1435	450	1221	5.2	17
Eagle Diversion	9-Oct-93	1445	500	1272	5.2	18
Eagle Diversion	9-Oct-93	1520	350	924	5.2	13
Birch @ Reclamation	9-Oct-93	1330	1.4	5.1	16	0.22
Birch @ Reclamation	9-Oct-93	1340	2.2	5.2	16	0.23
Birch @ Reclamation	9-Oct-93	1350	2.3	0.70	16	0.03
Birch @ Reclamation	9-Oct-93	1360	2.6	7.0	16	0.30
Birch @ Reclamation	9-Oct-93	1370	27	62	16	3
Birch @ Reclamation	9-Oct-93	1380	180	351	16	15
Birch @ Reclamation	9-Oct-93	1390	260	421	16	18
Birch @ Reclamation	9-Oct-93	1400	140	201	16	9
Birch @ Reclamation	9-Oct-93	1410	550	1011	16	44
Birch @ Reclamation	9-Oct-93	1420	550	898	16	39
Birch @ Reclamation	9-Oct-93	1430	300	476	16	21
Birch @ Reclamation	9-Oct-93	1440	280	269	16	12
Birch @ Reclamation	9-Oct-93	1450	150	276	16	12
Birch @ Reclamation	9-Oct-93	1460	250	450	16	19
Birch @ Reclamation	9-Oct-93	1470	200	399	16	17
Birch @ Reclamation	9-Oct-93	1480	140	294	16	13
Birch @ Reclamation	9-Oct-93	1490	150	273	16	12
Birch @ Reclamation	9-Oct-93	1500	110	250	16	11
Birch @ Reclamation	9-Oct-93	1510	170	356	16	15
Birch @ Reclamation	9-Oct-93	1520	250	511	16	22
Birch @ Reclamation	9-Oct-93	1530	170	343	16	15
Birch @ Reclamation	9-Oct-93	1540	130	260	16	11
Birch @ Reclamation	9-Oct-93	1550	110	197	16	8.5
Birch @ Reclamation	9-Oct-93	1560	80	204	16	8.8

Arsenic Data Collected at the Birch Creek Site (1993).

Site	Date	Time	Dissolved (mg/l)	Total (mg/l)
Birch Creek below Reclamation	24-Sep-93	*	<0.001	0.002
Birch Creek below Reclamation	9-Oct-93	13:29	<0.001	0.002
Birch Creek below Reclamation	9-Oct-93	14:35	<0.001	0.006
Birch Creek below Reclamation	15-Oct-93	*	<0.001	0.003
Eagle Creek above Ptarmigan Cr.	24-Sep-93	*	0.002	0.002
Eagle Creek above Ptarmigan Cr.	9-Oct-93	*	0.001	0.003
Eagle Creek above Ptarmigan Cr.	15-Oct-93	*	<0.001	0.002
Eagle Creek Diversion	9-Oct-93	13:05	0.003	0.012
Eagle Creek Diversion	9-Oct-93	13:20	0.004	0.016
Ptarmigan Creek above Eagle Cr.	24-Sep-93	*	<0.001	<0.001
Ptarmigan Creek above Eagle Cr.	15-Oct-93	*	<0.001	<0.001

Appendix D.

Raw turbidity, discharge, and Total Supended Soilds (1993)

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Birch Creek below Reclamation	3-Jun-93	12	31	80	6.7
Birch Creek below Reclamation	4-Jun-93	5.1	9.1	71	1.7
Birch Creek below Reclamation	5-Jun-93	5.9	17	73	3.3
Birch Creek below Reclamation	6-Jun-93	6.3	21	76	4.3
Birch Creek below Reclamation	7-Jun-93	16	61	64	10
Birch Creek below Reclamation	a-Jun-93	7.9	13	58	2.1
Birch Creek below Reclamation	9-Jun-93	34	754	95	193
Birch Creek below Reclamation	10-Jun-93	17	459	116	144
Birch Creek below Reclamation	11 -Jun-93	4.7	14	66	2.4
Birch Creek below Reclamation	12-Jun-93	4.1	8.8	56	1.3
Birch Creek below Reclamation	13-Jun-93	3.8	14	49	1.8
Birch Creek below Reclamation	14-Jun-93	2.9	11	47	1.3
Birch Creek below Reclamation	15-Jun-93	3.9	17	40	1.9
Birch Creek below Reclamation	16-Jun-93	2.6	5.8	37	0.58
Birch Creek below Reclamation	17-Jun-93	3.3	a.5	36	0.83
Birch Creek below Reclamation	1 a-Jun-93	1.5	5.7	43	0.65
Birch Creek below Reclamation	19-Jun-93	2.0	11	41	1.2
Birch Creek below Reclamation	20-Jun-93	2.8	29	61	4.7
Birch Creek below Reclamation	21-Jun-93	3.2	14	56	2.1
