U. S. Department of the Interior
Bureau of Land Management

Alaska Open File Report 113
BLM/AK/ST-07/014+7200+020
July 2007

BLM

Water Resources and Riparian Reclamation of Nome Creek, White Mountains National Recreation Area, Alaska

Jon Kostohrys

Alaska

The BLM Mission

The Bureau of Land Management sustains the health, diversity and productivity of the public lands for the use and enjoyment of present and future generations.

Cover Photo

Reclaimed and unreclaimed portions of Nome Creek are distinct in this aerial photograph from the White Mountains National Recreation Area, Alaska. (All photos by the author, unless noted)

Author

Jon Kostohrys recently retired as a hydrologist with the Bureau of Land Management, Fairbanks District Office, in Fairbanks, Alaska.

Disclaimer

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the Federal government.

Open File Reports

Open File Reports issued by BLM-Alaska present the results of inventories or other investigations on a variety of scientific and technical subjects that are made available to the public outside the formal BLM-Alaska technical publication series. The Open File Reports can include preliminary or incomplete data and are not published or distributed in quantity.

To request a copy of this or another BLM-Alaska scientific report, or for more information, please contact:

BLM-Alaska Public Information Center
222 W. Seventh Ave., #13
Anchorage, AK 99513
(907) 271-5960

Most BLM-Alaska scientific reports are also available for loan or inspection at the Alaska Resources Library and Information Services in Anchorage, (907) 27-ARLIS, and other major libraries in Alaska; USDI Resources Library in Washington, D.C.; the BLM National Business Center Library in Denver; and other select locations.

A bibliography of scientific reports is online at **www.blm.gov/ak**.

Water Resources and Riparian Reclamation of Nome Creek, White Mountains National Recreation Area, Alaska

Jon Kostohrys

BLM-Alaska Open File Report 113
July 2007

U. S. Department of the Interior
Bureau of Land Management

Abstract

In June 1989, the BLM began water resources monitoring and inventory on Nome Creek in preparation for a riparian reclamation and stream channel reconstruction project. The intent was to collect data useful in reconstruction of the stream within a single channel, to eliminate the unstable debris piles and settling ponds that contributed to excessive sediment runoff, and to stabilize and revegetate the floodplain. The reclamation techniques developed here could then be useful for other placer mining reclamation. The stream, after being reclaimed into a single pilot channel in 1991, was subject to repeated floods during the subsequent years from both storm runoff from summer rains and overflow icing (aufeis) during spring breakup, often eroding into the floodplain and destroying willow plantings adjacent to the stream. These problems, typical of similar projects in Alaska, were minimized by widening the pilot channel, flattening meanders on the inside of bends, and regrading the floodplain. A preliminary instream flow analysis was begun on the site above Ophir Creek so the results could be used in the BLM's application to the State of Alaska for a water right for the lower reach of the creek.

Recommendations include: 1) continue the reclamation work until the entire creek is consolidated into a single channel and all the unstable debris piles are recontoured into a well-graded and completely revegetated floodplain; and 2) continue to collect, analyze, and publish stream-gaging, water quality, and botanical data, not only for the reclamation work on the upper creek, but also for the instream flow project on the lower portion of the stream. This includes a satellite-capable gage installed above Ophir Creek to provide the public with real-time water-level information. Additionally, a thorough GIS mapping and analysis of the watershed would improve the accuracy of the area estimates of reclamation and revegetation, the miles of steam channel reconstructed, and the basin characteristics used in many water resources analyses.

Acknowledgments

Many people have been involved with this project during the almost two decades it has been in progress. Current BLM staff who participated in the field work include Lon Kelly, Eric Yeager, Collin Cogley, Tim DuPont, Mike Kliemann, Craig McCaa, Randy Tracy, Ed Lee, Randy Goodwin, Bunny Sterin, Sandy Westcott, Richard Kemnitz, Matt Whitmann, Jim Herriges, and Ingrid McSweeny. Former BLM staff included Billy Butts, Dick Bouts, Nate Collin, Roger Evans, Rod Everett, Brian Lubinski, Ethan Scott, Jacek Mysenko, Lisa Ragland, Anna McGlinn, Tanja Runkel, Verena Grüner, Eva Weithmann, and Xavier Sotelo. Special thanks to contractor Ed Anders, whose insight helped guide the reclamation work in the beginning years. Kristine Kosnik did the limited GIS analysis that produced the map. Craig McCaa provided a wizard's touch as the editor for the document.

Table of Contents

Figures

Tables

Appendix A

Appendix B

Appendix C

Introduction

In June 1989, the Steese/White Mountains District (now the Eastern Interior Field Office) of the Bureau of Land Management (BLM) began a streamflow monitoring and inventory project to collect background data on Nome Creek for a riparian reclamation and stream channel reconstruction project. Nome Creek, located within the southeastern portion of the White Mountains National Recreation Area (Figure 1), is a headwaters tributary of Beaver Creek National Wild River. Portions of the drainage were extensively placer mined for gold from the turn of the century until recent times (Figure 2). Miners disturbed over seven miles of the stream, often by diverting it into bypass channels or through old settling ponds. By the 1980s the floodplain was largely obliterated in many areas. Nome Creek, while remote at the time, was adjacent to the proposed Mount Prindle Campground and the Nome Creek Road, then in the design phase. The project goal was to collect streamflow data useful for the reclamation project, then reconstruct the stream with these objectives: 1) keep the stream within a single channel; 2) eliminate unstable debris piles and settling ponds that have contributed to excessive sediment runoff; and 3) stabilize and revegetate the floodplain adjacent to the proposed campground and road. The techniques developed here could then be used for other placer mining reclamation. An additional study, added to the project in 1999, was a preliminary instream flow analysis on lower Nome Creek, as recommended in previous studies done on Beaver Creek. A stream gage was located on the site above Ophir Creek, allowing data collected from 1999 to 2005 to be used for a

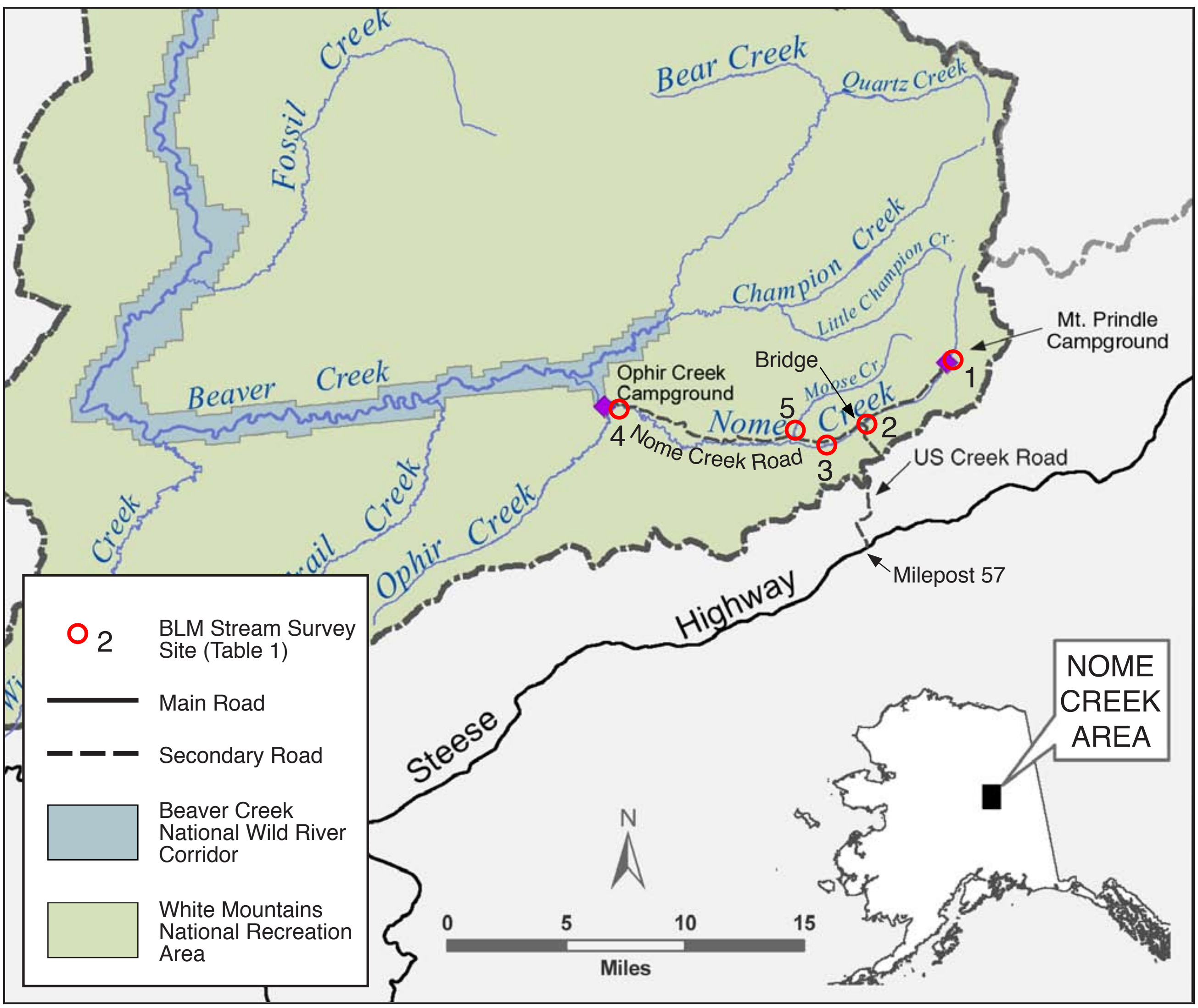

Figure 1. Map of the Nome Creek area and the White Mountains National Recreation Area.

water right application for the lower reach of the creek.

Basin Characteristics

The Nome Creek watershed is located in east-central interior Alaska. As described in Wahrhaftig (1965), the basin is part of the Yukon-Tanana Upland, an area characterized by rounded, even-topped ridges with moderate to gentle side slopes. The river valleys, often heavily forested, are separated by more sparsely vegetated, compact rugged mountains 4,000–5,000 feet in altitude. Some of the upland valleys, especially in the vicinity of Mount Prindle, experienced limited alpine glaciation during the Pleistocene (Weber and others 1988). Streams originating in this area have typical U-shaped valleys in their upper reaches, while those tributaries originating down-valley flow through narrow, V-shaped canyons (Figure 3). Proceeding down the Nome Creek valley, the width increases from about 1/4 mile near the headwaters to nearly a mile near the confluence with Beaver Creek (Figure 4). The lower valley contains wide, looping meanders, abandoned cut-off channels (sloughs), and extensive riparian and wetland areas. The floodplain, consisting largely of reworked outwash gravel, silt, and organic materials, is poorly drained and often underlain by discontinuous permafrost. Numerous flowing springs occur throughout the basin and contribute significantly to winter stream flow. The region is drained ultimately by the Yukon River.

The basin lies in the subpolar continental climatic zone, characterized by long, cold winters and short, hot summers. Temperature extremes can range from near –70˚F in winter to +90˚F in summer, though variations are great due to surrounding topography.

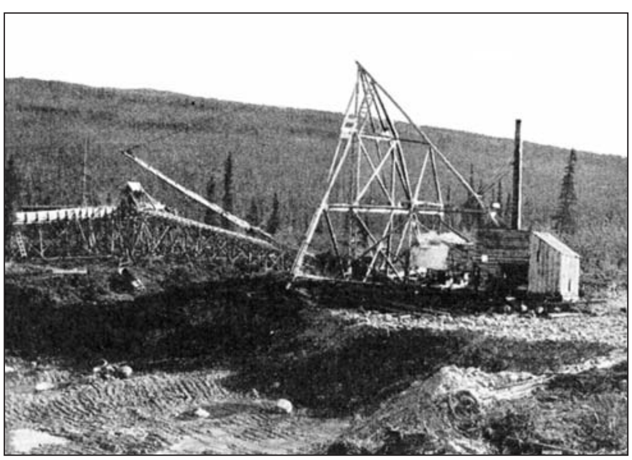

Figure 2. Drag-line used by a placer mining operation on Nome Creek in the early part of the 20th century.

The valley bottoms adjacent to Nome Creek are often 30 degrees colder than surrounding ridge tops during the winter. Precipitation is also strongly affected by topography. Snowfall in the White Mountains is moderate, with an average depth of 29 inches on the ground by early April, the equivalent of about 5.3 inches of water (USDA 2005). Breakup usually begins in late April to early May, and high streamflow may persist well into June. Periods of low water typically occur in July, while infrequent high flows from rainstorms can occur anytime from June through August. A rain gage operated since 1998 during the summer in upper Nome Creek recorded an average of about 12 inches of rainfall for the summer period. Freeze-up on streams often begins at higher elevations in mid-September, although reaches lower in the basin may remain open until November. Ice cover on streams is usually continuous for the winter, except in the vicinity of springs, and freezing to the bottom of the channel may occur in some places. Extensive areas of overflow icing (aufeis) are common during late winter on Nome Creek and some of its tributaries.

Methods

Hydrology

The BLM began initial channel surveys, floodplain mapping, and streamflow measurements in 1989. Peak-flow (crest stage) gages were installed at two sites on Nome Creek in 1989 and in 1996 on Moose Creek, a tributary to Nome Creek (Table 1). These are non-automated gages that record the peak water level whenever it exceeds a pre-set minimum (base) level. In 1999 an automated water-level recorder (data logger and pressure transducer) was installed at the site above Ophir Creek. This gage recorded water level data for the summer periods (generally late May to late September). A wire-weight gage was installed at the bridge in 1998, and observer readings were recorded intermittently most years.

Each summer during field inspections, the gages were referenced to known elevation (bench) marks or to separate reference gages to provide an accurate correction to the current water level. Cross-sectional discharge (streamflow) measurements were made using a Price AA or Pygmy type current meter to measure water velocity and a top-setting wading rod and tag line for depth and width. At least once a year, the stream banks, high-water marks, and water surface profiles were surveyed using a level and stadia rod or total-station theodolite. A water level vs. discharge rating was developed by combining the direct-discharge measurements (Rantz and others 1982) and computer-simulated peak flows using a slope–area method based on the Manning equation (Dalrymple and Benson, 1967). These rating curves were then used to compute discharge from the recorded water level data.

During periods when no water level data was available, such as during spring break-up, fall freeze-up, or recorder malfunction, the data was estimated from regression analysis, with the BLM gages on Beaver Creek (Kostohrys 2005) and U.S. Geological Survey (USGS) data from the Salcha River (USDI 1997 to 2005) as the reference sites. This analysis is based on the assumption that the nearby gaging station with the most reliable and longest period of streamflow record is the most useful reference site (Thomas 1967). The data collected during the early part of the century by the USGS (USDI 1915) was used to supplement the data at the site above Ophir Creek for the summer period.

Figure 3. The White Mountains form the headwaters of the Nome Creek watershed.

Reclamation

The initial channel design was based on limited field surveys in 1989, so the project used USGS peak-flow regression equations (Lamke 1979, Parks and Madison 1984, and later Jones and Fahl 1994) to validate bankfull discharge values. The basin characteristics used for the flood-recurrence calculations were estimated from topographic maps. Reclamation work commenced in July 1991 and continued almost every summer to the present. A D8 or larger tracked bulldozer was used exclusively most years, although an excavator (track hoe) was tried one summer. The channel reconstruction was more difficult than anticipated, as the center of the valley held silt-rich, saturated soils, thought to be buried settling ponds (Figure 5). In general, construction began with filling in of the settling ponds using material from surrounding tailings piles and then grading the area as flat as possible (Figure 6). A pilot channel was then dug, avoiding the filled-in ponds and meandering

Figure 4. The lower portion of the Nome Creek drainage is surrounded by low hills as the valley widens near the confluence with Beaver Creek.

Table 1. Location and characteristics of water resources survey sites in the Nome Creek drainage basin

Site No.	Stream survey site	Location (decimal degrees)		Drainage Area (sq.mi.)	Channel Type
		Latitude	Longitude		
1	Nome Creek above Sumner Creek	65.3680	-146.5925	11.7	Straight, step pool
2	Nome Creek at the bridge	65.3410	-146.7138	21.7	Disturbed by mining
3	Nome Creek at the Maze	65.3310	-146.7587	25.0	Disturbed by mining
4	Nome Creek above Ophir Creek	65.3630	-147.0379	90.8	Meandering, pool/riffle
5	Moose Creek above the Nome Creek Road	65.3408	-146.8170	11.7	Meandering, pool/riffle

Figure 5. The initial step in reclamation was to fill the settling ponds with the dozer, using the material from the surrounding tailings piles.

Figure 6. After filling the ponds, the bulldozer then graded the floodplain as flat as possible.

Figure 7. The bulldozer constructed the channel using short, almost level grading to deepen the pilot channel.

down the lowest portion of the valley at as uniform a grade as possible (Figure 7). Two years of reclamation (1996 and 1997) were completed in conjunction with road and campground construction, during which some of the largest and most accessible mined areas were stripped of tailings. This road project was a cooperative effort under the direction of Alaska Department of Transportation & Public Facilities (AKDOT), whose contractors completed only limited channel realignment and floodplain reclamation in these locations. The BLM subsequently regraded some of these areas, as needed, to the standards noted above.