Birch Creek below Reclamation	22-Jun-93	1.4	10	42	1.2
Birch Creek below Reclamation	23-Jun-93	1.6	5.1	37	0.51
Birch Creek below Reclamation	24-Jun-93	1.4	4.8	36	0.47
Birch Creek below Reclamation	25-Jun-93	1.6	6.0	36	0.57
Birch Creek below Reclamation	26-Jun-93	1.5	6.51	35	0.61
Birch Creek below Reclamation	27-Jun-93	19	81	51	11
Birch Creek below Reclamation	28-Jun-93	None	None	44	None
Birch Creek below Reclamation	29-Jun-93	None	None	37	None
Birch Creek below Reclamation	30-Jun-93	None	None	34	None
Birch Creek below Reclamation	1-Jul-93	1.5	7.5	38	0.77
Birch Creek below Reclamation	2-Jul-93	1.9	3.8	36	0.37
Birch Creek below Reclamation	3-Jul-93	1.3	6.1	33	0.53
Birch Creek below Reclamation	4-Jul-93	1.3	3.1	29	0.24
Birch Creek below Reclamation	5-Jul-93	0.9	3.3	26	0.23
Birch Creek below Reclamation	6-Jul-93	0.95	4.1	23	0.26
Birch Creek below Reclamation	7-Jul-93	5.7	39	22	2.4
Birch Creek below Reclamation	8-Jul-93	12	112	22	6.8
Birch Creek below Reclamation	9-Jul-93	1.2	6.0	21	0.34
Birch Creek below Reclamation	10-Jul-93	3.3	21	20	1.14
Birch Creek below Reclamation	11-Jul-93	5.2	30	19	1.5
Birch Creek below Reclamation	12-Jul-93	25	80	18	3.9
Birch Creek below Reclamation	13-Jul-93	6.9	a4	17	3.8
Birch Creek below Reclamation	14-Jul-93	12	60	16	2.6
Birch Creek below Reclamation	15-Jul-93	18	a7	16	3.7
Birch Creek below Reclamation	16-Jul-93	18	118	15	4.9
Birch Creek below Reclamation	17-Jul-93	6.0	19	14	0.72
Birch Creek below Reclamation	1 a-Jul-93	5.0	20	14	0.78
Birch Creek below Reclamation	19-Jul-93	8.8	38	13	1.3
Birch Creek below Reclamation	20-Jul-93	a.7	40	14	1.6

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Birch Creek below Reclamation	21-Jul-93	6.9	22	13	0.75
Birch Creek below Reclamation	22-Jul-93	1.8	28	12	0.89
Birch Creek below Reclamation	23-Jul-93	1.9	6	11	0.20
Birch Creek below Reclamation	24-Jul-93	2.6	16	12	0.49
Birch Creek below Reclamation	25-Jul-93	1.9	9.3	11	0.28
Birch Creek below Reclamation	26-Jul-93	1.3	4.0	12	0.13
Birch Creek below Reclamation	27-Jul-93	1.2	6.0	9.5	0.15
Birch Creek below Reclamation	28-Jul-93	0.75	6.2	10	0.17
Birch Creek below Reclamation	29-Jul-93	2.3	7.8	11	0.22
Birch Creek below Reclamation	30-Jul-93	2.1	8.6	9.6	0.22
Birch Creek below Reclamation	31-Jul-93	2.9	15	9.6	0.38
Birch Creek below Reclamation	1-Aug-93	4.5	17	9.1	0.42
Birch Creek below Reclamation	2-Aug-93	2.2	7.7	9.1	0.19
Birch Creek below Reclamation	3-Aug-93	2.1	8.2	8.8	0.19
Birch Creek below Reclamation	4-Aug-93	2.2	10	9.6	0.26
Birch Creek below Reclamation	5-Aug-93	1.4	6.3	8.6	0.15
Birch Creek below Reclamation	6-Aug-93	2.3	7.9	11	0.23
Birch Creek below Reclamation	7-Aug-93	1.7	6.6	12	0.22
Birch Creek below Reclamation	8-Aug-93	1.1	6.6	12	0.21
Birch Creek below Reclamation	9-Aug-93	1.4	5.4	12	0.18
Birch Creek below Reclamation	10-Aug-93	1.5	7.1	14	0.26
Birch Creek below Reclamation	11-Aug-93	1.6	7.1	14	0.27
Birch Creek below Reclamation	12-Aug-93	6.2	23	14	0.89
Birch Creek below Reclamation	13-Aug-93	2.3	5.8	12	0.19
Birch Creek below Reclamation	14-Aug-93	3.0	13	13	0.45
Birch Creek below Reclamation	15-Aug-93	1.9	5.2	14	0.20