Revegetation

In general, revegetation included planting of both dormant and live willow cuttings, grass seeding with fertilization, and fertilization alone to encourage native species. These techniques were all employed at different times and at varying levels. Brian Bogaczyk's detailed report on the early revegetation methods (Appendix C) is discussed in the results section.

Results and Discussion

Hydrology

Streamflow data from 1989 to 2005 is listed by site and year in Appendix A and precipitation data in Appendix B. The sites in mined areas had relatively unstable channels, which made determination of peak flows difficult. Graf (1988) notes that rivers with unconsolidated and mobile bed materials are inherently unstable, making use of the Manning (slope–area) equation for peak-flow determinations especially dependent on an accurate roughness factor (n-value). This factor not only varies with depth of flow, but is strongly influenced by channel materials and bed forms, which can be highly variable during rapidly changing flood flows. In general, the site above Sumner Creek (Figure 8), being almost completely unaffected by mining impacts and having the most stable channel, provided the most reliable discharge values. While it was possible to define a discharge rating for the site at the Maze (see area map, Fig. 1, for the site locations), the site at the bridge proved too unstable to define accurate discharge ratings that are necessary to compute flood frequency. The mean low-water level had dropped about 1.5 ft from 1998 to 2005 (Tables A-4 to A-11), whereas channel surveys showed that the streambed eroded almost 2 ft (Figure A-4). In fact, the channel upstream of the bridge eventually became so unstable that it undermined the gabions on the left bank, and a portion of the stream channel now flows behind the bridge abutment (Figure 9). An estimate of the highest peak discharge, based on limited surveys completed at that time, was calculated primarily to aid in the design and reconstruction of the bridge armoring. However, no flood-frequency data was computed for this site due to the channel instability. Because of its proximity to the bridge and its relatively more stable channel, the flood-frequency data from the site at the Maze could be used to estimate the channel redesign at the bridge, if needed. Summaries of the instantaneous peak-flow data and log-Pearson flood-frequency calculations are shown in Tables 2 and 3. A comparison of the log-Pearson gaged data and the USGS regression estimates for the site above Sumner Creek is shown in Table 4. It is interesting to note that all these regression equations underestimate the field-determined discharges at the lower-interval, higher-recurrence values.

The channel geometry data collected early in the study was originally intended to determine peak

Figure 8. Upper Nome Creek's stable channel provided the most accurate streamflow information.

Table 2. Summary of peak flow and runoff for the Nome Creek drainage basin

Stream Survey Site	Instantaneous Peak Discharge (cfs)	Peak Runoff (cfsm)	Peak Runoff (in)	Years of Data
Nome Creek above Sumner Creek	750	64	72	17
Nome Creek at the bridge*	1000	46	52	8*
Nome Creek at the Maze	1050	42	48	17
Nome Creek above Ophir Creek	2600	29	32	7
Moose Creek above the Nome Creek Road	360	31	35	10

* Limited data (see text)

Table 3. Instantaneous flood frequency computed from a log-Pearson Type III analysis

Stream survey site	Discharge (cfs)						
Recurrence (yrs)	1.5	2	5	10	25	50	100
Nome Creek above Sumner Creek	270	350	530	660	800	910	1010
Nome Creek at the bridge	ND	ND	ND	ND	ND	ND	ND
Nome Creek at the Maze	420	520	770	940	1150	1310	1470
Nome Creek above Ophir Creek	970	1200	1860	2400	3190	3860	4640
Moose Creek above the Nome Creek Road	120	150	250	320	420	520	620

ND = Not Determined (due to limited data and channel instability; see text)

Table 4. Comparison of log-Pearson flood-frequency discharges for Nome Creek above Sumner Creek

Recurrence (yrs)	Discharge (cfs)			
	Gaged Data	Lamke (1978)	Parks and Madison (1985)	Jones and Fahl (1994)
2	350	190	129	162
5	530	370	259	296
10	660	536	378	395
25	800	731	600	530
50	910	1031	818	626
100	1010	1432	1095	727

Parameters used in these calculations:

Drainage Area (sq. mi.)	12	Lamke's M	189
Precipitation (in)	20	Lamke's D	2.36
Mean Basin Elev. (ft)	3000	Lake & Pond Area	0

Table 5. Bankfull discharge, width, depth, and recurrence for survey sites on Nome Creek

Stream survey site	Discharge (cfs)	Width (ft)	Depth (ft)	Recurrence Interval (yrs)
Nome Creek above Sumner Creek	530	47	3.1	5.0
Nome Creek at the bridge	660	50	4.1	ND
Nome Creek at the Maze	760	50	4.5	4.8
Nome Creek above Ophir Creek	1500	90	6.0	3.0
Moose Creek above the Nome Creek Road	210	24	3.8	3.5

ND = Not Determined (see text)

Table 6. Comparison of channel geometry estimates using bankfull estimates for the site at Nome Creek above Sumner Creek

Bankfull Dimensions	Gaged Data*	Lamke* (1978)	Parks and Madison* (1985)	Jones and Fahl* (1994)	Emmett** (1972)
Width (ft)	47	31	28	30	32
Depth (ft)	3.0	2.6	2.3	2.5	1.4

* Dimensions are for a trapezoidal channel with 3:1 banks and sized for a 2-year recurrence discharge from these methods.

** Emmett calculates bankfull width and depth from drainage area alone.

discharges and channel characteristics. These cross sections were then compared to the bankfull surveys completed later. The intent of the resurveys was to see if significant erosion or deposition had altered channel conditions outside of the reclamation area and if this could be tied to a specific flood-recurrence event. The resurveys are shown in Appendix A and are summarized in Table 5, which also lists the bankfull flood frequency for each of the survey sites. In general, the sites with the smallest drainage area tended to have the highest recurrence interval for the calculated bankfull discharge.

Since the initial channel design was based on limited field surveys, the project used USGS regression equations (Lamke 1979, Parks and Madison 1984, and later Jones and Fahl 1994) to determine bankfull discharge values. An estimator of bankfull width and depth (Emmett 1972) was also used to verify the computations. A comparison of a channel design using these regression estimates and actual values for the upper site is shown in Table 6. It is apparent that the regression equations uniformly underestimated the field-measured bankfull channel dimensions at this site.

A preliminary instream flow analysis was completed on the site above Ophir Creek, as recommended in the Beaver Creek instream flow report (Van Havern and others 1987). The mean-monthly discharges, computed from data collected by the BLM and USGS, are listed in Table 7 and shown in an annual hydrograph (Figure 10). Wintertime flow above Ophir Creek was estimated by assuming that the difference in discharge between stream-gaging sites on Beaver Creek above and below Nome Creek (Kostohrys 2005) equals the discharge from Nome Creek. The long-term average Beaver Creek monthly data for the winter period (Oct–April) was used to provide the winter estimates.

Reclamation

During the summers of 1991, 1994, 1998, 2000, and 2003, severe storms caused extensive flooding in the basin. The pilot channel remained largely intact in some reaches, but other areas suffered from lateral erosion and braided channels, especially in areas with poor soils. Large overflow icing (aufeis), which occurs when the stream freezes down to the bed, filled the valley in the spring of 1996 and 1997 (Figure 11). During the subsequent breakup, the stream was unable to flow on its bed, so it migrated onto the floodplain, eroding the former settling ponds and regraded tailing piles.

Table 7. The mean monthly discharge (cfs) for Nome Creek above Ophir Creek, computed from BLM data for 1999–2005 and USGS data for 1911–12

Month	Mean Discharge (cfsm)	Runoff (cfsm)	Runoff (in)
Jan	9.2	0.10	0.11
Feb	6.3	0.07	0.08
Mar	4.5	0.05	0.06
Apr	36	0.40	0.45
May	154	1.70	1.92
Jun	160	1.76	1.99
Jul	138	1.52	1.72
Aug	140	1.54	1.74
Sep	123	1.35	1.53
Oct	64	0.71	0.80
Nov	37	0.41	0.46
Dec	16	0.17	0.19
Avg. Annual	74	0.81	0.92

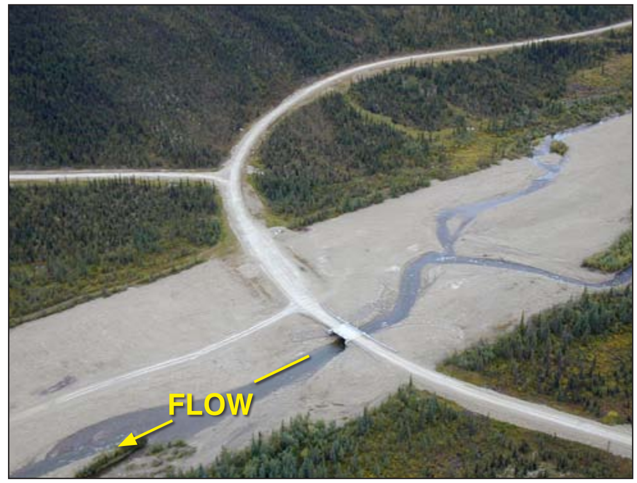

Figure 9. Aerial view of the channel upstream of the bridge, where the gabions are being eroded by the unstable channel.

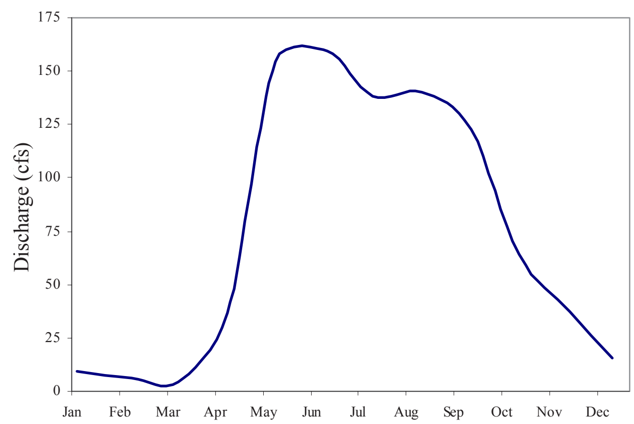

Figure 10. Annual hydrograph showing mean monthly discharge for Nome Creek above Ophir Creek.

Figure 11. Overflow icing (aufeis) forms during most winters and can persist well into summer.

Figure 12. In the upper reclamation area, the meanders had to be increased and the point bars releveled to stabilize the channel. Note the grass in the background, a result of hydroseeding during road construction.

Figure 13. Aerial photo of Nome Creek before the reclamation project began.

Figure 14. Aerial photo of the upper reclamation area, road, and campground after reclamation.

Similar erosion problems affect many stream channel reclamation projects in Alaska.

The bankfull discharge is often used to determine the channel dimensions for stream reclamation (Rosgen 1998). Wolman and Leopold (1957), among others, suggest that the recurrence interval for the bankfull discharge is between one and two years. Williams (1978) listed 16 ways of determining the bankfull discharge. In an examination of data on 40 rivers, he noted that the bankfull discharge had no common recurrence frequency and the 1.5-year flood seldom represented the bankfull discharge. As noted in Tables 5 and 6, the bankfull discharge for the most part closely matched the 5-year recurrence interval flood at the upper gaging site (where most of the bankfull discharge and channel information for the reclamation project was determined) and exceeded the 2-year flood at all other sites. For the upper site on Nome Creek, the discharge and channel geometry estimates based on regression equations undersized the channel and floodplain. Once the pilot channel was widened (to dimensions closer to the 5-year flood) and meanders were flattened (increasing the channel width at bends) (Figure 12), the channel erosion problems from flooding diminished. As can be seen in Figures 13 and 14, the contrast between the pre- and post-project channel is readily apparent in the upper area. While over-estimating channel dimensions may increase construction costs and possibly cause braided channels, underestimating can result in channel failure and catastrophic floodplain damage.

Revegetation

Brian Bogaczyk's summary of early revegetation results and Jim Herriges's follow-up report are included in Appendix C. Bogaczyk discusses the types of treatment, including live and dormant willow plantings, grass seeding, and fertilization. Limited willow planting and fertilization has continued to the present, such that most of the reconstructed floodplain along the first several miles of stream and floodplain are now covered with willows from 3 feet to over 6 feet tall. Though the areas reclaimed later have less revegetation, even those areas with sparse ground cover have been recolonized by naturally growing willow and grass seedlings. It appears that the most labor-saving and cost-effective revegetation resulted not from additional willow plantings, but rather from fertilization alone for several years after reclamation to encourage reintroduction of native species. Water quality appears to be better in the uppermost areas where revegetation is greatest, while the stream becomes more turbid in downstream areas where revegetation is limited or nearly absent.

Where tailing piles were removed for road construction materials and the stream channel and floodplain subsequently reconstructed, grass seeding and fertilizing (hydro-seeding) were done under AKDOT direction to restore the area as quickly as possible. While some of these areas have maintained viable ground cover, others have died out within several years after planting. To date, approximately 200 acres of floodplain and about five miles of the stream channel have been reclaimed, with most areas at least partially revegetated.

Recommendations

1. The reclamation work should continue until the entire creek is consolidated into a single channel and all unstable debris piles that contribute to excessive sediment runoff are recontoured into a well-graded floodplain.

2. The project to revegetate the floodplain should continue and the results of systematic water quality and botanical surveys should be summarized and published.

3. The water resources project to collect, analyze, and publish stream-gaging data should continue on Nome Creek, not only for the reclamation work on the upper creek but for the instream flow project on the lower portion of the stream. In this regard, the satellite-capable gage installed above Ophir Creek in 2005 should be maintained, as this gage is capable of generating real-time data that provides the public with access to current stream conditions. The application for water rights should be completed and filed with the Alaska Department of Natural Resources.

4. A thorough GIS mapping and analysis of the watershed should be done to improve the accuracy of the area estimates of reclamation and revegetation, the miles of steam channel reconstructed, and the basin characteristics used in many water resources analyses.

Literature Cited

AKDNR. 1989. Letter from Alaska Department of Natural Resources to the Steese/White Mountains District Office, Bureau of Land Management. On file. Fairbanks, AK.

Dalrymple, Tate; Benson, M.A. 1967. Measurement of Peak Discharge by the Slope–Area Method. In: Techniques of Water Resources Investigations, Book 3, Chapter A2. U.S. Department of the Interior, Geological Survey. 12 pages.

Emmett, W.W. 1972. Bankfull Channel Characteristics on Streams South of the Yukon River, Alaska. U.S. Department of the Interior, Geological Survey Open-File Report.

Graf, W.L. 1988. Fluvial Processes in Dryland Rivers. Blackburn Press. New Jersey. 346 pages.

Jones, S.H.; Fahl, C.B. 1994. Magnitude and Frequency of Floods in Alaska and Conterminous Basins of Canada. U.S Department of the Interior, Geological Survey Water-Resources Investigations Report 93-4179. Anchorage, Alaska. 122 pages.

Kostohrys, Jon. 2005. Water Resources of Beaver Creek National Wild River: Stream Gaging Data from 1993 to 2000 with Summary Statistics. BLM-Alaska Open File Report 102. U.S. Department of the Interior, Bureau of Land Management. Anchorage, Alaska. 40 pages.

Lamke. R.D. 1978. Flood characteristics of Alaskan streams. U.S Department of the Interior, Geological Survey Water-Resources Investigations Report 78-129. Anchorage, Alaska. 61 pages.

Parks, Bruce; Madison, Robert J. 1985. Estimation of Selected Flow and Water-Quality Characteristics of Alaskan Streams. Water-Resources Investigations Report 84-4247. U.S. Department of the Interior, Geological Survey. 50 pages.

Rantz, S.E. and others. 1982. Measurement and Computation of Streamflow: Volume 1&2. USGS Water-Supply Paper 2175. U.S. Department of the Interior, Geological Survey. 631 pages.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado. 246 pages.

Thomas, D.M. 1967. Extending Streamflow Records in Time. In: Techniques of Water Resources Investigations, Book 4, Section B. U.S. Department of the Interior, Geological Survey. 21 pages.

U.S. Department of Agriculture, Natural Resource Conservation Service. 2005. Alaska Annual Snow Survey Data Summary. http://www.ambcs.org.

U.S. Department of Interior, Geological Survey, 1915. Surface Water Supply of the Yukon-Tanana Region, Alaska. Water Supply Paper 342. 343 pages.

U.S. Department of the Interior, Geological Survey, 2000 to 2006 (in prep.). Water Resources Data - Alaska. Water Years 1999 to 2005.

Van Haveren, Bruce P.; Jackson, William L.; Martinez, Tony; Shelby, Bo; Carufel, Lou. 1987. Water Rights Assessment for Beaver Creek National Wild River, Alaska. U.S. Department of the Interior, Bureau of Land Management. Anchorage, Alaska. 113 pages.

Wahrhaftig, Clyde. 1965. Physiographic Divisions of Alaska. Geological Survey Professional Paper 482. U.S. Department of the Interior, Geological Survey. 52 pages.