Birch Creek below Reclamation	16-Aug-93	1.5	8.4	12	0.27
Birch Creek below Reclamation	17-Aug-93	7.4	40	11	1.2
Birch Creek below Reclamation	18-Aug-93	5.1	25	12	0.80
Birch Creek below Reclamation	19-Aug-93	7.7	38	12	1.2
Birch Creek below Reclamation	20-Aug-93	11	70	10	1.9
Birch Creek below Reclamation	21-Aug-93	8.0	42	11	1.3
Birch Creek below Reclamation	22-Aug-93	1.6	7.8	13	0.26
Birch Creek below Reclamation	23-Aug-93	1.6	8.0	14	0.31
Birch Creek below Reclamation	24-Aug-93	4.2	14	17	0.68
Birch Creek below Reclamation	25-Aug-93	8.1	25	21	1.4
Birch Creek below Reclamation	26-Aug-93	5.1	14	20	0.75
Birch Creek below Reclamation	27-Aug-93	90	138	19	7.1
Birch Creek below Reclamation	28-Aug-93	None	None	19	None
Birch Creek below Reclamation	29-Aug-93	None	None	18	None
Birch Creek below Reclamation	30-Aug-93	None	None	18	None
Birch Creek below Reclamation	31-Aug-93	None	None	21	None
Birch Creek below Reclamation	1-Sep-93	None	None	32	None
Birch Creek below Reclamation	2-Sep-93	None	None	48	None
Birch Creek below Reclamation	3-Sep-93	60	160	45	20
Birch Creek below Reclamation	4-Sep-93	60	152	41	17
Birch Creek below Reclamation	5-Sep-93	50	118	38	12
Birch Creek below Reclamation	6-Sep-93	38	83	37	8.3

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Birch Creek below Reclamation	7-Sep-93	16	51	34	4.7
Birch Creek below Reclamation	8-Sep-93	9.2	34	32	3.0
Birch Creek below Reclamation	9-Sep-93	15	41	30	3.3
Birch Creek below Reclamation	10-Sep-93	10	19	30	1.5
Birch Creek below Reclamation	11-Sep-93	9.4	19	27	1.4
Birch Creek below Reclamation	12-Sep-93	9.1	19	30	1.5
Birch Creek below Reclamation	13-Sep-93	10	15	30	1.2
Birch Creek below Reclamation	14-Sep-93	12	17	32	1.5
Birch Creek below Reclamation	15-Sep-93	6.4	11	31	0.95
Birch Creek below Reclamation	16-Sep-93	5.3	8.9	31	0.74
Birch Creek below Reclamation	17-Sep-93	6.6	11	30	0.86
Birch Creek below Reclamation	18-Sep-93	None	None	28	None
Birch Creek below Reclamation	19-Sep-93	None	None	31	None
Birch Creek below Reclamation	20-Sep-93	14	41	38	4.2
Birch Creek below Reclamation	21-Sep-93	27	115	51	16
Birch Creek below Reclamation	22-Sep-93	None	None	45	None
Birch Creek below Reclamation	23-Sep-93	None	None	39	None
Birch Creek below Reclamation	24-Sep-93	None	None	35	None
Birch Creek below Reclamation	25-Sep-93	None	None	33	None
Birch Creek below Reclamation	26-Sep93	None	None	31	None
Birch Creek below Reclamation	27-Sep-93	None	None	38	None
Birch Creek below Reclamation	28-Sep-93	None	None	32	None
Birch Creek below Reclamation	29-Sep-93	None	None	26	None
Birch Creek below Reclamation	30-Sep-93	None	None	24	None
Birch Creek below Reclamation	1-Oct-93	None	None	21	None
Birch Creek below Reclamation	2-Oct-93	None	None	18	None
Birch Creek below Reclamation	3-Oct-93	None	None	18	None
Eagle Creek above Ptarmigan Cr.	26-May-93	180	962	56	145
Eagle Creek above Ptarmigan Cr.	27-May-93	110	284	73	56
Eagle Creek above Ptarmigan Cr.	28-May-93	90	114	45	14
Eagle Creek above Ptarmigan Cr.	29-May-93	90	140	55	21
Eagle Creek above Ptarmigan Cr.	30-May-93	70	106	59	17
Eagle Creek above Ptarmigan Cr.	31-May-93	50	55	38	5.6
Eagle Creek above Ptarmigan Cr.	1-Jun-93	50	40	34	3.7