Weber, F.R.; McCammon, R.B.; Rinehart, C.D.; Light, T.D.; Wheeler, K.L. 1988. Geology and Mineral Resources of the White Mountains National Recreation Area, East-Central Alaska. Open File Report 88–284. U.S. Department of the Interior, Geological Survey. 120 pages.

Williams, G.P. 1978. Bankfull Discharge of Rivers. Water Resources Research 14:1141–1154.

Wolman, M.G.; Leopold, L.B. 1957. River floodplains: some observations on their formation. Professional Paper 282. U.S. Department of the Interior, Geological Survey. Pages 87–107.

Appendix A. Annual Data and Descriptions of Nome Creek Basin Stream-Gaging Sites

Nome Creek above Sumner Creek

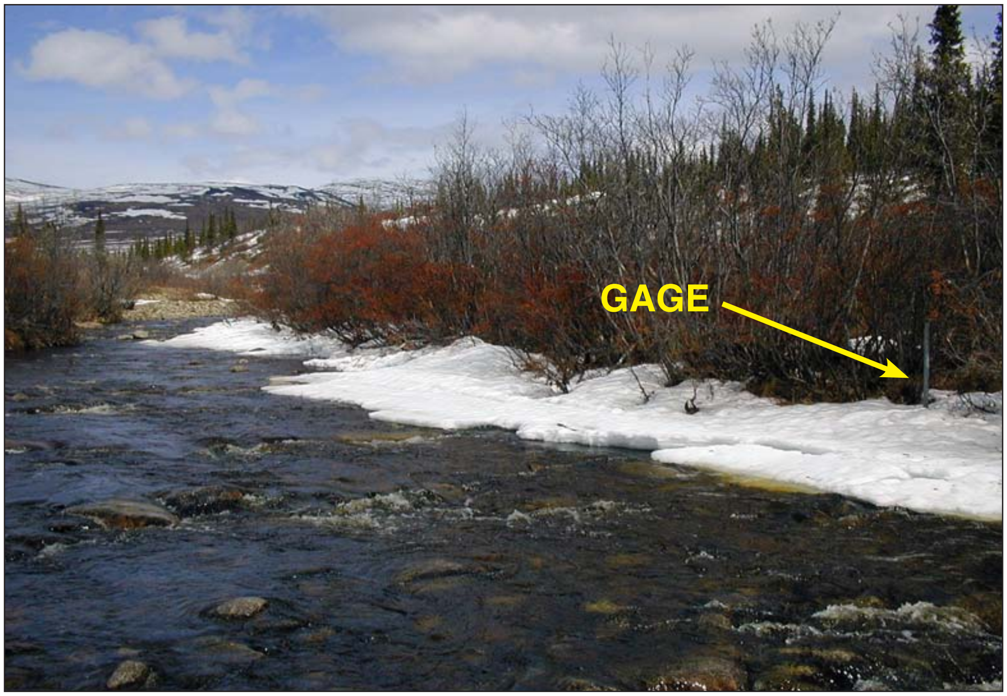

Figure A-1. Looking upstream at the crest-stage gage reach for Nome Creek above Sumner Creek during late spring. The remnant ice shelves can persist well into summer and confound peak discharge determinations.

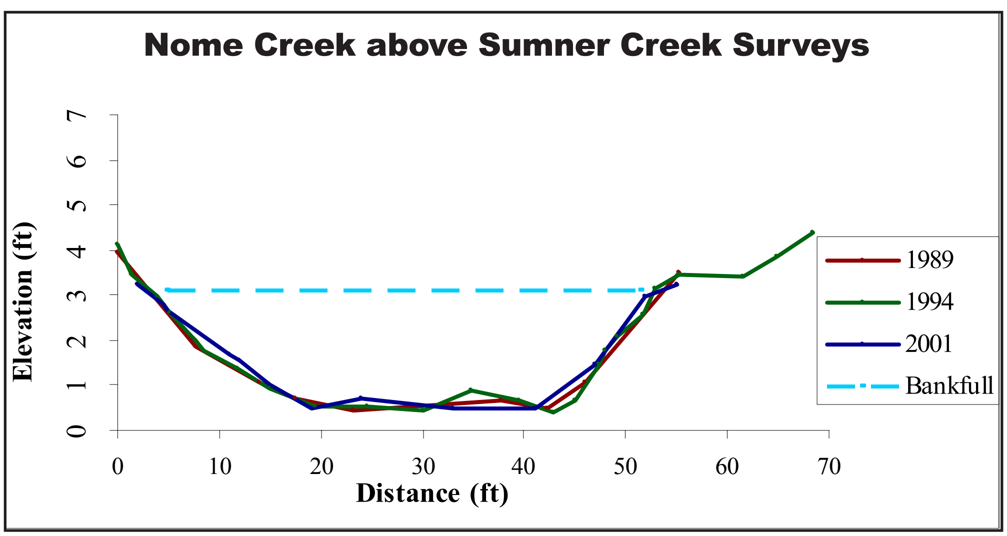

Figure A-2. Cross-sectional surveys for Nome Creek above Sumner Creek. This reach was above the mined area, had the most stable channel, and provided the best discharge data of all the sites.

Table A-1. Discharge measurement summary for Nome Creek above Sumner Creek

Measurement #	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Avg.Velocity (fps)	Avg. Depth (ft)
1	6/25/89*	2.65	405	48	78	5.2	1.6
2	6/27/89	1.57	39	38	20	2.0	0.5
3	8/10/89	1.25	12	27	9	1.3	0.3
4	7/13/90	1.79	73	36	27	2.7	0.8
5	9/5/90	1.87	89	39	33	2.7	0.8
6	7/19/91	1.25	14	31	11	1.3	0.4
7	8/18/91*	2.88	532	50	93	5.7	1.9
8	8/19/91	1.99	112	39	37	3.0	0.9
9	8/21/91	1.50	48	35	26	1.8	0.7
10	6/5/92	1.83	78	31	31	2.5	1.0
11	8/18/92	1.40	27	34	17	1.6	0.5
12	9/2/92	1.60	40	35	23	1.7	0.7
13	9/10/92	1.28	18	29	14	1.3	0.5
14	6/8/93	1.50	32	37	18	1.8	0.5
15	7/7/93	1.38	27	34	18	1.5	0.5
16	7/22/93	1.23	14	20	12	1.2	0.6
17	8/2/93	1.23	15	19	10	1.5	0.5
18	6/21/94	2.08	143	40	43	3.3	1.1
19	6/26/94*	3.52	750	58	118	6.4	2.0
20	8/24/94	1.45	31	34	16	1.9	0.5
21	8/25/94	2.15	164	53	52	3.2	1.0
22	8/26/94	1.78	69	45	32	2.2	0.7
23	9/14/94	1.35	19	23	15	1.3	0.7
24	6/24/95*	2.86	505	49	91	5.5	1.9
25	8/7/95	1.53	46	33	27	1.7	0.8
26	6/11/96	ND	166	85	86	1.9	1.0
27	7/16/96	1.34	22	26	20	1.1	0.8
28	7/25/96	1.10	6.6	17	10	0.7	0.6
29	8/11/97	1.35	25	26	23	1.1	0.9
30	6/5/98	1.31	17	25	18	0.9	0.7
31	7/21/98	1.43	27	33	20	1.4	0.6
32	8/14/98	1.72	52	35	27	1.9	0.8
33	8/17/98	2.28	204	53	58	3.5	1.1
34	8/8/99	2.01	93	35	34	2.7	1.0
35	8/11/00	1.94	83	38	41	2.0	1.1
36	8/13/00*	3.27	703	50	100	7.0	2.0
37	7/14/01*	2.80	365	46	77	4.7	1.7
38	7/31/01	1.66	43	34	28	1.5	0.8
39	7/15/03	2.14	144	36	46	3.1	1.3
40	9/22/05	1.42	21	24	16	1.3	0.7

* Slope-area (Manning equation) indirect discharge measurement
ND = Not Determined (backwater from ice)

Table A-2. Annual peak discharge summary for Nome Creek above Sumner Creek

Date of Peak	Water level	Discharge	Rank	Recurrence Interval
6/25/89	2.65	405	7	2.5
9/5/90	2.3	213	15	1.2
8/18/91	2.88	532	4	5
6/1/92	2.51	312	10	1.7
5/1/93	2.43	271	11	1.5
6/23/94	3.52	750	1	18
6/25/95	2.86	505	5	4.3
6/10/96	ND	265	12	1.4
7/1/97	1.99	109	17	1.0
8/16/98	2.41	222	14	1.3
7/22/99	2.09	131	16	1.1
8/13/00	3.27	703	2	13
7/14/01	2.8	365	8	2.2
7/31/02	2.76	363	9	2.2
7/29/03	3.2	629	3	8.6
6/1/04	2.49	248	13	1.4
7/2/05	2.87	420	6	2.8

ND = Not Determined (backwater from ice)

Nome Creek at the Bridge

Figure A-3. Looking downstream at the wire-weight gage reach for Nome Creek at the bridge. The gage was installed in 1998 on the downstream side and relocated to the upstream side of the bridge in 1999. Gaging continues to the present.

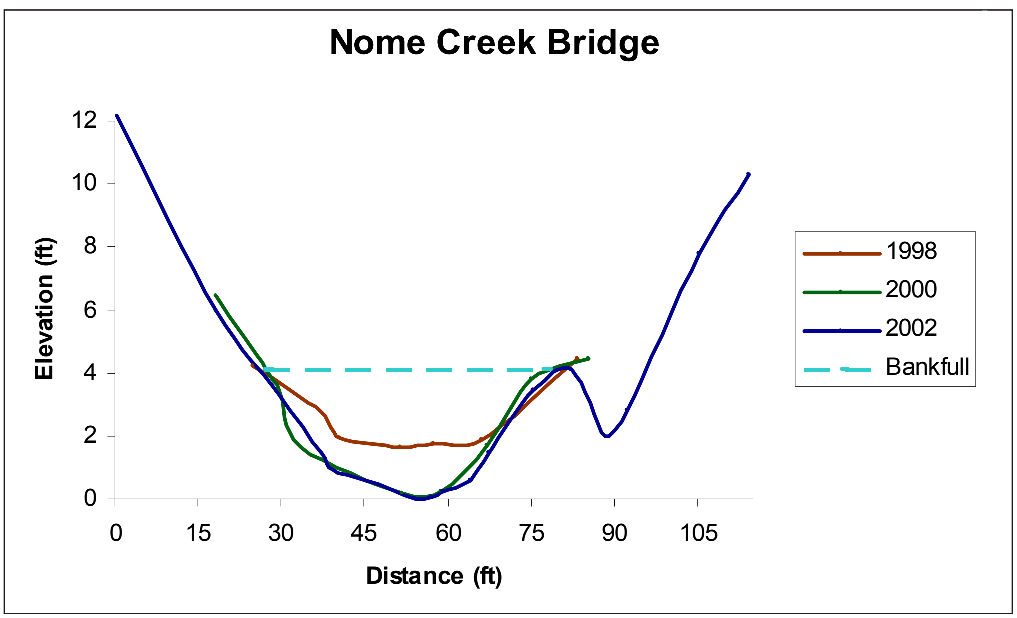

Figure A-4. Cross-sectional surveys for Nome Creek at the bridge. This reach was located in the reclamation area where tailings were removed for road construction and the stream channel relocated. It had the least stable channel, with erosion occurring after almost every high-water event, and its discharge data had the worst correlation of all the sites.

Table A-3. Discharge measurement summary for Nome Creek at the bridge

#	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Avg. Velocity (fps)	Avg. Depth (ft)
1	8/5/98	2.80	44	30	26	1.7	0.9
2	8/13/98	3.34	91	42	31	2.9	0.7
3	8/17/98	3.95	277	51	67	4.1	1.3
4	8/8/99	3.78	117	45	41	2.9	0.9
5	8/11/00	3.74	87	35	34	2.6	1.0
6	8/25/00	1.92	70	36	42	1.7	1.2
7	7/30/01	1.89	63	34	41	1.5	1.2
8	8/8/01	1.46	26	32	26	1.0	0.8
9	8/30/01	1.67	43	34	34	1.3	1.0
10	10/4/02	1.40	29	30	29	1.0	1.0
11	7/15/03	2.15	117	50	41	2.9	0.8
12	7/29/03	1.96	104	41	46	2.3	1.1
13	10/13/04	1.02	9.0	39	20	0.5	0.5

Table A-4. 1998 Wire-weight gage readings and water surface elevations for Nome Creek at the bridge

August			September		
Date	Wire Weight Reading	Water Surface Elevation (ft)	Date	Wire Weight Reading	Water Surface Elevation (ft)
1-Aug			1-Sep	5.06	42.96
2-Aug			2-Sep	5.09	42.99
3-Aug			3-Sep	5.05	42.95
4-Aug			4-Sep	5.04	42.94
5-Aug			5-Sep	5.01	42.91
6-Aug			6-Sep	4.99	42.89
7-Aug			7-Sep	4.94	42.84
8-Aug			8-Sep	4.95	42.85
9-Aug			9-Sep		
10-Aug			10-Sep		
11-Aug			11-Sep		
12-Aug			12-Sep		
13-Aug	5.29	43.19	13-Sep		
14-Aug	5.18	43.08	14-Sep		
15-Aug	5.27	43.17	15-Sep		
16-Aug	5.57	43.47	16-Sep	4.88	42.78
17-Aug	5.97	43.87	17-Sep		
18-Aug	5.70	43.60	18-Sep		
19-Aug	5.32	43.22	19-Sep		
20-Aug			20-Sep		
21-Aug	5.32	43.22	21-Sep		
22-Aug			22-Sep		
23-Aug	5.29	43.19	23-Sep		
24-Aug	5.22	43.12	24-Sep		
25-Aug			25-Sep		
26-Aug	5.16	43.06	26-Sep		
27-Aug	5.15	43.05	27-Sep		
28-Aug	5.14	43.04	28-Sep		
29-Aug	5.14	43.04	29-Sep		
30-Aug	5.12	43.02	30-Sep		
31-Aug	5.04	42.94			
Mean W. S. Elevation		43.08	Mean W. S. Elevation		42.91
Max. W. S. Elevation		43.87	Max. W. S. Elevation		42.99
Min. W. S. Elevation		42.94	Min. W. S. Elevation		42.78

Table A-5. 1999 wire-weight gage readings and water surface elevations for Nome Creek at the bridge

July			August			September		
Date	Wire Wt. Rdg.	W.S.Elev. (ft)	Date	W.Wt. Rdg.	W.S.Elev. (ft)	Date	W.Wt. Rdg.	W.S.Elev. (ft)
1-Jul	5.10	42.40	1-Aug			1-Sep	5.15	42.45
2-Jul			2-Aug			2-Sep		
3-Jul			3-Aug	5.50	42.80	3-Sep		
4-Jul			4-Aug			4-Sep		
5-Jul			5-Aug	5.45	42.75	5-Sep		
6-Jul			6-Aug	5.42	42.72	6-Sep		
7-Jul			7-Aug	5.53	42.83	7-Sep		
8-Jul			8-Aug	6.50	43.80	8-Sep		
9-Jul			9-Aug	6.14	43.44	9-Sep		
10-Jul			10-Aug			10-Sep		
11-Jul			11-Aug	5.95	43.25	11-Sep		
12-Jul			12-Aug	5.80	43.1	12-Sep		
13-Jul			13-Aug	6.10	43.4	13-Sep		
14-Jul			14-Aug	6.00	43.3	14-Sep		
15-Jul	5.12	42.42	15-Aug	5.78	43.08	15-Sep		
16-Jul			16-Aug			16-Sep		
17-Jul			17-Aug			17-Sep	5.55	42.85
18-Jul			18-Aug			18-Sep		
19-Jul			19-Aug			19-Sep		
20-Jul			20-Aug			20-Sep		
21-Jul			21-Aug			21-Sep		
22-Jul			22-Aug			22-Sep		
23-Jul	6.03	43.33	23-Aug			23-Sep		
24-Jul			24-Aug			24-Sep		
25-Jul			25-Aug	4.60	41.90	25-Sep		
26-Jul			26-Aug			26-Sep		
27-Jul			27-Aug			27-Sep		
28-Jul			28-Aug	4.50	41.80	28-Sep		
29-Jul			29-Aug			29-Sep		
30-Jul			30-Aug	4.50	41.80	30-Sep		
			31-Jul			31-Aug		
Mean W. S. Elevation		42.88	Mean W. S. Elev.		42.85	Mean W. S. Elevation		42.65
Max. W. S. Elevation		43.33	Max. W. S.Elev.		43.80	Max.W. S. Elevation		42.85
Min. W. S. Elevation		42.42	Min. W. S.Elev.		41.80	Min.W. S. Elevation		42.45

Table A-6. 2000 wire-weight gage readings and water surface elevations (ft) for Nome Creek at the bridge

June			July			August			September		
Date	W. Wt. Rdg.	W. S. Elev.	Date	W.Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.
1-Jun			1-Jul			1-Aug			1-Sep	4.33	41.63
2-Jun			2-Jul			2-Aug			2-Sep		
3-Jun			3-Jul			3-Aug			3-Sep		
4-Jun			4-Jul			4-Aug	5.48	42.78	4-Sep		
5-Jun			5-Jul			5-Aug	5.53	42.83	5-Sep		
6-Jun			6-Jul			6-Aug			6-Sep		
7-Jun			7-Jul			7-Aug	5.65	42.95	7-Sep		
8-Jun			8-Jul			8-Aug			8-Sep		
9-Jun			9-Jul			9-Aug			9-Sep		
10-Jun			10-Jul			10-Aug	5.54	42.84	10-Sep		
11-Jun			11-Jul			11-Aug	6.50	43.80	11-Sep		
12-Jun			12-Jul			12-Aug	5.92	43.22	12-Sep		
13-Jun			13-Jul			13-Aug			13-Sep		
14-Jun	7.35	44.65	14-Jul			14-Aug			14-Sep		
15-Jun			15-Jul			15-Aug	4.80	42.10	15-Sep	4.47	41.77
16-Jun			16-Jul			16-Aug			16-Sep		
17-Jun			17-Jul			17-Aug			17-Sep		
18-Jun			18-Jul	5.64	42.94	18-Aug			18-Sep		
19-Jun			19-Jul			19-Aug			19-Sep		
20-Jun			20-Jul			20-Aug			20-Sep		
21-Jun			21-Jul			21-Aug			21-Sep		
22-Jun			22-Jul			22-Aug			22-Sep		
23-Jun			23-Jul			23-Aug			23-Sep		
24-Jun			24-Jul			24-Aug			24-Sep		
25-Jun			25-Jul			25-Aug	4.60	41.90	25-Sep		
26-Jun			26-Jul	5.53	42.83	26-Aug			26-Sep		
27-Jun			27-Jul			27-Aug			27-Sep		
28-Jun			28-Jul	5.54	42.84	28-Aug	4.50	41.80	28-Sep		
29-Jun	5.7	43.00	29-Jul	5.46	42.76	29-Aug			29-Sep	4.48	41.78
30-Jun			30-Jul			30-Aug	4.50	41.80	30-Sep		
			31-Jul			31-Aug					
Mean W. S. Elevation		43.83	Mean.W. S. Elevation		42.84	Mean.W. S. Elevation		42.6	Mean W. S. Elevation		41.73
Max. W. S. Elevation		44.65	Max. W. S. Elevation		42.94	Max. W. S. Elevation		43.8	Max.W. S. Elevation		41.78
Min. W. S. Elevation		43	Min. W. S. Elevation		42.76	Min. W. S. Elevation		41.8	Min. W. S. Elevation		41.63

Table A-7. 2001 wire-weight gage readings and water surface elevations (ft) for Nome Creek at the bridge

June			July			August			September		
Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W .S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.
1-Jun			1-Jul			1-Aug	4.35	41.65	1-Sep	4.11	41.41
2-Jun			2-Jul			2-Aug	4.27	41.57	2-Sep		
3-Jun			3-Jul			3-Aug			3-Sep		
4-Jun			4-Jul			4-Aug	4.23	41.53	4-Sep		
5-Jun			5-Jul			5-Aug			5-Sep		
6-Jun			6-Jul			6-Aug	4.18	41.48	6-Sep		
7-Jun	5.00	42.30	7-Jul			7-Aug			7-Sep		
8-Jun			8-Jul			8-Aug	4.16	41.46	8-Sep		
9-Jun			9-Jul			9-Aug			9-Sep		
10-Jun			10-Jul			10-Aug	4.12	41.42	10-Sep		
11-Jun			11-Jul			11-Aug	4.54	41.84	11-Sep		
12-Jun			12-Jul			12-Aug			12-Sep		
13-Jun	4.60	41.90	13-Jul			13-Aug			13-Sep		
14-Jun	4.40	41.70	14-Jul			14-Aug			14-Sep		
15-Jun			15-Jul			15-Aug			15-Sep		
16-Jun			16-Jul			16-Aug			16-Sep		
17-Jun			17-Jul			17-Aug			17-Sep		
18-Jun			18-Jul			18-Aug			18-Sep		
19-Jun			19-Jul			19-Aug			19-Sep		
20-Jun			20-Jul			20-Aug			20-Sep		
21-Jun			21-Jul			21-Aug			21-Sep		
22-Jun			22-Jul			22-Aug	4.64	41.94	22-Sep		
23-Jun			23-Jul			23-Aug			23-Sep		
24-Jun			24-Jul			24-Aug			24-Sep		
25-Jun			25-Jul			25-Aug			25-Sep	4.15	41.45
26-Jun			26-Jul			26-Aug			26-Sep		
27-Jun			27-Jul	4.13	41.43	27-Aug	4.44	41.74	27-Sep		
28-Jun			28-Jul			28-Aug			28-Sep		
29-Jun			29-Jul	4.73	42.03	29-Aug			29-Sep		
30-Jun			30-Jul	4.59	41.89	30-Aug	4.37	41.67	30-Sep		
			31-Jul	4.41	41.71	31-Aug					
Mean W.S. Elevation		41.97	Mean W.S. Elevation		41.77	Mean W.S. Elevation		41.63	Mean W.S. Elevation		41.43
Max. W.S. Elevation		42.30	Max. W.S. Elevation		42.03	Max. W.S. Elevation		41.94	Max. W.S. Elevation		41.45
Min. W.S. Elevation		41.70	Min. W.S. Elevation		41.43	Min W.S. Elevation		41.42	Min. W.S. Elevation		41.41

Table A-8. 2002 wire-weight gage readings and water surface elevations (ft) for Nome Creek at the bridge

June			July			August			September		
Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.
1-Jun			1-Jul			1-Aug	4.23	41.53	1-Sep	4.28	41.58
2-Jun			2-Jul			2-Aug	4.13	41.43	2-Sep	4.30	41.60
3-Jun			3-Jul			3-Aug	4.04	41.34	3-Sep		
4-Jun	4.40	41.70	4-Jul			4-Aug	3.99	41.29	4-Sep		
5-Jun			5-Jul			5-Aug			5-Sep	4.12	41.42
6-Jun			6-Jul			6-Aug	3.97	41.27	6-Sep	4.30	41.60
7-Jun			7-Jul			7-Aug			7-Sep	4.62	41.92
8-Jun			8-Jul			8-Aug	3.95	41.25	8-Sep		
9-Jun			9-Jul			9-Aug			9-Sep		
10-Jun			10-Jul			10-Aug			10-Sep		
11-Jun			11-Jul			11-Aug	3.99	41.29	11-Sep		
12-Jun			12-Jul			12-Aug			12-Sep	4.22	41.52
13-Jun			13-Jul			13-Aug			13-Sep	4.18	41.48
14-Jun			14-Jul			14-Aug			14-Sep	4.10	41.40
15-Jun			15-Jul			15-Aug			15-Sep		
16-Jun			16-Jul			16-Aug	4.98	42.28	16-Sep	4.02	41.32
17-Jun			17-Jul			17-Aug	5.96	43.26	17-Sep		
18-Jun			18-Jul			18-Aug			18-Sep		
19-Jun			19-Jul			19-Aug			19-Sep		
20-Jun			20-Jul			20-Aug			20-Sep		
21-Jun	3.15	40.45	21-Jul			21-Aug			21-Sep		
22-Jun			22-Jul			22-Aug	4.69	41.99	22-Sep		
23-Jun			23-Jul			23-Aug			23-Sep		
24-Jun			24-Jul			24-Aug	4.65	41.95	24-Sep		
25-Jun			25-Jul	4.10	41.40	25-Aug	4.65	41.95	25-Sep		
26-Jun			26-Jul	5.60	42.90	26-Aug	4.48	41.78	26-Sep		
27-Jun			27-Jul	4.98	42.28	27-Aug			27-Sep		
28-Jun			28-Jul	4.84	42.14	28-Aug			28-Sep		
29-Jun			29-Jul			29-Aug	4.28	41.58	29-Sep		
30-Jun			30-Jul	4.30	41.60	30-Aug	4.30	41.60	30-Sep	4.30	41.60
			31-Jul			31-Aug					
Mean W. S. Elevation		41.08	Mean W. S. Elevation		42.06	Mean W. S. Elevation		41.72	Mean W. S. Elevation		41.54
Max. W. S. Elevation		41.70	Max. W. S. Elevation		42.90	Max. W. S. Elevation		43.26	Max. W. S. Elevation		41.92
Min. W. S. Elevation		40.45	Min W. S. Elevation		41.40	Min. W. S. Elevation		41.25	Min. W. S. Elevation		41.32

Table A-9. 2003 wire-weight gage readings and water surface elevations (ft) for Nome Creek at the bridge

June			July			August			September		
Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.
1-Jun			1-Jul			1-Aug	4.89	42.19	1-Sep	5.40	42.70
2-Jun			2-Jul			2-Aug			2-Sep		
3-Jun			3-Jul	4.08	41.38	3-Aug	5.44	42.74	3-Sep	5.00	42.30
4-Jun			4-Jul	4.00	41.30	4-Aug			4-Sep	4.78	42.08
5-Jun			5-Jul	3.89	41.19	5-Aug	4.74	42.04	5-Sep	4.88	42.18
6-Jun			6-Jul			6-Aug	4.49	41.79	6-Sep	4.75	42.05
7-Jun			7-Jul	4.07	41.37	7-Aug			7-Sep		
8-Jun	4.27	41.57	8-Jul			8-Aug			8-Sep	4.47	41.77
9-Jun			9-Jul			9-Aug	4.34	41.64	9-Sep		
10-Jun			10-Jul	3.93	41.23	10-Aug			10-Sep		
11-Jun			11-Jul			11-Aug	4.28	41.58	11-Sep	4.65	41.95
12-Jun	4.06	41.36	12-Jul	3.85	41.15	12-Aug			12-Sep		
13-Jun	3.99	41.29	13-Jul	3.85	41.15	13-Aug			13-Sep	4.38	41.68
14-Jun			14-Jul	4.20	41.5	14-Aug	4.15	41.45	14-Sep		
15-Jun	3.90	41.20	15-Jul	4.85	42.15	15-Aug			15-Sep	3.98	41.28
16-Jun			16-Jul	4.75	42.05	16-Aug	4.15	41.45	16-Sep	4.35	41.65
17-Jun			17-Jul	4.57	41.87	17-Aug	4.08	41.38	17-Sep		
18-Jun	3.98	41.28	18-Jul	4.4	41.7	18-Aug	4.02	41.32	18-Sep		
19-Jun	3.93	41.23	19-Jul	4.17	41.47	19-Aug			19-Sep		
20-Jun	3.83	41.13	20-Jul	4.09	41.39	20-Aug			20-Sep		
21-Jun			21-Jul	4.05	41.35	21-Aug	4.10	41.40	21-Sep		
22-Jun	3.74	41.04	22-Jul			22-Aug	4.05	41.35	22-Sep		
23-Jun	3.8	41.1	23-Jul			23-Aug	4.20	41.50	23-Sep		
24-Jun			24-Jul	3.97	41.27	24-Aug	5.07	42.37	24-Sep		
25-Jun	3.9	41.2	25-Jul			25-Aug	5.43	42.73	25-Sep		
26-Jun			26-Jul	4.05	41.35	26-Aug			26-Sep		
27-Jun	3.85	41.15	27-Jul	8.10	45.40	27-Aug	4.55	41.85	27-Sep		
28-Jun	3.84	41.14	28-Jul	7.42	44.72	28-Aug	4.47	41.77	28-Sep		
29-Jun	3.83	41.13	29-Jul			29-Aug	4.34	41.64	29-Sep		
30-Jun	3.79	41.09	30-Jul	4.64	41.94	30-Aug			30-Sep		
			31-Jul	5.47	42.77	31-Aug					
Mean W. S. Elevation		41.21	Mean W. S. Elevation		41.89	Mean W. S. Elevation		41.79	Mean W. S. Elevation		41.96
Max. W. S. Elevation		41.57	Max. W. S. Elevation		45.4	Max. W. S. Elevation		42.74	Max. W. S. Elevation		42.70
Min. W. S. Elevation		41.04	Min. W. S. Elevation		41.15	Min. W. S. Elevation		41.32	Min. W. S. Elevation		41.28

Table A-10. 2004 wire-weight gage readings and water surface elevations (ft) for Nome Creek at the bridge

June			July			August			September		
Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.
1-Jun	4.97	42.27	1-Jul			1-Aug	5.21	42.51	1-Sep		
2-Jun			2-Jul			2-Aug			2-Sep		
3-Jun			3-Jul			3-Aug	4.25	41.55	3-Sep		
4-Jun			4-Jul			4-Aug			4-Sep		
5-Jun			5-Jul			5-Aug			5-Sep		
6-Jun			6-Jul			6-Aug	4.19	41.49	6-Sep	3.83	41.13
7-Jun			7-Jul			7-Aug	4.03	41.33	7-Sep		
8-Jun			8-Jul			8-Aug	3.98	41.28	8-Sep		
9-Jun			9-Jul			9-Aug	3.90	41.20	9-Sep	3.78	41.08
10-Jun			10-Jul			10-Aug			10-Sep	3.75	41.05
11-Jun			11-Jul			11-Aug			11-Sep		
12-Jun	3.50	40.80	12-Jul			12-Aug			12-Sep		
13-Jun	3.65	40.95	13-Jul			13-Aug	3.87	41.17	13-Sep		
14-Jun	3.95	41.25	14-Jul			14-Aug	3.91	41.21	14-Sep		
15-Jun			15-Jul			15-Aug			15-Sep		
16-Jun	3.50	40.80	16-Jul	3.76	41.06	16-Aug	3.93	41.23	16-Sep		
17-Jun	4.05	41.35	17-Jul			17-Aug			17-Sep	3.71	41.01
18-Jun	3.96	41.26	18-Jul			18-Aug			18-Sep	3.71	41.01
19-Jun	3.93	41.23	19-Jul			19-Aug	3.87	41.17	19-Sep		
20-Jun			20-Jul			20-Aug	3.86	41.16	20-Sep		
21-Jun			21-Jul	3.84	41.14	21-Aug			21-Sep		
22-Jun			22-Jul			22-Aug			22-Sep		
23-Jun			23-Jul			23-Aug			23-Sep		
24-Jun			24-Jul			24-Aug			24-Sep		
25-Jun			25-Jul			25-Aug	3.86	41.16	25-Sep		
26-Jun			26-Jul			26-Aug	3.86	41.16	26-Sep		
27-Jun			27-Jul			27-Aug	3.84	41.14	27-Sep		
28-Jun			28-Jul			28-Aug			28-Sep		
29-Jun			29-Jul			29-Aug			29-Sep		
30-Jun			30-Jul	4.39	41.69	30-Aug			30-Sep		
			31-Jul	4.80	42.10	31-Aug					
Mean W. S. Elevation		41.24	Mean W. S. Elevation		41.30	Mean W. S. Elevation		41.07	Mean W. S. Elevation		41.06
Max. W. S. Elevation		42.27	Max. W. S. Elevation		42.10	Max. W. S. Elevation		42.51	Max. W. S. Elevation		41.13
Min. W. S. Elevation		40.80	Min. W. S. Elevation		41.06	Min. W. S. Elevation		41.14	Min. W. S. Elevation		41.01

Table A-11. 2005 wire-weight gage readings and water surface elevations (ft) for Nome Creek at the bridge