Eagle Creek above Ptarmigan Cr.	2-Jun-93	45	43	30	3.5
Eagle Creek above Ptarmigan Cr.	3-Jun-93	45	121	27	8.7
Eagle Creek above Ptarmigan Cr.	4-Jun-93	40	100	27	7.3
Eagle Creek above Ptarmigan Cr.	5-Jun-93	36	58	27	4.1
Eagle Creek above Ptarmigan Cr.	6-Jun-93	29	47	24	3.0
Eagle Creek above Ptarmigan Cr.	7-Jun-93	70	231	25	15
Eagle Creek above Ptarmigan Cr.	8-Jun-93	35	111	18	5.4
Eagle Creek above Ptarmigan Cr.	9-Jun-93	70	306	27	22
Eagle Creek above Ptarmigan Cr.	10-Jun-93	None	None	63	None
Eagle Creek above Ptarmigan Cr.	11-Jun-93	34	164	35	28
Eagle Creek above Ptarmigan Cr.	12-Jun-93	17	27	28	2.5
Eagle Creek above Ptarmigan Cr.	13-Jun-93	None	None	24	None
Eagle Creek above Ptarmigan Cr.	14-Jun-93	15	12	20	0.93

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Eagle Creek above Ptarmigan Cr.	15-Jun-93	20	52	19	3.4
Eagle Creek above Ptarmigan Cr.	16-Jun-93	None	None	14	None
Eagle Creek above Ptarmigan Cr.	17-Jun-93	None	None	10	None
Eagle Creek above Ptarmigan Cr.	18-Jun-93	None	None	13	None
Eagle Creek above Ptarmigan Cr.	19-Jun-93	None	None	11	None
Eagle Creek above Ptarmigan Cr.	20-Jun-93	12	42	12	2.2
Eagle Creek above Ptarmigan Cr.	21-Jun-93	8.3	17	25	0.88
Eagle Creek above Ptarmigan Cr.	22-Jun-93	13	58	19	2.25
Eagle Creek above Ptarmigan Cr.	23-Jun-93	6.3	13	20	0.35
Eagle Creek above Ptarmigan Cr.	24-Jun-93	3.5	6.02	18	0.20
Eagle Creek above Ptarmigan Cr.	25-Jun-93	7.1	10	16	0.30
Eagle Creek above Ptarmigan Cr.	26-Jun-93	6.5	17	20	0.58
Eagle Creek above Ptarmigan Cr.	27-Jun-93	33	110	31	7.5
Eagle Creek above Ptarmigan Cr.	28-Jun-93	10	24	37	1.3
Eagle Creek above Ptarmigan Cr.	29-Jun-93	3.6	19	29	1.0
Eagle Creek above Ptarmigan Cr.	30-Jun-93	3.0	6.3	22	0.30
Eagle Creek above Ptarmigan Cr.	1-Jul-93	2.5	9.8	18	0.48
Eagle Creek above Ptarmigan Cr.	2-Jul-93	3.8	7.9	16	0.42
Eagle Creek above Ptarmigan Cr.	3-Jul-93	8.5	9.6	12	0.81
Eagle Creek above Ptarmigan Cr.	4-Jul-93	2.7	9.4	15	0.94
Eagle Creek above Ptarmigan Cr.	5-Jul-93	2.3	5.5	14	0.43
Eagle Creek above Ptarmigan Cr.	6-Jul-93	2.2	7.4	12	0.44
Eagle Creek above Ptarmigan Cr.	7-Jul-93	2.0	6.0	12	0.29
Eagle Creek above Ptarmigan Cr.	8-Jul-93	5.5	17	12	0.72
Eagle Creek above Ptarmigan Cr.	9-Jul-93	15	67	5.1	2.1
Eagle Creek above Ptarmigan Cr.	10-Jul-93	360	918	8.7	36
Eagle Creek above Ptarmigan Cr.	11-Jul-93	26	114	8.7	4.4
Eagle Creek above Ptarmigan Cr.	12-Jul-93	12	38	8.5	1.2
Eagle Creek above Ptarmigan Cr.	13-Jul-93	8.5	20	8.2	0.62
Eagle Creek above Ptarmigan Cr.	14-Jul-93	2.5	7.2	8	0.23
Eagle Creek above Ptarmigan Cr.	15-Jul-93	4.2	9.6	6.6	0.13
Eagle Creek above Ptarmigan Cr.	16-Jul-93	3.8	6.0	6.7	0.14
Eagle Creek above Ptarmigan Cr.	17-Jul-93	2.5	3.6	7.4	0.09
Eagle Creek above Ptarmigan Cr.	18-Jul-93	2.2	2.4	6.2	0.05
Eagle Creek above Ptarmigan Cr.	19-Jul-93	4.4	6.6	6.2	0.19
Eagle Creek above Ptarmigan Cr.	20-Jul-93	2.2	2.6	5.1	0.06
Eagle Creek above Ptarmigan Cr.	21-Jul-93	1.6	3.7	5.1	0.07
Eagle Creek above Ptarmigan Cr.	22-Jul-93	8.8	21	3.6	0.38
Eagle Creek above Ptarmigan Cr.	23-Jul-93	3.9	21	5	0.43
Eagle Creek above Ptarmigan Cr.	24-Jul-93	2.4	4.1	4.5	0.07
Eagle Creek above Ptarmigan Cr.	25-Jul-93	2.2	3.7	5.3	0.06