May			June			July			August			September		
Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.	Date	W. Wt. Rdg.	W. S. Elev.
1-May			1-Jun	4.85	42.15	1-Jul	5.85	43.15	1-Aug			1-Sep	4.09	41.39
2-May			2-Jun	4.67	41.97	2-Jul	5.11	42.41	2-Aug			2-Sep		
3-May			3-Jun			3-Jul	4.57	41.87	3-Aug			3-Sep		
4-May			4-Jun	4.39	41.69	4-Jul	4.66	41.96	4-Aug	4.25	41.55	4-Sep	4.07	41.37
5-May			5-Jun	4.36	41.66	5-Jul			5-Aug	4.27	41.57	5-Sep		
6-May			6-Jun	4.33	41.63	6-Jul			6-Aug			6-Sep		
7-May			7-Jun			7-Jul	4.68	41.98	7-Aug	4.25	41.55	7-Sep		
8-May			8-Jun			8-Jul	4.57	41.87	8-Aug			8-Sep	4.10	41.40
9-May			9-Jun	4.23	41.53	9-Jul			9-Aug			9-Sep		
10-May	4.21	41.51	10-Jun	4.22	41.52	10-Jul	4.68	41.98	10-Aug			10-Sep	4.20	41.50
11-May			11-Jun			11-Jul			11-Aug			11-Sep	4.16	41.46
12-May			12-Jun			12-Jul	4.58	41.88	12-Aug	4.14	41.44	12-Sep		
13-May			13-Jun			13-Jul			13-Aug			13-Sep		
14-May			14-Jun			14-Jul			14-Aug	4.11	41.41	14-Sep		
15-May			15-Jun			15-Jul	4.50	41.80	15-Aug			15-Sep		
16-May			16-Jun	4.14	41.44	16-Jul			16-Aug			16-Sep		
17-May			17-Jun	4.25	41.55	17-Jul			17-Aug			17-Sep		
18-May			18-Jun			18-Jul	4.56	41.86	18-Aug			18-Sep		
19-May			19-Jun			19-Jul			19-Aug	4.07	41.37	19-Sep		
20-May			20-Jun	4.11	41.41	20-Jul			20-Aug			20-Sep		
21-May	4.10	41.40	21-Jun	4.10	41.40	21-Jul			21-Aug	4.07	41.37	21-Sep	4.12	41.42
22-May	4.29	41.59	22-Jun	4.05	41.35	22-Jul			22-Aug			22-Sep	4.20	41.50
23-May	4.08	41.38	23-Jun	4.08	41.38	23-Jul	4.39	41.69	23-Aug	4.05	41.35	23-Sep		
24-May			24-Jun	4.02	41.32	24-Jul			24-Aug			24-Sep		
25-May			25-Jun			25-Jul	4.36	41.66	25-Aug			25-Sep		
26-May	4.28	41.58	26-Jun			26-Jul			26-Aug	4.04	41.34	26-Sep		
27-May	4.29	41.59	27-Jun			27-Jul	4.32	41.62	27-Aug			27-Sep		
28-May	4.07	41.37	28-Jun	4.07	41.37	28-Jul			28-Aug			28-Sep		
29-May			29-Jun			29-Jul	4.34	41.64	29-Aug	4.10	41.40	29-Sep		
30-May			30-Jun			30-Jul	4.28	41.58	30-Aug			30-Sep		
31-May						31-Jul	4.31	41.61	31-Aug					
Mean W.S. Elev.		41.49	Mean W.S. Elev.		41.56	Mean W. S. Elev.		41.93	Mean W. S. Elev.		41.44	Mean W. S. Elev.		41.43
Max. W.S. Elev.		41.59	Max. W.S. Elev.		42.15	Max. W. S. Elev.		43.15	Max. W. S. Elev.		41.57	Max. W. S. Elev.		41.50
Min. W.S. Elev.		41.37	Min. W.S. Elev.		41.32	Min. W.S. Elev.		41.58	Min. W. S. Elev.		41.34	Min. W. S. Elev.		41.37

Nome Creek at the Maze

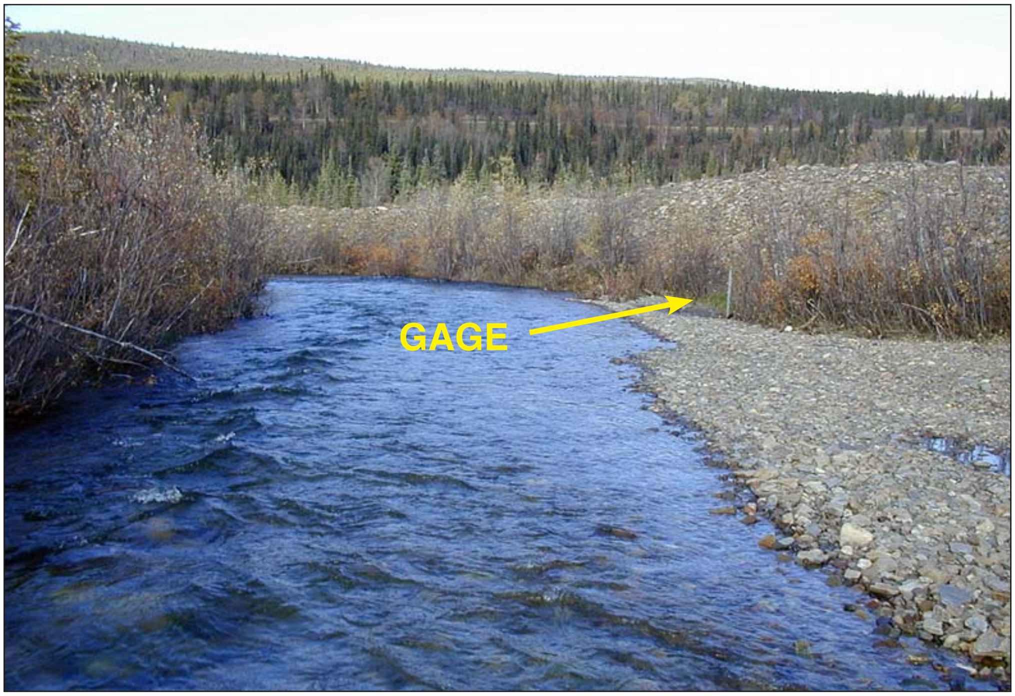

Figure A-5. Looking downstream at the crest-stage gage reach for Nome Creek at the Maze. The gage was installed in 1989 and gaging continues to the present. The unreclaimed tailings piles that give the Maze its name are to the right of the crest-stage gage.

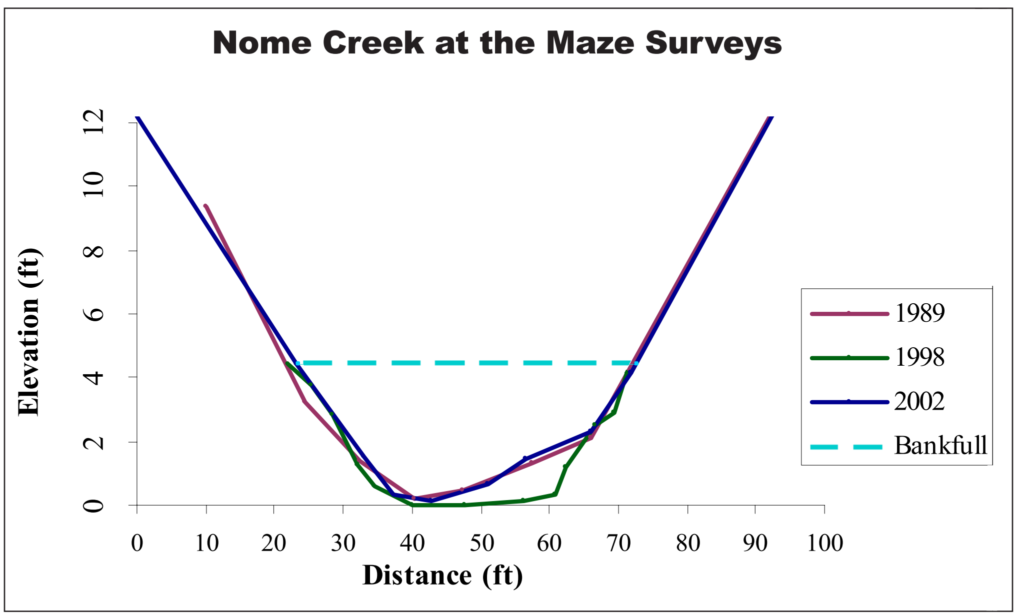

Figure A-6. Cross-sectional surveys for Nome Creek at the Maze. This reach was below the reclamation area and had a fairly stable channel until the flood of 2003, when a large sand bar was deposited at the gage.

Table A-12. Discharge measurement summary for Nome Creek at the Maze

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Velocity (fps)	Avg. Depth (ft)
6/13/89	0.95	40	21	16	2.5	0.8
6/25/89*	3.22	504	47	85	5.9	1.8
6/27/89	1.10	54	24	20	2.7	0.8
7/12/90	1.42	91	31	29	3.1	0.9
8/19/91	1.95	174	34	63	2.8	1.9
7/22/93	0.80	28	24	11	2.5	0.5
6/23/94	2.10	187	36	63	3.0	1.8
9/27/94	0.69	23	20	27	0.9	1.4
8/7/95	1.15	64	31	30	2.1	1.0
7/16/96	0.91	40	22	18	2.2	0.8
7/25/96	0.75	14	19	16	0.9	0.8
8/27/97	1.04	34	20	18	1.9	0.9
6/5/98	1.09	29	21	23	1.3	1.1
8/17/98*	3.48	631	43	121	5.2	2.8
9/3/98	1.25	58	26	24	2.4	0.9
8/8/99	1.74	145	36	42	3.5	1.2
8/11/00	1.49	90	26	26	3.5	1.0
8/14/00*	5.45	990	59	228	4.3	3.9
7/31/01	1.47	54	35	30	1.8	0.9
8/8/01	1.40	28	26	17	1.6	0.7
7/31/02*	4.89	760	61	150	5.1	2.5
10/4/02	1.59	32	19	13	2.5	0.7
7/18/03	2.48	63	22	19	3.3	0.9
7/29/03*	6.41	1,050	64	216	4.9	3.4
6/01/04*	4.36	358	53	96	3.7	1.8
10/13/04	2.02	12	26	11	1.1	0.4
7/02/05*	4.77	507	56	118	4.3	2.1
9/21/05	2.64	34	22	19	1.8	0.9

* Slope–area (Manning equation) indirect discharge measurement

Table A-13. Annual peak discharge summary for Nome Creek at the Maze

Year	Discharge	Rank	Reccurrance Interval (yrs)
1989	504	10	1.9
1990	292	15	1.1
1991	581	8	2.5
1992	604	7	2.7
1993	404	11	1.4
1994	932	3	9.8
1995	729	5	4.3
1996	380	13	1.3
1997	210	17	1.0
1998	631	6	2.9
1999	275	16	1.1
2000	990	2	13
2001	401	12	1.4
2002	760	4	4.8
2003	1,050	1	16
2004	358	14	1.4
2005	507	9	1.9

Nome Creek above Ophir Creek

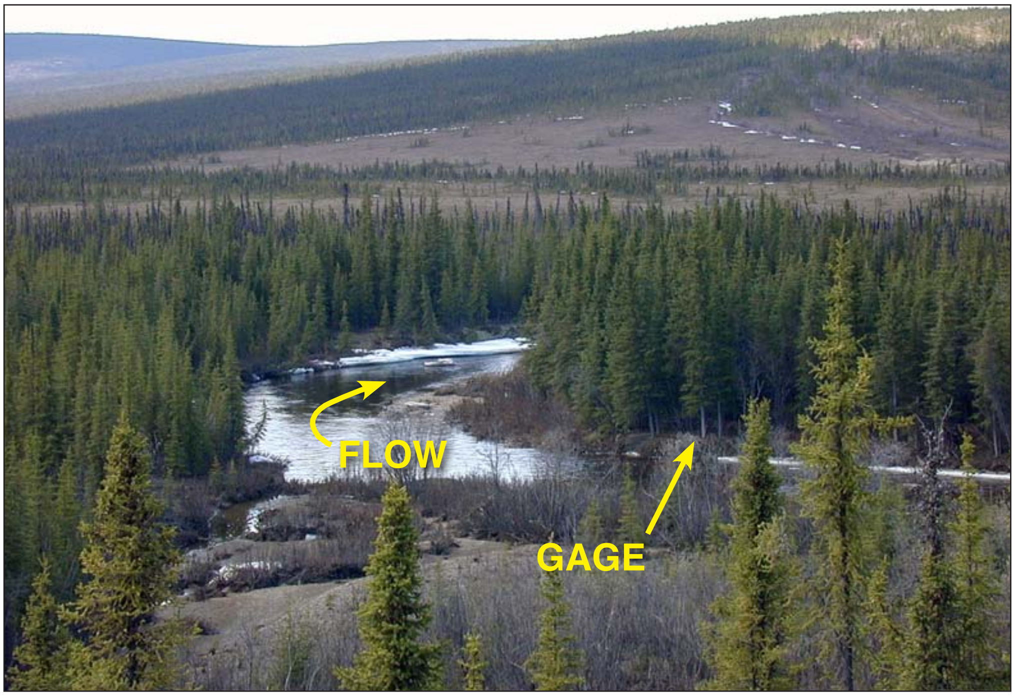

Figure A-7. Looking downstream at the data-logger gage reach for Nome Creek above Ophir Creek in late spring. The gage was installed in 1999 and gaging continues to the present.

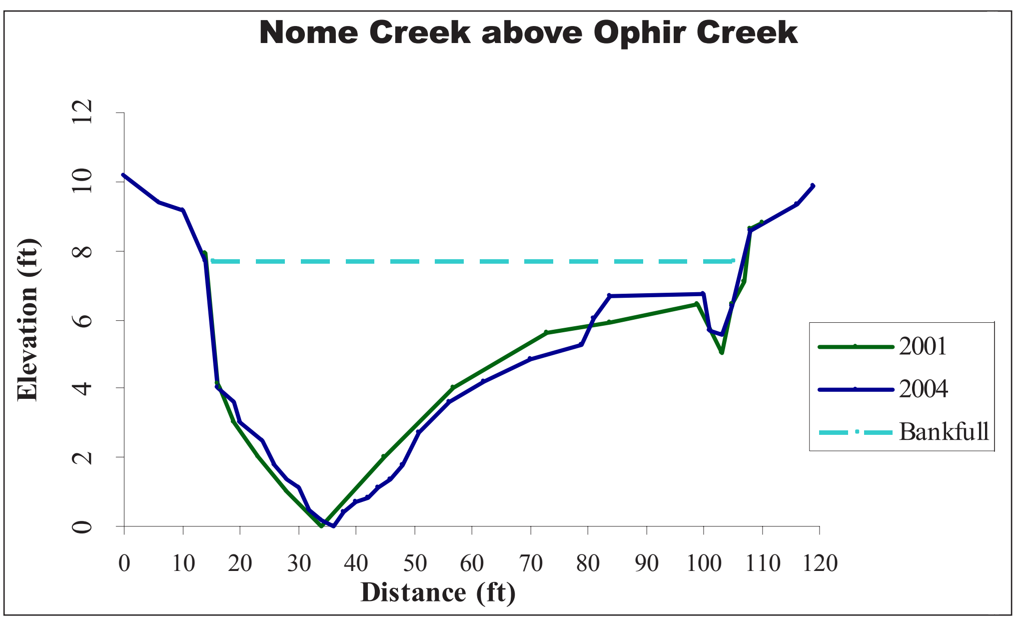

Figure A-8. Cross-sectional surveys for Nome Creek above Ophir Creek. This reach below the reclamation area had a fairly stable channel, but silty sediment was often deposited along the banks following high water.

Table A-14. Discharge measurement summary for Nome Creek above Ophir Creek

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Velocity (fps)	Avg. Depth (ft)
7/14/99	1.60	27	28	28	1.0	1.0
8/8/99	3.71	407	84	131	3.1	1.6
8/11/99	2.81	167	42	64	2.6	1.5
6/27/00	2.19	75	35	36	2.1	1.0
8/1/01	2.54	106	37	46	2.3	1.2
8/8/01	2.25	68	36	37	1.8	1.0
8/23/01	2.74	147	44	54	2.7	1.2
8/30/01	2.72	145	41	52	2.8	1.3
10/1/01	2.18	61	35	32	1.9	0.9
7/30/02	2.83	144	40	48	3.0	1.2
9/30/02	2.86	164	43	54	3.0	1.3
10/4/02	2.49	100	39	40	2.5	1.0
5/23/03	2.47	75	34	32	2.3	0.9
7/18/03	3.27	211	64	89	2.4	1.4
7/29/03	3.94	435	66	130	3.3	2.0
8/5/03	3.64	356	66	119	3.0	1.8
9/16/03	2.9	175	63	79	2.2	1.3
9/23/03	2.47	124	61	62	2.0	1.0
10/2/03	2.42	106	64	62	1.7	1.0
6/1/04	4.01	491	71	161	3.0	2.3
6/9/04	2.29	104	62	55	1.9	0.9
7/9/04	1.77	29	28	20	1.5	0.7
8/9/04	2.07	56	51	35	1.6	0.7
10/5/04	1.91	34	37	74	0.5	2.0
5/24/05	2.65	127	69	74	1.7	1.1
6/1/05	3.68	350	71	134	2.6	1.9
9/8/05	2.57	126	66	68	1.9	1.0
10/6/05	2.43	109	65	59	1.8	0.9
10/18/05	2.40	86	68	48	1.8	0.7
11/1/05	ND	46	47	44	1.0	0.9

ND = Not Determined (backwater from ice)

Table A-15. 1999 Mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Discharge	Date	Discharge	Date	Discharge
1-Jul	54	1-Aug	71	1-Sep	53
2-Jul	48	2-Aug	77	2-Sep	53
3-Jul	44	3-Aug	85	3-Sep	59
4-Jul	41	4-Aug	71	4-Sep	137
5-Jul	39	5-Aug	62	5-Sep	114
6-Jul	37	6-Aug	57	6-Sep	97
7-Jul	36	7-Aug	101	7-Sep	86
8-Jul	34	8-Aug	586	8-Sep	78
9-Jul	34	9-Aug	513	9-Sep	73
10-Jul	33	10-Aug	565	10-Sep	73
11-Jul	32	11-Aug	254	11-Sep	69
12-Jul	31	12-Aug	170	12-Sep	65
13-Jul	34	13-Aug	259	13-Sep	65
14-Jul	35	14-Aug	243	14-Sep	105
15-Jul	27	15-Aug	162	15-Sep	111
16-Jul	32	16-Aug	127	16-Sep	98
17-Jul	42	17-Aug	106	17-Sep	91
18-Jul	58	18-Aug	95	18-Sep	65
19-Jul	63	19-Aug	87	19-Sep	64
20-Jul	59	20-Aug	80	20-Sep	62
21-Jul	55	21-Aug	74	21-Sep	60
22-Jul	56	22-Aug	70	22-Sep	58
23-Jul	122	23-Aug	68	23-Sep	57
24-Jul	96	24-Aug	72	24-Sep	56
25-Jul	86	25-Aug	70	25-Sep	57
26-Jul	105	26-Aug	65	26-Sep	63
27-Jul	267	27-Aug	62	27-Sep	69
28-Jul	166	28-Aug	60	28-Sep	69
29-Jul	122	29-Aug	58	29-Sep	68
30-Jul	100	30-Aug	56	30-Sep	67
31-Jul	84	31-Aug	54		
Mean Discharge	67	Mean Discharge	144	Mean Discharge	75
Max. Discharge	267	Max. Discharge	586	Max. Discharge	137
Min. Discharge	27	Min. Discharge	54	Min. Discharge	53
Runoff (cfsm)	0.73	Runoff (cfsm)	1.59	Runoff (cfsm)	0.82
Runoff (in)	0.83	Runoff (in)	1.80	Runoff (in)	0.93
Peak Recorded	4.58 ft	Peak Discharge	795 cfs	Date	9-Aug
Minimum Recorded	1.60 ft	Min. Discharge	27 cfs	Date	15-Jul

Gage operated July 1–Sept. 17

Estimated period: Sept. 18–30

Table A-16. 2000 mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun	191	1-Jul	60	1-Aug	69	1-Sep	70
2-Jun	200	2-Jul	57	2-Aug	65	2-Sep	115
3-Jun	199	3-Jul	57	3-Aug	66	3-Sep	118
4-Jun	201	4-Jul	62	4-Aug	65	4-Sep	100
5-Jun	198	5-Jul	58	5-Aug	66	5-Sep	90
6-Jun	192	6-Jul	57	6-Aug	78	6-Sep	103
7-Jun	186	7-Jul	56	7-Aug	77	7-Sep	120
8-Jun	177	8-Jul	54	8-Aug	74	8-Sep	138
9-Jun	173	9-Jul	53	9-Aug	69	9-Sep	169
10-Jun	181	10-Jul	61	10-Aug	68	10-Sep	134
11-Jun	188	11-Jul	68	11-Aug	108	11-Sep	150
12-Jun	168	12-Jul	305	12-Aug	137	12-Sep	175
13-Jun	150	13-Jul	201	13-Aug	598	13-Sep	181
14-Jun	153	14-Jul	126	14-Aug	640	14-Sep	155
15-Jun	152	15-Jul	107	15-Aug	163	15-Sep	149
16-Jun	178	16-Jul	92	16-Aug	79	16-Sep	129
17-Jun	181	17-Jul	91	17-Aug	55	17-Sep	124
18-Jun	150	18-Jul	113	18-Aug	111	18-Sep	105
19-Jun	131	19-Jul	101	19-Aug	229	19-Sep	111
20-Jun	121	20-Jul	87	20-Aug	140	20-Sep	112
21-Jun	116	21-Jul	82	21-Aug	99	21-Sep	118
22-Jun	109	22-Jul	79	22-Aug	110	22-Sep	271
23-Jun	103	23-Jul	75	23-Aug	186	23-Sep	420
24-Jun	99	24-Jul	73	24-Aug	143	24-Sep	339
25-Jun	93	25-Jul	73	25-Aug	116	25-Sep	293
26-Jun	88	26-Jul	67	26-Aug	134	26-Sep	266
27-Jun	79	27-Jul	67	27-Aug	104	27-Sep	224
28-Jun	72	28-Jul	69	28-Aug	90	28-Sep	181
29-Jun	64	29-Jul	71	29-Aug	79	29-Sep	169
30-Jun	63	30-Jul	69	30-Aug	78	30-Sep	148
		31-Jul	70	31-Aug	77		
Mean Discharge	146	Mean Discharge	86	Mean Discharge	135	Mean Discharge	166
Max. Discharge	205	Max. Discharge	305	Max. Discharge	640	Max. Discharge	420
Min. Discharge	63	Min. Discharge	53	Min. Discharge	55	Min. Discharge	70
Runoff (cfsm)	1.60	Runoff (cfsm)	0.94	Runoff (cfsm)	1.48	Runoff (cfsm)	1.82
Runoff (in)	1.81	Runoff (in)	1.07	Runoff (in)	1.67	Runoff (in)	2.06
Peak Recorded	5.07 ft	Discharge	1,100	Date	14-Aug		
Min. Recorded	1.89 ft	Discharge	47	Date	5-Aug		

Gage operated June 27–Sep 29
Estimated period: Jun 1–26, Sep 30

Table A-17. 2001 mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun	124	1-Jul	123	1-Aug	104	1-Sep	172
2-Jun	135	2-Jul	180	2-Aug	90	2-Sep	152
3-Jun	151	3-Jul	265	3-Aug	83	3-Sep	138
4-Jun	167	4-Jul	143	4-Aug	85	4-Sep	130
5-Jun	154	5-Jul	189	5-Aug	82	5-Sep	133
6-Jun	184	6-Jul	313	6-Aug	75	6-Sep	136
7-Jun	179	7-Jul	312	7-Aug	70	7-Sep	128
8-Jun	228	8-Jul	193	8-Aug	65	8-Sep	122
9-Jun	281	9-Jul	153	9-Aug	62	9-Sep	115
10-Jun	197	10-Jul	131	10-Aug	80	10-Sep	109
11-Jun	155	11-Jul	121	11-Aug	111	11-Sep	103
12-Jun	137	12-Jul	104	12-Aug	278	12-Sep	100
13-Jun	128	13-Jul	90	13-Aug	307	13-Sep	97
14-Jun	209	14-Jul	200	14-Aug	326	14-Sep	93
15-Jun	152	15-Jul	359	15-Aug	681	15-Sep	89
16-Jun	116	16-Jul	190	16-Aug	581	16-Sep	84
17-Jun	96	17-Jul	122	17-Aug	463	17-Sep	81
18-Jun	84	18-Jul	101	18-Aug	313	18-Sep	79
19-Jun	77	19-Jul	85	19-Aug	268	19-Sep	77
20-Jun	84	20-Jul	75	20-Aug	225	20-Sep	75
21-Jun	71	21-Jul	69	21-Aug	188	21-Sep	75
22-Jun	61	22-Jul	67	22-Aug	165	22-Sep	73
23-Jun	55	23-Jul	74	23-Aug	152	23-Sep	72
24-Jun	50	24-Jul	68	24-Aug	184	24-Sep	71
25-Jun	45	25-Jul	66	25-Aug	265	25-Sep	68
26-Jun	42	26-Jul	66	26-Aug	246	26-Sep	67
27-Jun	41	27-Jul	63	27-Aug	198	27-Sep	66
28-Jun	42	28-Jul	77	28-Aug	176	28-Sep	65
29-Jun	39	29-Jul	220	29-Aug	156	29-Sep	62
30-Jun	57	30-Jul	191	30-Aug	143	30-Sep	61
		31-Jul	129	31-Aug	151		
Mean Discharge	118	Mean Discharge	146	Mean Discharge	206	Mean Discharge	96
Max. Discharge	281	Max. Discharge	359	Max. Discharge	681	Max. Discharge	172
Min. Discharege	39	Min. Discharge	63	Min. Discharge	62	Min. Discharge	61
Runoff (cfsm)	1.30	Runoff (cfsm)	1.61	Runoff (cfsm)	2.26	Runoff (cfsm)	1.06
Runoff (in)	1.47	Runoff (in)	1.82	Runoff (in)	2.56	Runoff (in)	1.20
Peak Recorded	4.57 ft	Peak Discharge	778 cfs	Date	15-Aug		
Min. Recorded	1.92 ft	Min. Discharge	37 cfs	Date	29-Jun		

Gage operated June 14–Sep 30
Estimated period: June 1–13

Table A-18. 2002 mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun	95	1-Jul	72	1-Aug	97	1-Sep	116
2-Jun	122	2-Jul	79	2-Aug	85	2-Sep	120
3-Jun	166	3-Jul	744	3-Aug	77	3-Sep	110
4-Jun	246	4-Jul	1,124	4-Aug	71	4-Sep	104
5-Jun	216	5-Jul	392	5-Aug	66	5-Sep	101
6-Jun	216	6-Jul	366	6-Aug	63	6-Sep	271
7-Jun	173	7-Jul	334	7-Aug	60	7-Sep	214
8-Jun	149	8-Jul	225	8-Aug	61	8-Sep	164
9-Jun	134	9-Jul	157	9-Aug	61	9-Sep	137
10-Jun	119	10-Jul	123	10-Aug	68	10-Sep	120
11-Jun	119	11-Jul	100	11-Aug	71	11-Sep	120
12-Jun	284	12-Jul	95	12-Aug	81	12-Sep	111
13-Jun	524	13-Jul	234	13-Aug	96	13-Sep	104
14-Jun	458	14-Jul	137	14-Aug	106	14-Sep	98
15-Jun	318	15-Jul	103	15-Aug	93	15-Sep	93
16-Jun	199	16-Jul	87	16-Aug	255	16-Sep	89
17-Jun	149	17-Jul	78	17-Aug	1,105	17-Sep	86
18-Jun	121	18-Jul	73	18-Aug	740	18-Sep	94
19-Jun	102	19-Jul	182	19-Aug	861	19-Sep	91
20-Jun	96	20-Jul	150	20-Aug	496	20-Sep	91
21-Jun	101	21-Jul	116	21-Aug	281	21-Sep	88
22-Jun	98	22-Jul	103	22-Aug	231	22-Sep	82
23-Jun	94	23-Jul	86	23-Aug	208	23-Sep	78
24-Jun	91	24-Jul	78	24-Aug	207	24-Sep	76
25-Jun	91	25-Jul	80	25-Aug	209	25-Sep	79
26-Jun	102	26-Jul	503	26-Aug	177	26-Sep	78
27-Jun	101	27-Jul	476	27-Aug	152	27-Sep	102
28-Jun	90	28-Jul	415	28-Aug	135	28-Sep	106
29-Jun	82	29-Jul	242	29-Aug	123	29-Sep	141
30-Jun	76	30-Jul	156	30-Aug	113	30-Sep	161
		31-Jul	118	31-Aug	109		
Mean Discharge	164	Mean Discharge	233	Mean Discharge	212	Mean Discharge	114
Max. Discharge	524	Max. Discharge	1,124	Max. Discharge	1,105	Max. Discharge	271
Min. Discharge	76	Min. Discharge	72	Min. Discharge	60	Min. Discharge	76
Runoff (cfsm)	1.81	Runoff (cfsm)	2.56	Runoff (cfsm)	2.33	Runoff (cfsm)	1.25
Runoff (in)	2.04	Runoff (in)	2.90	Runoff (in)	2.63	Runoff (in)	1.42
Peak Recorded	6.02 ft	Peak Discharge	1,956 cfs	Date	5-Jul		
Min. Recorded	2.12 ft	Min. Discharge	59 cfs	Date	2-Jul		

Gage operated Jun 4–Sep 30

Estimated period: Jun 1–3

Table A-19. 2003 mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.
1-May	188	1-Jun	180	1-Jul	49	1-Aug	565	1-Sep	538	1-Oct	107
2-May	142	2-Jun	180	2-Jul	47	2-Aug	374	2-Sep	850	2-Oct	104
3-May	119	3-Jun	165	3-Jul	58	3-Aug	383	3-Sep	620	3-Oct	100
4-May	103	4-Jun	156	4-Jul	74	4-Aug	445	4-Sep	488	4-Oct	98
5-May	87	5-Jun	134	5-Jul	61	5-Aug	357	5-Sep	397	5-Oct	98
6-May	79	6-Jun	245	6-Jul	59	6-Aug	302	6-Sep	345	6-Oct	97
7-May	76	7-Jun	606	7-Jul	182	7-Aug	244	7-Sep	300	7-Oct	96
8-May	76	8-Jun	357	8-Jul	121	8-Aug	203	8-Sep	265	8-Oct	94
9-May	76	9-Jun	189	9-Jul	83	9-Aug	176	9-Sep	237	9-Oct	93
10-May	88	10-Jun	139	10-Jul	70	10-Aug	161	10-Sep	218	10-Oct	91
11-May	129	11-Jun	122	11-Jul	72	11-Aug	153	11-Sep	309	11-Oct	89
12-May	145	12-Jun	101	12-Jul	70	12-Aug	152	12-Sep	418	12-Oct	87
13-May	156	13-Jun	77	13-Jul	63	13-Aug	147	13-Sep	281	13-Oct	85
14-May	169	14-Jun	66	14-Jul	93	14-Aug	139	14-Sep	224	14-Oct	80
15-May	141	15-Jun	59	15-Jul	410	15-Aug	130	15-Sep	196	15-Oct	78
16-May	121	16-Jun	58	16-Jul	646	16-Aug	127	16-Sep	183	16-Oct	72
17-May	107	17-Jun	59	17-Jul	398	17-Aug	121	17-Sep	167	17-Oct	65
18-May	91	18-Jun	57	18-Jul	245	18-Aug	118	18-Sep	155	18-Oct	61
19-May	84	19-Jun	55	19-Jul	141	19-Aug	111	19-Sep	154	19-Oct	57
20-May	81	20-Jun	50	20-Jul	105	20-Aug	107	20-Sep	143	20-Oct	52
21-May	82	21-Jun	46	21-Jul	86	21-Aug	103	21-Sep	139	21-Oct	50
22-May	82	22-Jun	44	22-Jul	74	22-Aug	101	22-Sep	129	22-Oct	48
23-May	91	23-Jun	43	23-Jul	66	23-Aug	107	23-Sep	120	23-Oct	50
24-May	118	24-Jun	43	24-Jul	61	24-Aug	414	24-Sep	113	24-Oct	52
25-May	122	25-Jun	53	25-Jul	58	25-Aug	487	25-Sep	110	25-Oct	55
26-May	122	26-Jun	54	26-Jul	67	26-Aug	319	26-Sep	110	26-Oct	59
27-May	127	27-Jun	51	27-Jul	1,222	27-Aug	241	27-Sep	106	27-Oct	63
28-May	128	28-Jun	52	28-Jul	1,367	28-Aug	202	28-Sep	104	28-Oct	67
29-May	157	29-Jun	55	29-Jul	487	29-Aug	184	29-Sep	105	29-Oct	71
30-May	159	30-Jun	52	30-Jul	321	30-Aug	184	30-Sep	106	30-Oct	69
31-May	150			31-Jul	677	31-Aug	201			31-Oct	67
Mean Disch.	117	Mean Disch.	118	Mean Disch.	243	Mean Disch.	228	Mean Disch.	254	Mean Disch.	76
Max. Disch.	188	Max. Disch.	606	Max. Disch.	1,367	Max. Disch.	565	Max. Disch.	850	Max. Disch.	107
Min. Disch.	77	Min. Disch.	43	Min. Disch.	47	Min. Disch.	101	Min. Disch.	104	Min. Disch.	49
Runoff (cfsm)	1.28	Runoff (cfsm)	1.30	Runoff (cfsm)	2.67	Runoff (cfsm)	2.50	Runoff (cfsm)	2.79	Runoff (cfsm)	0.84
Runoff (in)	1.45	Runoff (in)	1.47	Runoff (in)	3.02	Runoff (in)	2.83	Runoff (in)	3.16	Runoff (in)	0.96
Peak Rec.	7.43 ft	Peak Disch.	2,600 cfs	Date	27-Jul						
Min. Rec.	2.06 ft	Min. Disch.	41 cfs	Date	24-Jun						

Gage operated May 23–Oct 2.