Eagle Creek above Ptarmigan Cr.	26-Jul-93	1.2	2.3	4.4	0.03
Eagle Creek above Ptarmigan Cr.	27-Jul-93	1.3	4.1	3.5	0.06
Eagle Creek above Ptarmigan Cr.	28-Jul-93	1.6	3.3	1.1	0.03
Eagle Creek above Ptarmigan Cr.	29-Jul-93	0.85	1.5	4.7	0.02
Eagle Creek above Ptarmigan Cr.	30-Jul-93	4.7	12	4.2	0.14
Eagle Creek above Ptarmigan Cr.	31-Jul-93	1.6	4.1	5.1	0.06
Eagle Creek above Ptarmigan Cr.	1-Aug-93	1.3	2.7	4.2	0.03

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Eagle Creek above Ptarmigan Cr.	2-Aug-93	1.9	3.3	3.7	0.03
Eagle Creek above Ptarmigan Cr.	3-Aug-93	1.6	4.2	2.1	0.01
Eagle Creek above Ptarmigan Cr.	4-Aug-93	11	39	1.9	0.50
Eagle Creek above Ptarmigan Cr.	5-Aug-93	2.8	12	2.6	0.14
Eagle Creek above Ptarmigan Cr.	6-Aug-93	11	61	0.71	0.83
Eagle Creek above Ptarmigan Cr.	7-Aug-93	15	37	2.5	0.42
Eagle Creek above Ptarmigan Cr.	8-Aug-93	3.9	12	2.2	0.12
Eagle Creek above Ptarmigan Cr.	9-Aug-93	5.4	21	0.44	0.12
Eagle Creek above Ptarmigan Cr.	10-Aug-93	4.2	26	2.1	0.14
Eagle Creek above Ptarmigan Cr.	11-Aug-93	2.6	21	6.1	0.15
Eagle Creek above Ptarmigan Cr.	12-Aug-93	2.7	17	6.3	0.03
Eagle Creek above Ptarmigan Cr.	13-Aug-93	5.8	22	3.2	0.15
Eagle Creek above Ptarmigan Cr.	14-Aug-93	1.9	12	6.7	0.07
Eagle Creek above Ptarmigan Cr.	15-Aug-93	3.1	13	6.5	0.02
Eagle Creek above Ptarmigan Cr.	16-Aug-93	7.6	27	6.4	0.16
Eagle Creek above Ptarmigan Cr.	17-Aug-93	1.8	8.9	5.4	0.14
Eagle Creek above Ptarmigan Cr.	18-Aug-93	1.7	8.7	5.8	0.15
Eagle Creek above Ptarmigan Cr.	19-Aug-93	8.3	30	5	0.26
Eagle Creek above Ptarmigan Cr.	20-Aug-93	40	85	4.9	1.5
Eagle Creek above Ptarmigan Cr.	21-Aug-93	5.3	27	2.5	0.48
Eagle Creek above Ptarmigan Cr.	22-Aug-93	2.5	19	5.9	0.33
Eagle Creek above Ptarmigan Cr.	23-Aug-93	1.4	24	5.8	0.34
Eagle Creek above Ptarmigan Cr.	24-Aug-93	8.4	142	5.8	2.2
Eagle Creek above Ptarmigan Cr.	25-Aug-93	9.1	109	9.3	1.5
Eagle Creek above Ptarmigan Cr.	26-Aug-93	7.1	78	12	1.0
Eagle Creek above Ptarmigan Cr.	27-Aug-93	150	907	5.7	6.2
Eagle Creek above Ptarmigan Cr.	28-Aug-93	26	144	10	2.3
Eagle Creek above Ptarmigan Cr.	29-Aug-93	11	71	10	1.1
Eagle Creek above Ptarmigan Cr.	30-Aug-93	11	48	7.8	0.74
Eagle Creek above Ptarmigan Cr.	31-Aug-93	14	85	9.2	2.1
Eagle Creek above Ptarmigan Cr.	1-Sep-93	260	1277	11	43
Eagle Creek above Ptarmigan Cr.	2-Sep-93	400	657	23	10
Eagle Creek above Ptarmigan Cr.	3-Sep-93	160	647	28	18
Eagle Creek above Ptarmigan Cr.	4-Sep-93	140	536	28	15
Eagle Creek above Ptarmigan Cr.	5-Sep-93	120	515	25	11
Eagle Creek above Ptarmigan Cr.	6-Sep-93	110	391	22	9.7
Eagle Creek above Ptarmigan Cr.	7-Sep-93	65	232	19	6.9
Eagle Creek above Ptarmigan Cr.	8-Sep-93	31	96	18	6.0
Eagle Creek above Ptarmigan Cr.	9-Sep-93	29	112	15	8.5
Eagle Creek above Ptarmigan Cr.	10-Sep-93	22	58	15	4.4
Eagle Creek above Ptarmigan Cr.	11-Sep-93	26	69	11	4.8
Eagle Creek above Ptarmigan Cr.	12-Sep-93	15	50	10	2.9
Eagle Creek above Ptarmigan Cr.	13-Sep-93	12	42	12	2.2
Eagle Creek above Ptarmigan Cr.	14-Sep-93	13	46	13	2.2
Eagle Creek above Ptarmigan Cr.	15-Sep-93	11	36	13	1.5
Eagle Creek above Ptarmigan Cr.	16-Sep-93	12	37	13	1.4
Eagle Creek above Ptarmigan Cr.	17-Sep-93	19	43	14	1.3