Estimated period: May 1–22, Oct 3–31

Table A-20. 2004 mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun	385	1-Jul	37	1-Aug	282	1-Sep	53	1-Oct	56
2-Jun	93	2-Jul	38	2-Aug	237	2-Sep	76	2-Oct	49
3-Jun	79	3-Jul	39	3-Aug	146	3-Sep	77	3-Oct	44
4-Jun	68	4-Jul	39	4-Aug	112	4-Sep	70	4-Oct	39
5-Jun	60	5-Jul	39	5-Aug	92	5-Sep	64	5-Oct	34
6-Jun	58	6-Jul	41	6-Aug	80	6-Sep	59	6-Oct	33
7-Jun	78	7-Jul	40	7-Aug	73	7-Sep	56	7-Oct	33
8-Jun	66	8-Jul	38	8-Aug	68	8-Sep	56	8-Oct	32
9-Jun	57	9-Jul	38	9-Aug	64	9-Sep	54	9-Oct	32
10-Jun	51	10-Jul	39	10-Aug	63	10-Sep	53	10-Oct	31
11-Jun	48	11-Jul	38	11-Aug	62	11-Sep	52	11-Oct	31
12-Jun	45	12-Jul	37	12-Aug	64	12-Sep	50	12-Oct	30
13-Jun	44	13-Jul	36	13-Aug	62	13-Sep	49	13-Oct	30
14-Jun	42	14-Jul	36	14-Aug	61	14-Sep	48	14-Oct	29
15-Jun	43	15-Jul	36	15-Aug	61	15-Sep	47	15-Oct	29
16-Jun	42	16-Jul	37	16-Aug	60	16-Sep	45	16-Oct	28
17-Jun	41	17-Jul	36	17-Aug	60	17-Sep	44	17-Oct	28
18-Jun	40	18-Jul	35	18-Aug	61	18-Sep	43	18-Oct	27
19-Jun	40	19-Jul	35	19-Aug	60	19-Sep	43	19-Oct	27
20-Jun	39	20-Jul	38	20-Aug	60	20-Sep	44	20-Oct	26
21-Jun	39	21-Jul	40	21-Aug	60	21-Sep	49	21-Oct	26
22-Jun	38	22-Jul	39	22-Aug	61	22-Sep	47	22-Oct	25
23-Jun	37	23-Jul	44	23-Aug	61	23-Sep	48	23-Oct	25
24-Jun	38	24-Jul	64	24-Aug	60	24-Sep	47	24-Oct	24
25-Jun	39	25-Jul	61	25-Aug	59	25-Sep	45	25-Oct	24
26-Jun	39	26-Jul	66	26-Aug	57	26-Sep	46	26-Oct	23
27-Jun	39	27-Jul	56	27-Aug	57	27-Sep	55	27-Oct	23
28-Jun	41	28-Jul	50	28-Aug	56	28-Sep	50	28-Oct	22
29-Jun	40	29-Jul	48	29-Aug	55	29-Sep	46	29-Oct	22
30-Jun	38	30-Jul	81	30-Aug	54	30-Sep	48	30-Oct	21
		31-Jul	175	31-Aug	53			31-Oct	21
Mean Discharge	60	Mean Discharge	48	Mean Discharge	79	Mean Discharge	52	Mean Discharge	30
Max. Discharge	385	Max. Discharge	175	Max. Discharge	282	Max. Discharge	77	Max. Discharge	56
Min. Discharge	37	Min. Discharge	35	Min. Discharge	53	Min. Discharge	43	Min. Discharge	21
Runoff (cfsm)	0.66	Runoff (cfsm)	0.52	Runoff (cfsm)	0.87	Runoff (cfsm)	0.57	Runoff (cfsm)	0.33
Runoff (in)	0.75	Runoff (in)	0.59	Runoff (in)	0.99	Runoff (in)	0.65	Runoff (in)	0.38
Peak Recorded	4.05 ft	Peak Discharge	504 cfs	Date 1-Jun					
Min. Recorded	1.71 ft	Min. Discharge	34 cfs	Date 19-Jul					
Discharge	781 cfs	Date	31-May	(Annual Peak determined from floodmarks)					

Gage operated June 1–Oct 5 / Ice Effect: Oct 3–5. Estimated period: Oct 3–31

Table A-21. 2005 mean daily discharge (cfs) for Nome Creek above Ophir Creek

Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.	Date	Disch.
1-May	231	1-Jun	373	1-Jul	716	1-Aug	135	1-Sep	126	1-Oct	138	1-Nov	46
2-May	223	2-Jun	486	2-Jul	1,048	2-Aug	142	2-Sep	110	2-Oct	130	2-Nov	45
3-May	218	3-Jun	277	3-Jul	715	3-Aug	141	3-Sep	104	3-Oct	123	3-Nov	44
4-May	211	4-Jun	237	4-Jul	398	4-Aug	135	4-Sep	103	4-Oct	113	4-Nov	43
5-May	198	5-Jun	213	5-Jul	358	5-Aug	145	5-Sep	101	5-Oct	108	5-Nov	42
6-May	184	6-Jun	175	6-Jul	267	6-Aug	156	6-Sep	97	6-Oct	106	6-Nov	41
7-May	174	7-Jun	154	7-Jul	308	7-Aug	149	7-Sep	96	7-Oct	103	7-Nov	40
8-May	175	8-Jun	142	8-Jul	293	8-Aug	140	8-Sep	122	8-Oct	98	8-Nov	39
9-May	195	9-Jun	135	9-Jul	300	9-Aug	134	9-Sep	117	9-Oct	93	9-Nov	38
10-May	231	10-Jun	130	10-Jul	402	10-Aug	129	10-Sep	118	10-Oct	93	10-Nov	37
11-May	231	11-Jun	127	11-Jul	346	11-Aug	124	11-Sep	114	11-Oct	92	11-Nov	36
12-May	211	12-Jun	140	12-Jul	286	12-Aug	118	12-Sep	106	12-Oct	91	12-Nov	35
13-May	193	13-Jun	143	13-Jul	276	13-Aug	116	13-Sep	103	13-Oct	90	13-Nov	34
14-May	205	14-Jun	132	14-Jul	250	14-Aug	113	14-Sep	104	14-Oct	90	14-Nov	33
15-May	206	15-Jun	125	15-Jul	223	15-Aug	108	15-Sep	103	15-Oct	89	15-Nov	32
16-May	212	16-Jun	120	16-Jul	205	16-Aug	104	16-Sep	101	16-Oct	88	16-Nov	31
17-May	226	17-Jun	202	17-Jul	213	17-Aug	101	17-Sep	96	17-Oct	87	17-Nov	30
18-May	219	18-Jun	162	18-Jul	376	18-Aug	98	18-Sep	96	18-Oct	86	18-Nov	29
19-May	390	19-Jun	146	19-Jul	690	19-Aug	93	19-Sep	93	19-Oct	83	19-Nov	29
20-May	264	20-Jun	159	20-Jul	333	20-Aug	89	20-Sep	91	20-Oct	80	20-Nov	28
21-May	201	21-Jun	145	21-Jul	240	21-Aug	90	21-Sep	100	21-Oct	77	21-Nov	27
22-May	167	22-Jun	133	22-Jul	203	22-Aug	91	22-Sep	113	22-Oct	75	22-Nov	26
23-May	143	23-Jun	130	23-Jul	180	23-Aug	89	23-Sep	160	23-Oct	72	23-Nov	26
24-May	134	24-Jun	116	24-Jul	167	24-Aug	93	24-Sep	261	24-Oct	69	24-Nov	25
25-May	131	25-Jun	120	25-Jul	154	25-Aug	108	25-Sep	364	25-Oct	66	25-Nov	24
26-May	128	26-Jun	121	26-Jul	148	26-Aug	95	26-Sep	340	26-Oct	63	26-Nov	23
27-May	128	27-Jun	111	27-Jul	143	27-Aug	107	27-Sep	270	27-Oct	60	27-Nov	23
28-May	134	28-Jun	105	28-Jul	137	28-Aug	115	28-Sep	203	28-Oct	57	28-Nov	22
29-May	127	29-Jun	99	29-Jul	130	29-Aug	117	29-Sep	166	29-Oct	55	29-Nov	21
30-May	127	30-Jun	97	30-Jul	129	30-Aug	122	30-Sep	148	30-Oct	52	30-Nov	20
31-May	125			31-Jul	131	31-Aug	122			31-Oct	49		
Mean Disch.	192	Mean Disch.	165	Mean Disch.	315	Mean Disch.	117	Mean Disch.	141	Mean Disch.	86	Mean Disch.	32
Max. Disch.	388	Max. Disch.	486	Max. Disch.	1,048	Max. Disch.	156	Max. Disch.	364	Max. Disch.	138	Max. Disch.	46
Min. Disch.	125	Min. Disch.	97	Min. Disch.	129	Min. Disch.	89	Min. Disch.	91	Min. Disch.	49	Min. Disch.	20
Runoff (cfsm)	2.11	Runoff (cfsm)	1.81	Runoff (cfsm)	3.46	Runoff (cfsm)	1.28	Runoff (cfsm)	1.55	Runoff (cfsm)	1.02	Runoff (cfsm)	1.02
Runoff (in)	2.39	Runoff (in)	2.05	Runoff (in)	3.92	Runoff (in)	1.45	Runoff (in)	1.75	Runoff (in)	1.15	Runoff (in)	1.15
Peak Recorded	6.3 ft	Peak Disch.	1,697 cfs	Date	2-Jul								
Min. Recorded	2.28 ft	Min. Disch.	86 cfs	Date	20-Aug								

Gage operated: May 24–Oct 9.

Estimated period: May 1–23, Oct 10–Nov 30.

Moose Creek above the Nome Creek Road

Figure A-9. Looking downstream at the crest-stage gage reach for Moose Creek above the Nome Creek Road. The gage reach was selected and surveys were begun in 1996. Gaging continues to the present. The hydrologist is marking the cork line for measurement on the gage stick.

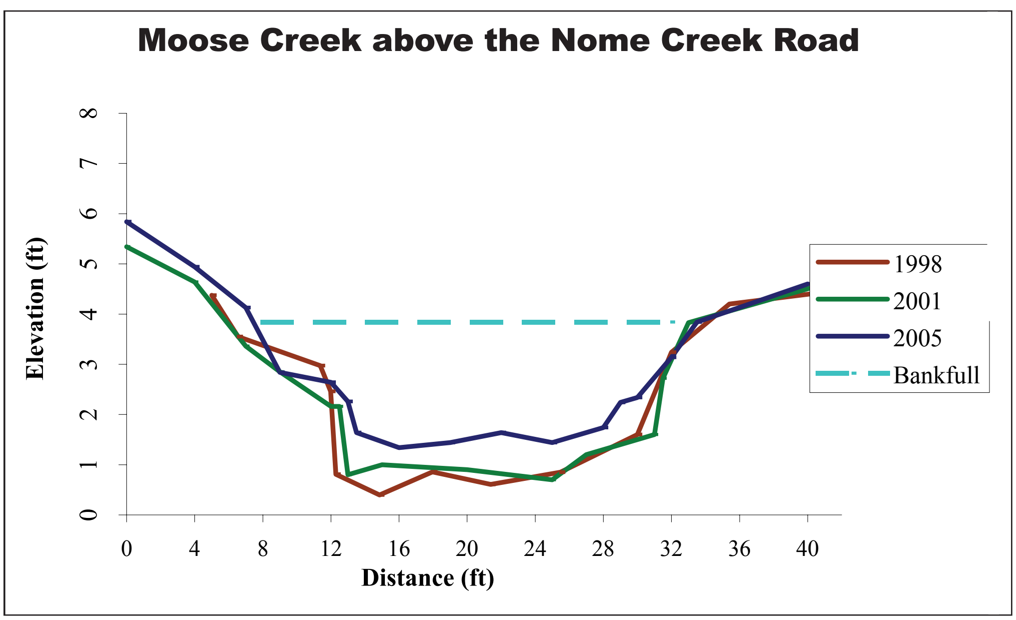

Figure A-10. Cross-sectional surveys for Moose Creek above the Nome Creek Road. This reach, which is upstream of any mining, had a fairly stable channel until high-water events in 2000 and 2003. This could be due to forest fires that occurred in the basin during the early 1990s. These fires likely initiated thermokarst erosion in the headwaters.

Table A-22. Discharge measurement summary for Moose Creek

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Velocity (fps)	Avg.Depth (ft)
6/14/1995	ND*	10	12	5.4	1.9	0.5
8/8/1995	ND*	13	16	14	0.9	0.9
8/28/1995	ND*	22	20	12	1.8	0.6
8/29/1996	2.0	11	18	7.3	1.5	0.4
8/28/1997	2.0	11	20	7.3	1.5	0.4
7/21/1998	2.0	11	20	8.4	1.3	0.4
8/13/1998	2.52	28	19	17	1.6	0.9
8/17/1998	3.22	103	21	32	3.2	1.5
8/8/1999	2.70	55	21	25	2.2	1.2
7/31/2001	1.61	16	18	14	1.1	0.8
7/15/2003	2.11	58	23	23	2.5	1.0
6/1/2005	2.55	97	22	29	3.3	1.3
9/22/2005	2.24	16	13	10	1.6	0.8

ND* = Not Determined (measurement at different site downstream of current gage)

Table A-23. Annual peak discharge and recurrence interval for Moose Creek floods

Date	Stage (ft)	Discharge (cfs)	Rank	Recurrence Interval (yrs)
1996	2.95	87	9	1.2
1997	2.97	96	8	1.2
1998	3.55	190	4	2.9
1999	3.30	140	5	1.8
2000	4.20	360	1	15
2001	2.85	131	7	1.6
2002	2.35	79	10	1.1
2003	3.73	274	3	6.7
2004	2.88	135	6	1.7
2005	4.13	300	2	8.5

Appendix B. Rainfall Data for Nome Creek

Table B-1. Monthly rainfall (inches) at Nome Creek above Sumner Creek CSG site

Year	June	July	Aug	Sep	Summer
1998	1.4	1.4	4.9	0.9	8.5
1999	1.5	3.2	4.2	1.6	10.3
2000	1.5	2.2	7.4	2.0	13.0
2001	1.3	4.7	3.8	0.7	10.5
2002	0.8	5	4.3	2.4	12.5
2003	1.5	7.6	5.6	1.3	15.9
2004	0.2	1.2	2.9	1.0	5.2
2005	2.0	5.5	2.1	2.3	11.8
Averages	1.3	3.8	4.4	1.5	11.0

Partial months estimated from Fairbanks Weather Bureau data

Table B-2. 2004 precipitation summary (inches) for Nome Creek above Ophir Creek rain gauge

Date	Precipitation	Date	Precipitation	Date	Precipitation	Date	Precipitation
1-Jun	0	1-Jul	0	1-Aug	0.39	1-Sep	0.12
2-Jun	0	2-Jul	0	2-Aug	0	2-Sep	0.11
3-Jun	0	3-Jul	0	3-Aug	0	3-Sep	0
4-Jun	0	4-Jul	0	4-Aug	0	4-Sep	0
5-Jun	0	5-Jul	0.06	5-Aug	0	5-Sep	0
6-Jun	0	6-Jul	0.1	6-Aug	0	6-Sep	0.01
7-Jun	0	7-Jul	0	7-Aug	0	7-Sep	0
8-Jun	0.01	8-Jul	0	8-Aug	0	8-Sep	0
9-Jun	0.04	9-Jul	0.02	9-Aug	0	9-Sep	0
10-Jun	0	10-Jul	0.05	10-Aug	0	10-Sep	0
11-Jun	0	11-Jul	0	11-Aug	0	11-Sep	0
12-Jun	0	12-Jul	0	12-Aug	0	12-Sep	0
13-Jun	0.07	13-Jul	0	13-Aug	0	13-Sep	0
14-Jun	0.12	14-Jul	0	14-Aug	0	14-Sep	0
15-Jun	0.03	15-Jul	0	15-Aug	0	15-Sep	0
16-Jun	0	16-Jul	0	16-Aug	0	16-Sep	0
17-Jun	0	17-Jul	0	17-Aug	0	17-Sep	0
18-Jun	0	18-Jul	0	18-Aug	0	18-Sep	0
19-Jun	0	19-Jul	0	19-Aug	0	19-Sep	0
20-Jun	0	20-Jul	0	20-Aug	0	20-Sep	0.1
21-Jun	0	21-Jul	0.01	21-Aug	0	21-Sep	0.09
22-Jun	0	22-Jul	0.02	22-Aug	0	22-Sep	0
23-Jun	0	23-Jul	0.35	23-Aug	0	23-Sep	0.09
24-Jun	0	24-Jul	0	24-Aug	0	24-Sep	0
25-Jun	0	25-Jul	0.02	25-Aug	0	25-Sep	0
26-Jun	0.06	26-Jul	0	26-Aug	0	26-Sep	0.27
27-Jun	0	27-Jul	0	27-Aug	0	27-Sep	0
28-Jun	0	28-Jul	0	28-Aug	0	28-Sep	0
29-Jun	0	29-Jul	0.19	29-Aug	0	29-Sep	0
30-Jun	0	30-Jul	0.41	30-Aug	0	30-Sep	0
		31-Jul	0.18	31-Aug	0		
Monthly	0.33	Monthly	1.41	Monthly	0.39	Monthly	0.79
Total Precip.	2.92						

Table B-3. 2005 precipitation summary (inches) for Nome Creek above Ophir Creek rain gauge