Eagle Creek above Ptarmigan Cr.	18-Sep-93	None	None	14	None

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Eagle Creek above Ptarmigan Cr.	19-Sep-93	40	109	12	3.5
Eagle Creek above Ptarmigan Cr.	20-Sep-93	50	165.78	13	5.7
Eagle Creek above Ptarmigan Cr.	21-Sep-93	75	450.53	20	15.78
Eagle Creek above Ptarmigan Cr.	22-Sep-93	None	None	27	None
Eagle Creek above Ptarmigan Cr.	23-Sep-93	None	None	25	None
Eagle Creek above Ptarmigan Cr.	24-Sep-93	None	None	21	None
Eagle Creek above Ptarmigan Cr.	25-Sep-93	None	None	19	None
Eagle Creek above Ptarmigan Cr.	26-Sep-93	None	None	15	None
Eagle Creek above Ptarmigan Cr.	27-Sep-93	None	None	24	None
Eagle Creek above Ptarmigan Cr.	28-Sep-93	None	None	10	None
Eagle Creek above Ptarmigan Cr.	29-Sep-93	None	None	7.2	None
Eagle Creek above Ptarmigan Cr.	30-Sep-93	None	None	8.1	None
Eagle Creek above Ptarmigan Cr.	1-Oct-93	None	None	8.2	None
Eagle Creek above Ptarmigan Cr.	2-Oct-93	None	None	7.7	None
Eagle Creek above Ptarmigan Cr.	3-Oct-93	None	None	5.8	None
Eagle Creek above Ptarmigan Cr.	4-Oct-93	None	None	5.6	None
Eagle Creek above Ptarmigan Cr.	5-Oct-93	None	None	4.8	None
Eagle Creek above Ptarmigan Cr.	6-Oct-93	None	None	6	None
Ptarmigan Creek above Eagle Cr.	25-May-93	1.2	8.4		
Ptarmigan Creek above Eagle Cr.	26-May-93	2.2	25	97	6.5
Ptarmigan Creek above Eagle Cr.	27-May-93	1.3	7.5	115	2.3
Ptarmigan Creek above Eagle Cr.	28-May-93	1.1	6.8	91	1.7
Ptarmigan Creek above Eagle Cr.	29-May-93	1.1	4.5	83	1.0
Ptarmigan Creek above Eagle Cr.	30-May-93	0.85	2.0	93	0.51
Ptarmigan Creek above Eagle Cr.	31 -May-93	0.60	2.4	81	0.54
Ptarmigan Creek above Eagle Cr.	1 -Jun-93	0.65	2.7	68	0.51
Ptarmigan Creek above Eagle Cr.	2-Jun-93	0.80	1.6	61	0.26
Ptarmigan Creek above Eagle Cr.	3-Jun-93	0.75	0.5	58	0.08
Ptarmigan Creek above Eagle Cr.	4-Jun-93	0.55	1.2	56	0.18
Ptarmigan Creek above Eagle Cr.	5-Jun-93	0.60	0.97	55	0.14
Ptarmigan Creek above Eagle Cr.	6-Jun-93	0.65	0.65	55	0.09
Ptarmigan Creek above Eagle Cr.	7-Jun-93	0.45	0.53	55	0.08
Ptarmigan Creek above Eagle Cr.	8-Jun-93	0.55	0.56	51	0.08
Ptarmigan Creek above Eagle Cr.	9-Jun-93	0.80	4.4	45	0.53
Ptarmigan Creek above Eagle Cr.	10-Jun-93	1.1	1.6	68	0.29
Ptarmigan Creek above Eagle Cr.	11-Jun-93	0.45	24	73	4.7
Ptarmigan Creek above Eagle Cr.	12-Jun-93	0.65	5.3	50	0.71
Ptarmigan Creek above Eagle Cr.	13-Jun-93	0.45	2.3	41	0.25
Ptarmigan Creek above Eagle Cr.	14-Jun-93	0.35	0.82	37	0.08
Ptarmigan Creek above Eagle Cr.	15-Jun-93	0.15	2.67	34	0.25
Ptarmigan Creek above Eagle Cr.	16-Jun-93	0.35	2.04	31	0.17
Ptarmigan Creek above Eagle Cr.	17-Jun-93	0.25	1.47	29	0.12
Ptarmigan Creek above Eagle Cr.	18-Jun-93	0.20	1.36	29	0.11
Ptarmigan Creek above Eagle Cr.	19-Jun-93	0.15	1.24	33	0.11
Ptarmigan Creek above Eagle Cr.	20-Jun-93	0.30	2.15	33	0.19
Ptarmigan Creek above Eagle Cr.	21 -Jun-93	0.45	1.04	46	0.13
Ptarmigan Creek above Eagle Cr.	22-Jun-93	2.1	1.37	42	0.15

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Ptarmigan Creek above Eagle Cr.	23-Jun-93	1.0	2.4	32	0.20
Ptarmigan Creek above Eagle Cr.	24-Jun-93	0.7	0.82	26	0.06
Ptarmigan Creek above Eagle Cr.	25-Jun-93	0.55	0.93	23	0.06
Ptarmigan Creek above Eagle Cr.	26-Jun-93	0.75	0.51	22	0.03
Ptarmigan Creek above Eagle Cr.	27-Jun-93	0.65	0.73	21	0.04
Ptarmigan Creek above Eagle Cr.	28-Jun-93	0.45	0.81	22	0.05
Ptarmigan Creek above Eagle Cr.	29-Jun-93	0.45	0.80	22	0.05
Ptarmigan Creek above Eagle Cr.	30-Jun-93	0.55	1.11	20	0.06
Ptarmigan Creek above Eagle Cr.	1-Jul-93	0.45	0.30	20	0.02
Ptarmigan Creek above Eagle Cr.	2-Jul-93	0.40	None	28	None
Ptarmigan Creek above Eagle Cr.	3-Jul-93	0.35	0.40	26	0.03
Ptarmigan Creek above Eagle Cr.	4-Jul-93	0.50	0.61	22	0.04
Ptarmigan Creek above Eagle Cr.	5-Jul-93	0.55	0.40	19	0.02
Ptarmigan Creek above Eagle Cr.	6-Jul-93	0.70	0.31	17	0.01
Ptarmigan Creek above Eagle Cr.	7-Jul-93	0.45	0.42	16	0.02
Ptarmigan Creek above Eagle Cr.	8-Jul-93	0.65	0.10	16	0.00
Ptarmigan Creek above Eagle Cr.	9-Jul-93	0.55	0.33	15	0.01
Ptarmigan Creek above Eagle Cr.	10-Jul-93	0.50	0.31	14	0.01
Ptarmigan Creek above Eagle Cr.	11-Jul-93	0.45	0.10	13	0.00
Ptarmigan Creek above Eagle Cr.	12-Jul-93	0.45	7.4	13	0.25
Ptarmigan Creek above Eagle Cr.	13-Jul-93	0.45	0.73	12	0.02
Ptarmigan Creek above Eagle Cr.	14-Jul-93	0.35	0.53	11	0.02
Ptarmigan Creek above Eagle Cr.	15-Jul-93	0.40	0.11	11	0.00
Ptarmigan Creek above Eagle Cr.	16-Jul-93	0.55	0.10	9.8	0.00
Ptarmigan Creek above Eagle Cr.	17-Jul-93	0.40	0.84	9	0.02
Ptarmigan Creek above Eagle Cr.	18-Jul-93	0.50	1.6	9.4	0.04
Ptarmigan Creek above Eagle Cr.	19-Jul-93	0.50	0.63	9.3	0.02
Ptarmigan Creek above Eagle Cr.	20-Jul-93	0.50	0.63	9.1	0.02
Ptarmigan Creek above Eagle Cr.	21-Jul-93	0.80	0.42	8.6	0.01
Ptarmigan Creek above Eagle Cr.	22-Jul-93	None	None	8.6	None
Ptarmigan Creek above Eagle Cr.	23-Jul-93	None	None	8.5	None
Ptarmigan Creek above Eagle Cr.	24-Jul-93	None	None	8.3	None
Ptarmigan Creek above Eagle Cr.	25-Jul-93	None	None	7.9	None
Ptarmigan Creek above Eagle Cr.	26-Jul-93	None	None	7.6	None
Ptarmigan Creek above Eagle Cr.	27-Jul-93	None	None	6.9	None
Ptarmigan Creek above Eagle Cr.	28-Jul-93	None	None	6.9	None
Ptarmigan Creek above Eagle Cr.	29-Jul-93	None	None	7	None
Ptarmigan Creek above Eagle Cr.	30-Jul-93	None	None	7.1	None
Ptarmigan Creek above Eagle Cr.	31-Jul-93	None	None	6.6	None
Ptarmigan Creek above Eagle Cr.	1-Aug-93	None	None	6.6	None
Ptarmigan Creek above Eagle Cr.	2-Aug-93	None	None	6.3	None
Ptarmigan Creek above Eagle Cr.	3-Aug-93	None	None	6.6	None
Ptarmigan Creek above Eagle Cr.	4-Aug-93	None	None	6.3	None
Ptarmigan Creek above Eagle Cr.	5-Aug-93	None	None	6	None
Ptarmigan Creek above Eagle Cr.	6-Aug-93	0.55	1.53	6.8	0.03
Ptarmigan Creek above Eagle Cr.	7-Aug-93	0.40	0.70	8.2	0.02
Ptarmigan Creek above Eagle Cr.	8-Aug-93	0.40	1.2	8.6	0.03
Ptarmigan Creek above Eagle Cr.	9-Aug-93	0.60	1.5	8.6	0.04

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Ptarmigan Creek above Eagle Cr.	10-Aug-93	0.35	1.2	9	0.03
Ptarmigan Creek above Eagle Cr.	11-Aug-93	0.25	1.2	8.3	0.03
Ptarmigan Creek above Eagle Cr.	12-Aug-93	0.35	1.6	7.9	0.03
Ptarmigan Creek above Eagle Cr.	13-Aug-93	None	None	7.9	None
Ptarmigan Creek above Eagle Cr.	14-Aug-93	0.90	2.0	7.6	0.04
Ptarmigan Creek above Eagle Cr.	15-Aug-93	0.30	1.3	7.9	0.03