Date	Precipitation	Date	Precipitation	Date	Precipitation	Date	Precipitation
1-Jun	0.01	1-Jul	0.71	1-Aug	0.11	1-Sep	0
2-Jun	0.03	2-Jul	0.21	2-Aug	0.08	2-Sep	0
3-Jun	0.29	3-Jul	0	3-Aug	0	3-Sep	0.02
4-Jun	0.11	4-Jul	0.21	4-Aug	0.01	4-Sep	0.06
5-Jun	0	5-Jul	0.02	5-Aug	0.01	5-Sep	0.02
6-Jun	0	6-Jul	0.2	6-Aug	0.28	6-Sep	0.01
7-Jun	0	7-Jul	0.27	7-Aug	0	7-Sep	0.16
8-Jun	0	8-Jul	0.04	8-Aug	0	8-Sep	0
9-Jun	0	9-Jul	0.33	9-Aug	0	9-Sep	0.01
10-Jun	0	10-Jul	0.10	10-Aug	0	10-Sep	0.03
11-Jun	0.04	11-Jul	0.03	11-Aug	0	11-Sep	0
12-Jun	0.26	12-Jul	0.03	12-Aug	0	12-Sep	0.01
13-Jun	0	13-Jul	0.11	13-Aug	0	13-Sep	0
14-Jun	0	14-Jul	0	14-Aug	0	14-Sep	0.05
15-Jun	0	15-Jul	0	15-Aug	0	15-Sep	0
16-Jun	0.41	16-Jul	0.04	16-Aug	0	16-Sep	0
17-Jun	0.05	17-Jul	0.11	17-Aug	0	17-Sep	0.01
18-Jun	0	18-Jul	0.35	18-Aug	0	18-Sep	0.05
19-Jun	0.26	19-Jul	0	19-Aug	0	19-Sep	0
20-Jun	0.02	20-Jul	0	20-Aug	0	20-Sep	0.12
21-Jun	0	21-Jul	0	21-Aug	0	21-Sep	0.01
22-Jun	0.17	22-Jul	0	22-Aug	0.01	22-Sep	0.14
23-Jun	0	23-Jul	0	23-Aug	0	23-Sep	0.23
24-Jun	0	24-Jul	0	24-Aug	0.18	24-Sep	0.26
25-Jun	0.12	25-Jul	0	25-Aug	0	25-Sep	0.18
26-Jun	0	26-Jul	0	26-Aug	0	26-Sep	0.12
27-Jun	0	27-Jul	0	27-Aug	0.11	27-Sep	0.01
28-Jun	0	28-Jul	0	28-Aug	0	28-Sep	0
29-Jun	0	29-Jul	0.01	29-Aug	0.17	29-Sep	0
30-Jun	0	30-Jul	0	30-Aug	0.15	30-Sep	0.01
	0.71	31-Jul	0.09	31-Aug	0.12		
Monthly	2.48	Monthly	2.86	Monthly	1.23	Monthly	1.51
Total Precip.	8.08						

Appendix C. Nome Creek Reclamation Project—Revegetation Report

Brian A Bogaczyk, Steese-White Mountains District Botanist
13 January 1994

Introduction

Nome Creek is a tributary of Beaver Creek National Wild and Scenic River, located in BLM's White Mountains National Recreation Area (WMNRA). Upper portions of Nome Creek were illegally mined in the early 1980s, and abandoned in an unreclaimed state. Because of its proximity to Beaver Creek's Wild and Scenic River Corridor, its accessibility, and plans to develop the site as a campground/boat launch, BLM's Steese/White Mountains District (SWMD) [now the Eastern Interior Field Office] has been attempting to reclaim parts of the valley that are no longer open to mineral entry. During 1991 and 1992 SWMD's Soil, Water and Air Program let heavy equipment contracts for consolidating and reconfiguring the stream channel and recontouring tailings piles in upper Nome Creek (above Pavey's claim).

In 1992, SWMD Fisheries organized willow cutting and planting into reclaimed areas along the creek. Approximately 2000 cuttings were placed in the gravel on 28 June 1992. In 1993, the SWMD hydrologist and botanist organized willow cutting and planting into areas recontoured in 1992. In addition, grasses were seeded in 3.0 acres of recontoured terrain.

Methods

Preparatory to the 1992 willow planting, District personnel harvested dormant felt-leaf willow (*Salix alaxensis*) cuttings. Cuttings were obtained in late winter (mid-April) before sap began to rise, and were approximately 12 inches long, and 2 yrs or older growth. Ten BLM employees invested about 6 hours (60 work hours) gathering cuttings. The previous summer's growth is not desirable when planting cuttings because the buds are not as likely to be viable as buds on older stems. Cuttings were stored in freezers until 28 June 1992, when they were taken to the site and planted into the gravel using a dibble. Substrate in the reclamation area consists of fine to coarse gravel, with occasional cobbles and boulders. Much of the topsoil has been washed downstream by mining operations, though some areas have ample topsoil integrated with the coarse material for colonization by willows and forbs. All planting was done into areas that had been recontoured in 1991, immediately upstream of Pavey's claim boundary, along the south and north banks. Planting areas were selected based on distance to groundwater and presence of above-surface seeps. Ideally, cuttings were planted so that about 75% of the cutting was below ground (about 8") with 1 to 2 viable buds above the surface. Also, 8 to 12 willow cuttings were lashed together with twine and anchored into the stream bank using large boulders to provide microsites protected from flooding and spring ice jams. Two BLM employees and about 6 student volunteers invested about 6 hours (48 work hours) planting the site.

On 11 June 1993, felt-leaf willow cuttings were harvested green, on-site, on the same day as planting. Cuttings were approximately 12 inches long and were 2 yrs or older growth. Planting was done into areas recontoured in 1991 and 1992, entirely on the south bank, extending from near Pavey's claim boundary upstream to the grass seeding area. Planting sites were selected based on wetness of site through the growing season. Ideally, sites with seeps and permafrost drains were selected. As before, about 75% of the cutting was placed below ground, and 1 to 2 viable buds remained above ground. To reduce water loss by evapotranspiration, most of the green leaves were stripped off willow cuttings after planting. A crew of three BLM employees and nine student volunteers spent about 4 hours planting the site.

On 24 June 1993, an approximately 3.0-acre area, located at the upstream extent of disturbance and south of the creek, was seeded with 70% Arctared red fescue (*Festuca rubra*, $2.43/lb.) 20% Bering hairgrass (*Deschampsia caespitosa*, $13.64/lb.)) and 10% lbs annual ryegrass (*Lolium multiflorum*, $0.75/lb.). Seed was purchased from Alaska Feed in Fairbanks; total cost, including mixing and bagging was $940. Fertilizer (50% of 10-20-20 and 50% of 10-10-20) was available from a 1988 and 1989 revegetation project in SWMD. Fertilizer was broadcast concurrently with seeding. Hand broadcasting mills were used to distribute seed and fertilizer. Two BLM employees and two volunteers took about 5 hours, or 20 work hours, to seed and fertilize the site.

On 25 August 1993 a transect was established in the grass seeding area on a bearing of 046°. Twenty-two 1 m^2 plots were established at 10 m intervals along the transect. The percent cover of the following were estimated:

- rock (areas with only rock as substrate, therefore no growing site available)
- grass
- exposed bare ground (area capable of supporting plant growth, but isn't)
- forbs
- mosses/liverworts
- willow
- exposed rock (rock visible through grasses and other vegetation when looking down at plot)
- other plant species

Also on 25 August, six 5 m x 5 m plots in the 1992 and 1993 willow planting areas, respectively (12 plots total) were examined. Within each plot, the number of willow cuttings planted, number alive, and number of volunteer plants present were quantified. Finally a 30 m transect on the stream bank was established to quantify survival of willow bundles.

Results and Discussion

In 1992 approximately 2000 cuttings were planted upstream of the boundary of Pavey's claim, on both banks of the creek. Most planting was within 200–300 m of Pavey's claim boundary. About 24 willow bundles were planted and armored into the bank. Table C-1 contains survival data, gathered on 25 August 1993, from six 5 m x 5 m plots randomly located in the 1992 planting areas. Mean survival was 90% (n=46); median and mode survival were 100%. Also on 25 August 1993, a 30 m transect was established to assess survival of willows that had been armored into the bank. Nine willow bundles were encountered along the transect, and all nine were alive and doing well, though it is possible that some were washed out and therefore not sampled. Nome Creek experienced relatively low flows in the spring of 1993. If there had been a large spring flood, these bundles would have undoubtedly been washed out. This may yet happen if upcoming runoff events are excessive.

Table C-1. Number of cuttings alive, dead, total number, percent survival of cuttings and approximate number of volunteer willows, per 5 m x 5 m plot in 1992 willow planting area. Mean survival was 90% (n = 46), median and mode survival were 100%, st. dev. = 15%.

Plot #	# Alive	# Dead	Total	% Survival	Volunteer Willows
1	4	1	5	80	20
2	11	0	11	100	50
3	3	0	3	100	100
4	4	0	4	100	200
5	5	0	5	100	100
6	10	6	16	62.5	12

Table C-2. Number of willow cuttings alive, dead, marginally alive, total number, and percent survival of cuttings, per 5 m x 5 m plot in 1993 willow planting area. Mean percent survival was 87% (n = 51), median = 95%, mode = 100%, st. dev. = 17%.

Plot #	# Alive	# Dead	# Marginal	Total	% Survival
1	9	1	0	10	90
2	3	0	0	3	100
3	11	0	0	11	100
4	6	3	1	10	60
5	6	0	0	6	100
6	11	2	1	11	73

Figure C-1. Upstream portion of the reclaimed area, showing extensive establishment of grass in 1993 on what became known as the "field of dreams." Most of this grass was dead or dying by 1996.

Though most of the willows planted in 1992 were still alive, there was great variation in growth of individual cuttings. Some appeared to be just holding their own, most put on 2–3 inches of new leaders, and a few had leaders 12 inches or more in length.

In 1988 and 1989, SWMD fisheries biologist Lou Carufel planted several dozen felt-leaf willow cuttings on some tailings piles on the north bank of Nome Creek near where Quartz Creek Trail ascends the hill. I visited these plantings in 1993 and noted their survival and growth. It appeared that about half the cuttings were still alive, but most were quite small, i.e. less than 3 ft, and had not developed growth forms comparable to willows that have colonized the site naturally. The site had been invaded by hundreds of volunteer felt-leaf willow, and these individuals were 4–7 ft tall and had far more mass. I concluded that given the number and vigor of volunteer willows present, planting willows appeared to be ineffective in hastening the outcome of revegetation at this site. Our study plots in willow planting areas on upper Nome Creek (Tables C-1 and C-2) contained numerous volunteer willows, forbs and grasses. I suspect that by summer 1995 natural revegetation processes will have far outstripped the willows we planted in 1992 and 1993.

In 1993 approx. 1250 cuttings were planted along the stream, on both north and south banks. Planted areas extended upstream from 1992 plantings all the way to the upper extent of mining disturbance on Nome Creek. After 2 years of willow planting (summers of 1992 and 1993), it appears that all seeps and permafrost drains in the reclaimed area have been planted with willows at about 2 m x 2 m spacing (highly variable). Table C-2 contains data from six 5 m x 5 m plots randomly located in the 1993 planting areas. Mean survival was 87% (n=51).

Three acres of grasses were seeded at the upper limit of the reclamation area, on the south bank of Nome Creek. The intended rate of seeding was 42 lbs/acre, but the initial acreage estimate was too high, which resulted in a seeding rate of 55 lbs/acre (38.5 lbs Arctared red fescue, 11 lbs Bering hairgrass and 5.5 lbs annual ryegrass /acre). Fertilizer application (50% 20-20-10 and 50% 20-10-10) was about 400 lbs/acre. Seeding and fertilizing rates appeared to be very dense. Shortly after seeding, a slow rain shower began and lasted for several hours. Germination occurred about a week after seeding, and precipitation events were frequent and adequate for seedling growth for the rest of the summer. Fortuitous precipitation undoubtedly aided the success of this seeding as well as the willow planting. An unusually dry summer, and resultant moisture stress, would have probably killed the grass and willow cuttings before they could develop adequate rootstock. In retrospect, the seeding rate was probably excessive, and the resultant dense growth of vegetation could serve to impede the course of natural revegetation by forming a ground cover that usurps all accept-

Table C-3. Percent coverage of rock, grass, exposed bare ground, forbs, mosses and liverworts, willow, exposed rock, and other in 22 1 m^2 plots along transect (046°) in grass seeded area, Nome Creek, August 23, 1993.

Plot #	Rock	Grass	X.B. Gnd.	Forbs	Moss/Lv	Willow	X. Rock	Other
1	70	40	10	0	0	1	0	0
2	6	90	10	0	10	0	0	0
3	10	80	13	0	2	0	0	0
4	7	91	5	0	1	0	4	0
5	12	65	20	0	6	0	9	0
6	1	85	13	3	5	0	0	1
7	13	80	2	13	10	4	4	0
8	8	90	7	0	25	1	4	1
9	15	60	25	0	5	0	10	0
10	10	98	2	0	5	0	1	1
11	9	95	6	0	4	0	3	0
12	5	90	7	4	20	0	2	3
13	10	85	10	0	25	0	4	1
14	11	50	40	0	1	0	10	1
15	85	10	10	0	0	0	80	0
16	90	7	5	0	0	0	88	0
17	75	20	12	2	0	0	70	0
18	85	20	5	0	0	0	80	0
19	35	80	12	0	7	0	7	0
20	8	90	4	3	15	1	2	0
21	10	85	10	2	12	1	4	0
22	2	90	5	1	12	2	1	0
Mean	26.3	68.2	10.6	1.3	7.5	0.45	17.4	0.36
ST ERR	6.7	6.4	1.8	0.61	1.7	0.20	6.4	0.15
Median	10	82.5	10	0	5	0	4	0
Mode	10	90	10	0	0	0	4	0
ST DEV	31.3	29.9	8.6	2.9	7.9	1.0	30.2	0.73

X.B. Gnd. = exposed bare ground
Moss/Lv = mosses and liverworts
X. Rock = exposed rock

able growing sites and moisture. Table C-3 describes results of a transect established to quantify composition of the grass seeding area. Data were gathered on 25 August, which corresponded with onset of early fall. Most deciduous leaves were turning color and several light frosts had occurred.

Figure C-1 shows the upstream portion of the reclamation area, including where grasses were seeded. Aerial photography was flown in September 1993, after recontouring and stream placement were completed. Snow was on the ground, but the stream had not yet frozen.

1996 Field Evaluation

by Jim Herriges, Steese-White Mountains Wildlife Biologist

November 1996

Willow Planting

Most planted willows had been lost to flood scouring or dirtmoving with heavy equipment. The remainder continued to have high survival. Plants from cuttings continued to be, on average, larger than plants that had naturally seeded. However, the natural recolonizers were much more numerous. Good natural colonization occurred in most areas where willow cuttings were planted, which was largely in areas with some subsurface moisture. In an especially wet area (site of old bypass channel and settling pond), little natural colonization was evident, but vigor of planted cuttings was also low.

Some benefit from the planted cuttings can be seen (e.g., a few have trapped organic debris and some fines), but total cover of willows from planted cuttings is probably much lower than that of colonizing willows. Cuttings should be planted in a wider variety of conditions to determine if there are situations where planted cuttings will grow where natural seeding is not likely to occur.

Grass Seeding

Jim Sisk assisted in a quick assessment of plant cover in the seeded area. Seeded grasses had created a dense, tough sod. However, much of the grass was dead or dying. Live grass cover (predominantly red fescue and Bering hair grass, with small amounts of native *Calamagrostis* (bluejoint) averaged only 15%, while dead grass litter averaged 69%. Number and vigor of native species was low—there was never more than a trace of forb species and willow cover was more than 1% in only one of 17 plots. It appeared that few plants in the planting area had not already been present at the time of seeding.

In contrast, an adjacent area with some limited fines and topsoil that had not been seeded or fertilized was beginning to have significant grass and willow cover. Four 1 m^2 plots showed average live grass cover (*Calamagrostis* with some *Carex*) of 34%, as well as 9% willow and 37% rock. The number of plant species growing in these plots was higher than in the grass-seeded area.

Though no controls were designed into this work, these results suggest that, at these levels, grass-seeding and fertilizing can result in vegetative cover that will probably be effective in holding soil. However, it appears that recolonization of native species was significantly hampered. And the thatch of dead grass may hamper natural recolonization for some time. This may be acceptable in situations where risk of erosion of unvegetated topsoil is high. Additional applications of fertilizer might sustain the planted grasses in a vigorous state.

One portion of the seeded area apparently did not receive fertilizer. The seeded grasses established there, but did not reach the size or density that they did where fertilized. This left more space available for natural colonization and also apparently resulted in greater longevity of the introduced grasses, as the proportion of live to dead grass was high.

These results indicate that seeding and fertilizing at lower application rates should be tested as a means of promoting natural revegetation. Lower rates of seed or fertilizer might create a ground surface microclimate more suitable for plant growth without usurping all available colonization sites.

Fertilizer Trials

To test the hypothesis that fertilization alone will aid natural revegetation, Jon Kostohrys, Jim Herriges, and Evie Weithmann applied fertilizer to two areas of respread mine tailings—one with significant respread topsoil and the other with no organic matter or topsoil. Dirtwork had been conducted the previous summer. The areas were subdivided into strips for three treatments: high fertilizer level (approximately 388 lbs/acre), low fertilizer level (approximately 194 lbs/acre), and an unseeded control.

Revegetation of Area Scraped of Topsoil

We also inspected an area at the upper end of Nome Creek, which had been only scraped sometime before 1990. Plant cover was very high, with good diversity and good willow growth. In areas where topsoil is not available for respreading for reclamation, we might want to consider scraping topsoil/organic matter from an adjacent un-mined site and spreading it over the recontoured area.