Ptarmigan Creek above Eagle Cr.	16-Aug-93	0.45	1.4	7.6	0.03
Ptarmigan Creek above Eagle Cr.	17-Aug-93	0.50	0.99	6.9	0.02
Ptarmigan Creek above Eagle Cr.	18-Aug-93	0.50	1.2	7.2	0.02
Ptarmigan Creek above Eagle Cr.	19-Aug-93	0.40	1.0	6.6	0.02
Ptarmigan Creek above Eagle Cr.	20-Aug-93	0.55	1.5	6.3	0.03
Ptarmigan Creek above Eagle Cr.	21-Aug-93	0.40	1.8	6.6	0.03
Ptarmigan Creek above Eagle Cr.	22-Aug-93	0.65	1.6	6.9	0.03
Ptarmigan Creek above Eagle Cr.	23-Aug-93	0.80	1.5	7.9	0.03
Ptarmigan Creek above Eagle Cr.	24-Aug-93	0.30	0.37	9.2	0.01
Ptarmigan Creek above Eagle Cr.	25-Aug-93	0.60	0.62	10	0.02
Ptarmigan Creek above Eagle Cr.	26-Aug-93	1.8	1.9	11	0.06
Ptarmigan Creek above Eagle Cr.	27-Aug-93	None	None	11	None
Ptarmigan Creek above Eagle Cr.	28-Aug-93	None	None	10	None
Ptarmigan Creek above Eagle Cr.	29-Aug-93	None	None	9.8	None
Ptarmigan Creek above Eagle Cr.	30-Aug-93	None	None	9.8	None
Ptarmigan Creek above Eagle Cr.	31-Aug-93	None	None	9.8	None
Ptarmigan Creek above Eagle Cr.	1-Sep-93	None	None	11	None
Ptarmigan Creek above Eagle Cr.	2-Sep-93	0.95	2.5	17	0.11
Ptarmigan Creek above Eagle Cr.	3-Sep-93	0.25	2.4	26	0.17
Ptarmigan Creek above Eagle Cr.	4-Sep-93	0.30	1.1	25	0.07
Ptarmigan Creek above Eagle Cr.	5-Sep-93	0.20	0.92	24	0.06
Ptarmigan Creek above Eagle Cr.	6-Sep-93	0.30	1.1	23	0.07
Ptarmigan Creek above Eagle Cr.	7-Sep-93	0.30	0.61	22	0.04
Ptarmigan Creek above Eagle Cr.	8-Sep-93	0.25	0.96	20	0.05
Ptarmigan Creek above Eagle Cr.	9-Sep-93	0.30	2.1	19	0.11
Ptarmigan Creek above Eagle Cr.	10-Sep-93	0.25	0.59	19	0.03
Ptarmigan Creek above Eagle Cr.	11-Sep-93	0.30	0.79	19	0.04
Ptarmigan Creek above Eagle Cr.	12-Sep-93	None	None	18	None
Ptarmigan Creek above Eagle Cr.	13-Sep-93	None	None	19	None
Ptarmigan Creek above Eagle Cr.	14-Sep-93	None	None	19	None
Ptarmigan Creek above Eagle Cr.	15-Sep-93	None	None	20	None
Ptarmigan Creek above Eagle Cr.	16-Sep-93	None	None	19	None
Ptarmigan Creek above Eagle Cr.	17-Sep-93	None	None	20	None
Ptarmigan Creek above Eagle Cr.	18-Sep-93	None	None	21	None
Ptarmigan Creek above Eagle Cr.	19-Sep-93	None	None	20	None
Ptarmigan Creek above Eagle Cr.	20-Sep-93	None	None	21	None
Ptarmigan Creek above Eagle Cr.	21-Sep-93	None	None	24	None
Ptarmigan Creek above Eagle Cr.	22-Sep-93	None	None	33	None
Ptarmigan Creek above Eagle Cr.	23-Sep-93	None	None	31	None
Ptarmigan Creek above Eagle Cr.	24-Sep-93	4.8	2.93	26	0.21
Ptarmigan Creek above Eagle Cr.	25-Sep-93	None	None	24	None
Ptarmigan Creek above Eagle Cr.	26-Sep-93	None	None	22	None

Site	Date	Turbidity (NTU)	TSS (mg/l)	Discharge (cfs)	Load (ton/day)
Ptarmigan Creek above Eagle Cr.	27-Sep-93	None	None	20	None
Ptarmigan Creek above Eagle Cr.	28Sep93	None	None	17	None
Ptarmigan Creek above Eagle Cr.	29-Sep-93	None	None	17	None
Ptarmigan Creek above Eagle Cr.	30-Sep-93	None	None	18	None
Ptarmigan Creek above Eagle Cr.	1-Oct-93	None	None	17	None
Ptarmigan Creek above Eagle Cr.	2-Oct-93	None	None	15	None
Ptarmigan Creek above Eagle Cr.	3-Oct-93	None	None	15	None
Ptarmigan Creek above Eagle Cr.	4-Oct-93	None	None	14	None
Ptarmigan Creek above Eagle Cr.	5-Oct-93	None	None	13	None